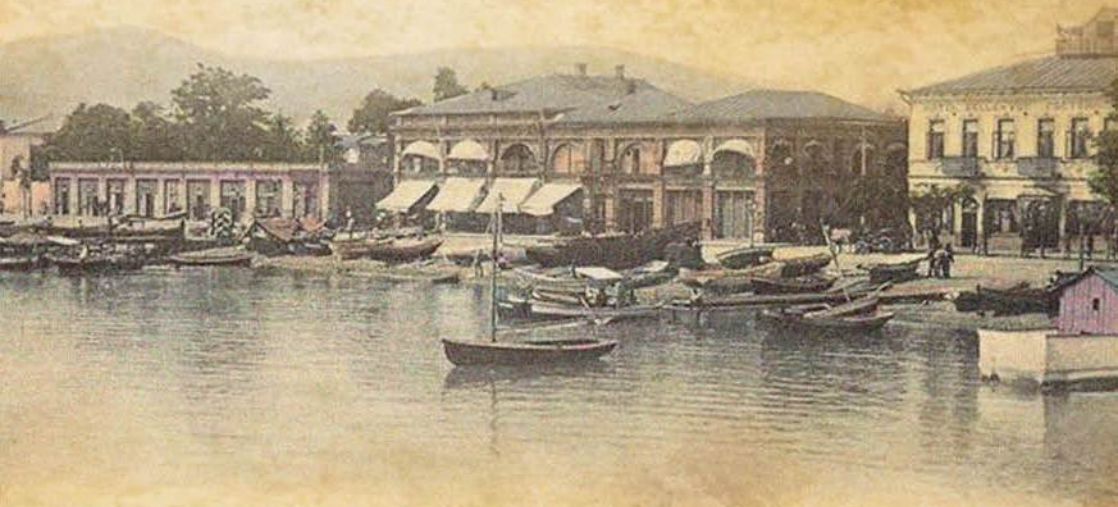
Ministry of Environment and Natural Resources Protection of Georgia

Empowered lives.
Resilient nations.



CLIMATE CHANGE STRATEGY OF AJARA

CLIMATE CHANGE STRATEGY OF AJARA

In preparation of the present Report large group of experts were involved representing: Ministry of Environment and Natural Resources Protection of Georgia; Ministry of Agriculture of Georgia; Ministry of Energy of Georgia; Ministry of Economy and Sustainable Development of Georgia; Ministry of Labor, Health and Social Affairs of Georgia; Ministry of Regional Development and Infrastructure of Georgia; Ministry of Education and Science of Georgia; Separate academic institutions; Ajara Environment Protection and Natural Resources Administration, Batumi Municipality; Ajara Municipalities; National experts and NGO representatives. A special desert in the preparation of this document is credited to the UNDP Georgia for assisting the Georgian Government in preparation of the Report.

ABBREVIATIONS

AR.	Autonomous Republic
ADB	Asian Development Bank
BAU	Business as Usual
C	Carbon
CDM	Clean Development Mechanism
CENN	Caucasus Environmental Non-Governmental Network
CH_4	Methane
CO	Carbon oxide
CO_2	Carbon dioxide
CoM	Covenant of Mayors
CVDs	Cardio-vascular diseases
EBRD	European Bank for Reconstruction and Development
EEEF	European Energy Efficiency Fund
ELENA	European Local Energy Assistance
EU	European Union
FAO	Food and Agriculture Organization
GCM	Global Climate Model
GDP	Cross Domestic Product
Gg	Gigagram (10^3 tons)
GHG	Greenhouse gas
GPG	Good Practice Guideline
GIZ	German Agency for International Cooperation
GW	Gigawatt (10^9 W= 1 million KW)
HI	Heat Index
HPP	Hydro power plant
IEE	Institute of electrical engineers
IPCC	Intergovernmental Panel on Climate Change
JESSICA	Joint European Support for Sustainable Investment in City Areas
JICA	Japan International Cooperation Agency
KfW	German Reconstruction Credit Bank
LEPL	Legal Entity of Public Low
LULUCF	Land Use, Land-Use Change and Forestry
MW	Megawatt (10^6 W)
NMVOCs	Non-methane volatile organic compounds
REC	Regional Environmental Center
RH	Relative Humidity
SEAP	Sustainable Energy Action Plan
SIDA	Swedish International Development Agency
TCI	Tourism Climate Index
TJ	Terajoule (10^{12} Joule)
UNDP	United Nation Development Programme
UNEP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WB	World Bank
WHO	World Health Organization

CONTENT

FOREWORD

In accordance with the requirements of the UN Framework Convention on Climate Change, activities carried out in the country in regard to the climate change problem are occasionally summarized in the National Communications that are discussed and evaluated by the main governing body of the Convention at the annual meetings of the Parties. Following the national communications submitted by Georgia in 1999 and 2009, the country started working on the preparation of the Third National Communication in 2012, the significant part of which is dedicated to the study of climate change current impact on different sectors of economy and natural eco-systems in one of the unique regions of the country – in Ajara. The uniqueness of Ajara is specified by several factors, among which leading is that Ajara for the time being represents the only region in Georgia that is endowed with subtropical climate and relevant recreation resources possessing the huge potential for tourism development. Natural conditions in Ajara contribute to the development of multiple fields of agricultural sector, due to what Ajara can be considered as the specimen area for the development of both national priorities – tourism and agriculture; it can also be regarded as a strategic polygon, where the newest technologies should be introduced in order to reach the most ambitious targets.

One of the serious obstacles on its way to reaching these objectives is caused by the complicated natural conditions of Ajara that are expressed in intensive wash out of sea shores in the coastal zone, abundant precipitation and subsequent destructive extreme events – flash floods, landslides, mudflows and avalanches. The global warming process, due to which significant changes have started in climate of Ajara since the beginning of the current century, has intensified extreme events even more: permanent raising of the sea level and heavy storms create threat to the infrastructure of the coastal zone, flash- floods and landslides result in loss of land, destruction of buildings and the increase in the number of eco-migrants. Together with climate change, the anthropogenic impact on the environment also supports strengthening of the above processes that is caused due to the increase of population and economic activities.

Taking into consideration the above-mentioned circumstances, in the Third National Communication special attention is paid to the study of the current state of Ajara economy and natural ecosystems; definition of current climate change impact and the assessment of the expected changes in climate in the nearest decades using the models elaborated in the frame of the Second National Communication. Within the access of the statistical data, the GHG inventory at the regional level was carried out; possibilities of reduction of GHG emissions and adaptation measures were also considered; Ajara climate change strategy was prepared enabling other regions to conduct the same undertaking.

It should be highlighted, that within this “regional communication” up to 15 project

proposals were elaborated aiming at the implementation of specific actions to reduce climate change vulnerability in Ajara; as well as the reduction of GHG emissions from Ajara territory and strengthening the sinks. This report opens the door to the implementation of other environment protection projects needed for Ajara with the help of international donors and other sources.

Head of Directorate for Environment and Natural Resources of Ajara Autonomous Republic Mr. Vakhtang Tsuladze

INTRODUCTION

With its unique physical-geographic conditions Ajara holds distinguished place among other regions of Georgia. Strong humid subtropical climate, started with seaside beaches and swampy lowlands and finished with Alpine meadows – a set of diverse landscapes, rich water and forest resources, almost evenly distributed resorts and other resort-related places throughout the whole territory of the region - the wealth concentrated in a relatively small area results in a growing interest towards the economy and natural ecosystems of Ajara.

The resort potential of Ajara was well estimated in the second half of 19th century, when its territory was included in co-called "Russian Riviera", which consists of Krimmer, Sochi and Georgian seaside. It is remarkable, that high precipitation somehow limited Ajara's resort potential, but on the other hand, it contributed to the spreading of valuable agriculture crops.

Regarding the relief, Ajara represents quite complicated system of mountains and valleys as a part of the western part of the Meskhetian ridge, which is divided by the main river of the region – Adjaristskali. Seaside at some places is quite wide and represents beaches (Batumi, Chaqvi, Kobuleti) and at some places borders to part of the steep Meskhetian ridge ("Mtsvane Kontskhi"). Coastal zone includes the low-lying regions and mountain slopes of up to 100-200 meters of altitude. Hilly relief in the east part in the range of 200-1 000 meters is turning into mountainous zone, which turns into higher zone of 1 000-2 000 altitude on Meskhetian, Arsiani and Shavshveti hills. The highest mountains of Ajara region (Kentchaula, Sakhornia, Khino, etc.) do not even reach 3 000 meters and they do not have a permanent snow shield. But at the same time, on the Goderdzi pass (2 015 meters) and on the hills of some other mountains the snow shield remains for 7-8 months. Mountains represent 80% of Ajara region, foothills – 15% and lowland – only 5% (2 900 km^2).

A 53 km of the seaside relief was significantly changed during the last century due to the sea level raise by 20 cm, construction of the Batumi Port, decreasing in inert material delivered by the Chorokhi River and strengthening the intensity of storm. This segment has lost 150 ha of territory washed out by the Black Sea.

Due to diversity of relief, climate in Ajara varies as well. Until 70-ies of past century mean annual temperature varied from 14.5^{0}C (Batumi) to 2.4^{0}C (Goderdzi pass). The sum of annual precipitation level was achieving 2 600 mm in lowlands and 1 500 mm in Alpine zones. From 1990, due to the impact of global warming, the climate of Ajara started changing. Particularly, in every climate zone, the number of which is achieving seven, increase in mean annual temperature by 0.2-0.3^{0}C was registered. According to that fact, it is projected that the temperature by 2050 will increase by 1.6-1.7^{0}C. The different picture was registered in variation of precipitation: in lowland and mountainous zones annual sum of precipitation increased by 16% when in Alpine zones it decreased by 15%. According to the future projection, the slight increase in precipitation is expected by the middle of current century.

The variety of relief and climate create high touristic-recreational potential of Ajara. There are officially registered 6 climate and climate-spa resorts and 27 resort places at the territory of the region, with altitude from 0 (Batumi, Kobuleti) to 1 850 meters (Beshumi, Jinali). The touristic potential of Ajara is strengthened by existence of four protected territories (in Kobuleti, Kintrishi, Mtirala and Machakhela), the total area of which is 39 035 ha and is itself 13.5% bigger than the whole area of the region. From this territory the most significant are the National Reserve of Kintrishi, founded in the middle of previous century, and the National Park of Mtirala which was opened in 2006. Those oasis of wild nature, which are very close to Kobuleti (25 km) and Batumi (12 km), are great attractions for many tourists. Due to the fact mentioned above and at the same time, due to the reconstruction of coastal zone facilities can be explained the fact, that the number of visitors in Ajara increased from 80 000 to one million during the past seven years.

In mountainous area of Ajara region the level of mean annual precipitation is 1 300 mm, but in western part of Mtirala Mountain it reaches 4 000 mm (1 334 mm). The high level of precipitation causes abundance of water resources, which is not yet used appropriately. Efficient utilization of technical potential of hydrological recourses of Ajara in addition to other renewable energy resources (wind, sun, biomass) would contribute to the energy independence of the region and its sustainable development despite the absence of fossil fuel.

As well as water resources, Ajara is rich with forests, which covers 60% of territory of the region. The composition of forests varies and includes up to 400 sorts of buses and trees, from which the most widely distributed are: Beech, chestnut, spruce, and fir. During the past half of the century different harmful diseases have started to distribute in the forests of Ajara region. As a result, 6.1% of forests are infected by harmful diseases. Very alarming is the increase in distribution of those diseases in such valuable sorts as are chestnut and boxwood.

In spreading of flora in Ajara, along with climate, contributes distribution of types of soil. From 11 soils registered in this region the most wide-spread are the following: alluvial and red soil (coastal area), gray (mountainous) and the mountain - meadow cord (alpine zone) soils. Last decades due to increase of heavy precipitation and utilization of agriculture lands, significant increase in water erosion of soil in Ajara is noticed, which covers 30-35% of arable lands.

Agricultural lands occupy only 25% of whole territory of Ajara region, from where the biggest part is situated on the slope of more than 10% of inclination. The situation is particularly alarming in sub-alpine zone, where due to active use of land cover by animals, lawn cover of the land was destroyed in many places. That is accompanied by the soil degradation, which is also contributed by cutting down forests. All those processes led to lower the upper limit of forests by 200-300 meters.

In spite of the shortage of agriculture lands, agriculture is quite multi-profile. Due to natural conditions, perennials hold the biggest area (22%) in planting lands after the pastures (51%), in which citrus and fruit dominate. According to agro-climatic

conditions, Ajara belongs to the extremely northern zone, which affects the production negatively and increase the chance of frost. In the current century as a result of global warming projected increase of the temperature by 3-4^{0}C will create better conditions for citrus production in Ajara region and at the same time, will create necessity of moving of agro-climatic zones. From other brunches of agriculture, production of potato is characterized with high production, which, unlike other industries, in recent years was able to fully satisfy local demand. The horticulture development has a high potential, along with development of tourism.

Besides agriculture and tourism, in the economic sector of Ajara reconstruction business and food industry are noticeable. The first one is directed towards the improvement of tourism infrastructure, and the second – to satisfy increasing demand of local and out of country demands. Transportation sector plays significant role in developing of economies. And at the same time, along with household industry, contributes to emission of greenhouse gases from Ajara.

In this document, based on the available sources, in the frames of the United Nations Framework Convention to Climate Change, in 2011 it was discussed for first time the emission of greenhouse gasses and absorption characteristics of Ajara territory. Based on this information, certain project proposals were elaborated connected to the mitigation; reduction of the emission of greenhouse gasses and increase of absorption of greenhouse gasses in sub-alpine zone.

Diverse ecosystems and development of economic sectors in Ajara are under threat of natural disasters, which were significantly increased in frequency and severity due to global warming. In coastal zone such are storms and permanent increase in sea level, which results in washing out of coastal area and destroying residential buildings and other infrastructure. For example, in March of 24, 2013, storm with magnitude of 6 destroyed many coast-protecting buildings in Batumi and Kobuleti, washed out beaches, flooded new boulevard, streets and squares of Batumi. Fortunately the severe wind was not followed by high precipitation, which could have resulted in additional destruction as a result of floods and landslides in coastal zone and mountainous areas. Above mentioned natural disasters tend to be repeated every year in different regions of Ajara, which sometimes is followed by avalanches as well. According to the information mentioned above, it is necessary to take in consideration the character of natural disasters during the planning of any sort of project, and importance of preventive measures. Based on those needs, in this document it is widely discussed the importance of elaborate project proposals on adaptation to climate change, which showed a necessity of deep analyses of related materials and statistics as well. Taking in consideration the huge development potential of Ajara, implementing of those projects may be a great start of sustainable development of the region.

1. GHG inventory in Ajara

1.1. Results of inventory

Under the Third National Communication of Georgia to the UNFCCC, the first attempt to generate disaggregated Greenhouse Gas (GHG) inventory has taken place for Ajara Autonomous Republic. Four inventory sectors have been assessed for this territory: energy, industrial processes, Land use, land use change and forestry, (LULUCF) and waste.

In 2011 in total 312.47 thousand tons of direct GHGs in CO_2 equivalent were emitted to the atmosphere from this region, however, the LULUCF sector contributed to the removal of 606.70 thousand tons of CO_2, resulting in the net removals of 294.23 thousand tons of CO_2 equivalent emissions from the whole territory.

Table 1.1 shows the CO_2 equivalent emissions of GHGs from the territory of Ajara for three main direct gases (the emissions of indirect GHGs are negligible and are presented in Table 1.2).

Table 1.1. Summary table of CO_2 equivalent emissions (in Gg) in 2011 from the territory of Ajara

Greenhouse gas source and sink categories	NET CO_2	CH_4	N_2O	Total
Total national emissions and removals	-394.35	87.29	12.83	-294.23
Energy	212.35	16.10	3.53	231.98
Fuel combustion (sectoral approach)	212.35	16.10	3.53	231.98
Energy industries	0.00	0.00	0.00	0.00
Transport	143.34	0.48	0.37	144.19
Other sectors (including manufacturing industries and construction)	69.01	15.62	3.16	87.79
Industrial processes	0.00	0.00	0.00	0.00
Minerals	0.00			0.00
Other production	0.00	0.00	0.00	0.00
Land-use change and forestry	-606.70	0.00	0.00	-606.70
Changes in forest and other woody biomass stocks	-734.70	0.00	0.00	-734.70
CO_2 emissions and removals from soil	128.00			128.00
Waste		71.19	9.30	80.49
Solid waste disposal on land		68.04		68.04
Waste-water handling		3.15	9.30	12.45
Memo items				
CO_2 emissions from biomass	266.15			266.15

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	312.47
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	-294.23

CO_2 is the largest contributor to emissions of Ajara AR with 76.3% share in total emissions, methane's share is 19.4% and N_2O has remaining 4.3%. Largest emitter is the energy sector, contributing 83.4% to total emissions without LULUCF.

Indirect GHGs are also emitted from the territory of Ajara. Table 1.2 shows anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors[1].

Table 1.2. Greenhouse gas emissions (in Gg) by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 removals	CH_4	N_2O	NOx	CO	NMVOCs	S0x
Total regional emissions and removals	**340.35**	**-734.70**	**4.16**	**0.04**	**1.77**	**20.21**	**3.04**	**0.00**
Energy	**212.35**	**0.00**	**0.77**	**0.01**	**1.77**	**20.21**	**2.97**	**0.00**
Fuel combustion (sectoral approach)	212.35		0.77	0.01	1.77	20.21	2.97	0.00
Transport	0.00		0.00	0.00	0.00	0.00	0.00	0.00
Other sectors (including manufacturing industries and construction)	143.34		0.02	0.00	1.44	7.91	1.50	0.00
Industrial processes	69.01		0.74	0.01	0.33	12.30	1.47	0.00
Minerals	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.00**
Other production	0.00				0.00	0.00	0.00	0.00
Land-use change and forestry	0.00		0.00	0.00	0.00	0.00	0.07	0.00
Changes in forest and other woody biomass stocks	**128**	**-735**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CO_2 emissions and removals from soil	0.00	-734.70						
Waste	128.00	0.00						
Solid waste disposal on land			**3.39**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**
Waste-water handling			3.24		0.00		0.00	
Memo items			0.15	0.03	0.00	0.00	0.00	
CO_2 emissions from biomass								

As in case of direct GHGs, the largest emitter of indirect GHG gasses is energy sector. Small amounts of these gasses are also emitted from industrial processes. Bellow each sector is discussed in detail.

1.2. Energy sector

Emissions from energy sector include emissions from fuel combustion activities (both stationary and mobile) (1A) and fugitive emissions (1B). Oil and gas extraction does not happen on the territory of Ajara. Fugitive emissions from fuels (oil terminals and gas distribution) were not assessed at this stage. Thus, in this section we consider only emissions from fossil fuel combustion.

[1] Precursor is compound, which resulted in physical or chemical processes affecting the concentration of greenhouse gases or aerosols. There is SOx in the follwoing table.

1.2.1. Sub-sector: Fuel combustion activities (1A)

General overview of the sub-sector

Energy sector in Ajara is notable for some specific features. In particular, in the subsector "Public electricity and heat production" (1A1a), it has been assumed, that as there are no thermal power plants and any significant heat generating utilities at the territory of Ajara, and the region is mainly provided with imported electricity, emission from this subsector could be considered as zero. In the "Fuel combustion" subsector only 3 source categories were considered: Residential (1A4b), Commercial (1A4a) and Road Transportation (1A3b).

Emissions from the sector

Data on fuel consumption in Ajara's energy sector in 2011 are presented in Table 1.3.

Table 1.3. Fuel consumption in Ajara's energy sector in 2011

Subsector	Natural gas, m^3	Gasoline, tons	Diesel fuel, tons	Kerosene, tons	LPG, tons	Firewood, Tons
Residential (1A4b)	11 443 518	0	0	990	7 830	325 000
Commercial (1A4a) (including industry)	7 432 158	0	1 506	450	398	1 950
Transportation (1A3b)	119 656	18 825 260	26 831 360	0	0	0
Total	18 995 332	18 825 260	28 337 460	1 440	8 223	326 950

These activity data from Table 1.3 are used to calculate GHG emissions by Ajara's energy sector in 2011 using the IPCC 1996 revised guidelines[2]. The following emission factors have been applied, selected for the conditions similar to Ajara (Table 1.4), quantities of fuel calorific value used in calculations are presented in Table 1.5:

Table 1.4. GHG emission factors used in different sub-sectors according to fuel types

GHG sources \ Fuel category	Nat. gas	Gasoline	Diesel fuel	Kerosene	LPG	Firewood
CO_2 emission factors (t/TJ), all source categories	15.3	18.9	20.2	21.1	17.2	
CH_4 emission factors (Kg/TJ)						
- Residential	5.0	10.0	10.0	10.0	10.0	300.0
- Commercial	5.0	10.0	10.0	10.0	10.0	300.0
- Transportation	50.0	20.0	5.0	-	-	-
N_2O emission factors (Kg/TJ), all sectors	0.1	0.6	0.6	0.6	0.6	4.0

[2] IPCC 1996 revised guideline. http://www.ipcc-nggip.iges.or.jp/

NOx emission factors (Kg/TJ)						
- Residential	50.0	100.0	100.0	100.0	100.0	100.0
- Commercial	50.0	100.0	100.0	100.0	100.0	100.0
- Transportation	600.0	600.0	800.0	-	-	-
CO emission factors (Kg/TJ)						
- Residential	50.0	20.0	20.0	20.0	20.0	5 000.0
- Commercial	50.0	20.0	20.0	20.0	20.0	5 000.0
- Transportation	400.0	8 000.0	1 000.0	-	-	-
NMVOCs emission factors (Kg/TJ)						
- Residential	5.0	5.0	5.0	5.0	5.0	600.0
- Commercial	5.0	5.0	5.0	5.0	5.0	600.0
- Transportation	5.0	1 500.0	200.0	-	-	-

Table 1.5. Net calorific values of fuel

Fuel	Calorific value (TJ/unit)
Natural gas, 10^6 m^3	33.70
Gasoline, 10^3 t	44.80
Diesel fuel, 10^3 t	43.33
Kerosene,10^3 t	40.19

As to other parameters used by methodology to calculate emissions, the fraction of carbon deposited in products was assumed to be zero, while standard values have been applied for the fraction of oxidized carbon: 0.995 for natural gas and 0.99 for oil products.

Using the activity data and emission factors provided in Table 1.4, the 2011 GHG emissions from Ajara energy sector were calculated according to subsectors (Table 1.6).

Table 1.6. GHG emissions (Gg) from Ajara energy sector in 2011

Source categories	CO_2	CH_4	N_2O	NOx	CO	NMVOCs
Residential (1A4b)	48.01	0.74	0.01	0.31	12.21	1.47
Commercial (including industry) (1A4a)	21.00	0.01	0.00	0.02	0.09	0.01
Transportation (1A3b)	143.34	0.02	0.00	1.44	7.91	1.50
Total	212.35	0.77	0.01	1.77	20.21	2.98

It is evident from this table that road transportation sector is the major contributor to CO_2 emissions from Ajara's territory (more than 67.5%) and it also has greatest share in NOx emissions.

1.3. Industrial processes

General overview of the sector

Until 1990-es a number of large industrial enterprises were functioning at the territory of Ajara, among them: oil refinery, shipbuilding, electro-technical, wood processing plants, tea processing, canning factories, etc. Nowadays, the industrial processes in Ajara are represented only by subsectors 2A "Mineral Products"/Asphalt Roofing (2A5) and 2D "Other products"/Food and Drink (2D2). Cement at the territory of Ajara is produced using imported clinker and hence, according to IPCC methodology, CO_2 emissions from its production are attributed to producing country. Owing to available data, the following activities have been examined in this sector: asphalt production (2A5), bread and confectionery baking, drying and grinding of wheat, roasting and grinding of coffee, beer brewing (2D2). Data on the amount of product for 2009-2011 are presented in Table 1.7.

Table 1.7. Products from industrial processes in Ajara (2009-2011)

Years \ Process	Asphalt production, t	Wheat processing, t	Baking, t	Coffee processing, t	Brewing, hl
2009	98 534.0	NA	2 870.2	395.6	20 000.0
2010	88 953.0	38 028.0	3 370.2	451.5	21 500.0
2011	72 073.0	6 610.0	5 779.2	380.9	20 000.0

Notes: NA data not available; hl-10[2] litre.

Emissions from the sector

The above-presented data were used to calculate GHG emissions from the sector 2 with Tier 1 method of IPCC 1996 revised Guideline. According to the methodology, only CO and NMVOCs are calculated from food and drink production process. The following values of emission factors were applied (Table 1.8).

Table 1.8. Emission factors used to calculate GHG emissions from industrial process in Ajara (Kg/t produce)

Process \ GHG	CO_2	CO	NMVOCs
2A5: Asphalt production	22.00	0.01	0.05
2D2: Food and drink production			
- Wheat processing			1.30
- Bread baking			10.00
- Coffee processing			0.55
- Brewing			0.35

On the basis of these data, the below-given amounts of GHG emissions have been obtained (Table 1.9.):

Table 1.9. GHG emissions (in Gg) from industrial processes in Ajara in 2009-2011

Process	Asphalt production			Wheat processing	Baking	Coffee processing	Brewing
GHG Year	CO_2	$CO10^{-3}$	NMVOCs 10^{-3}	NMVOCs 10^{-3}	NMVOCs 10^{-3}-	NMVOCs 10^{-3}-	NMVOCs 10^{-3}-
2009	2.168	0.990	0.490	NA	29.000	0.220	0.700
2010	1.960	0.890	0.450	49.000	34.000	0.250	0.800
2011	1.586	0.720	0.360	9.000	58.000	0.210	0.700

Although the CO_2 emissions were calculated according to the IPCC revised guidelines, they were not incorporated in the total emissions. Thus, the overall results of GHG emission calculations from industrial processes in Ajara are summarized in Table 1.10.

Table 1.10. Summary data on GHG emissions (Gg) from industrial processes in Ajara (2009-2011)

Subsector	Asphalt production (2A5)			Food and drinks (2D2)	Total from sector (2)		
GHG Year	CO_2 Gg	CO 10^{-3}	NMVOCs 10^{-3}	NMVOCs 10^{-3}	CO_2	CO 10^{-3}	NMVOCs 10^{-3}
2009	0.000	0.985		29.920			
2010	0.000						
2011	0.000		0.360				68.270

1.4. Land use, Land use change and Forestry (LULUCF)

General overview of the sector

Ajara is a typical mountainous region: 80% of its territory (2 900 km^2) is occupied by mountains, 15% - by foothills and 5% belongs to lowland. Only 25% of the total area is used in agriculture and about 65% of the territory is covered by forests. Areas under different land-use categories considered in Ajara's GHG inventory are given in Table 1.11[3].

Table 1.11. Areas under land-use categories in Ajara (2004)

#	Land-use categories	Area, ha	%
1	Forest lands (forests, parks, agroforestry lands and shrubs)	188 645.0	65.0
2	Arable land (cropland, perennials, meliorated lands and land with temporary fallow)	26 208.0	9.0
3	Pastures (pastures and hayfield)	44 918.0	15.6
4	Wetlands (marshes and aquatic areas)	4 047.0	1.4
5	Settlements (roads and buildings)	7 873.0	2.7
6	Other lands (barren and waste land)	18 309.0	6.3
	Total in Ajara	**290 000.0**	**100.0**

[3] Directorate for Environment and Natural Resources of Ajara A.R

As it comes from this Table, major part of GHG emissions/removals in Ajara's LULUCF sector is linked with forest lands.

Main features of Ajara's latest (2005) forest cadastre, used in GHG inventory for the LULUCF sector, are presented in Table 1.12[3].

Table 1.12. Data from Ajara forest cadastre

Forest types	Area, ha	Wood-stock 10^3 m^3	Increment (aboveground) $10^3 m^3$/yr	Increment (aboveground) per 1 ha, m^3/yr
Deciduous	143 506.0	333 715.0	336.2	2.3
Coniferous	45 139.0	16 735.0	171.7	3.8
Total	**188 645.0**	**501 065.0**	**507.9**	**2.7**

Emissions from the sector

Source category Forest Land (5A):

According to available data on the measurements of woody mass specific weight in Ajara, it has been derived that this value for the absolutely dry deciduous wood on the average is equal to 0.56 ton/m^3, and 0.43 ton/m^3 for the coniferous wood. Using these data and default values of other emission factors (Tier 1 approach) determined for climate conditions close to Ajara (temperate warm humid), it has been derived that for the period of 2000-2011 the average annual net uptake of carbon (C) in Ajara forests (considering subsequent losses) was equal to – 167.4 thousand t C/yr with relevant mean CO_2 absorption rate of 613. 8 Gg/yr. Corresponding average annual values of carbon (C) uptake per 1 ha of forest area made 0.89 t C/yr equivalent to $3.2*10^{-3}$ Gg/yr CO_2.

Emissions of non-CO_2 GHGs have been calculated for the registered in Ajara cases of forest fires[3] in 2006, 2007, 2008 and 2010 as well. Average amount of emitted gases (in 10^{-3} Gg) per annum made 1.78 (CH_4), 8.9 (CO), 0.010 (N_2O) and 0.18 (NOx).

Source category Croplands (5B):

In 1997-2011 total area of arable land in Ajara varied in the range of 26-27 thousand ha, including about 10.4 thousand ha of cropland and 16.1 thousand ha under perennials, mainly orchards, citrus and tea plantations. Using the same Tier 1 approach, it was determined that in the period of 2000-2011 the average annual rate of carbon uptake in Ajara arable land mineral soils was equal to 1 902 t C/yr and corresponding CO_2 made 7.0 Gg CO_2/yr. At the same time, the annual carbon stock increment to perennial crops biomass equaled to – $33.9*10^3$ t C/yr on the average with relevant CO_2 sinks considering some crop losses in 2000 and 2004 equal to 78.0 Gg CO_2/yr.

Source category Grasslands (5C):

As for Ajara's pastures and hayfields, in 2000-2011, average annual CO_2 emissions from this subsector reached 133 Gg CO_2/yr (pastures) and 4.1 Gg CO_2/yr (hayfields).

Due to the absence of corresponding data, CO_2 emissions and sinks were not calculated for Ajara's wetlands, settlements and other lands.

Finally, a summary Table shows carbon uptake and CO_2 removals from Ajara's LULUCF sector in 2011.

Table 1.13. CO_2 emission from Ajara's LULUCF sector in 2011

#	Subsector	Deposited/emitted carbon, 10^3 tC	Absorbed/emitted carbon dioxide, Gg CO_2
1	Forest lands	-166.9	-612.0
2	Cropland	-1.9	-6.90
	Orchards	-33.4	-122.5
	Total croplands	-35.3	-129.4
3	Pasture	35.7	+130.9
	Hayfields	1.1	+4.0
	Total grasslands	36.8	+134.9
	Net emission	**-165.4**	**-606.5**

Note: In this Table, as in the text above, sign (+) corresponds to C and CO_2 emissions into the atmosphere and sign (-) to the uptake/removal of C and CO_2 from the atmosphere.

1.5. Waste sector

General overview of the sector

From May 2012 a state-owned solid waste management company started to operate in the regions of Georgia. Its objective is the arrangement of solid waste disposal sites (SWDS) in the regions and provision of their functioning according to international standards. Till then 63 landfills, mainly unmanaged, were operating on the territory of Georgia, among them 5 old SWDS-s (at present closed, except the Batumi landfill) are located in Ajara. About 11% of all residential waste in Georgia is generated in Ajara region.

Up to now 137 large and small wastewater handling units are functioning in Ajara with total capacity of 92 850 m^3. Among them one is biological (the Adlia wastewater treatment facility being operational since August 2012) and others are mechanical systems. Annually, about 22 453 000 m^3 of inadequately treated wastewater is collected in Ajara.

In Ajara's waste sector the inventory has been undertaken for 2 subsectors: "Solid waste disposal on land" (6A) and "Wastewater handling" (6B). Waste incineration and other waste categories, similar to the Second National Communication, were not considered.

1.5.1. Source-category "Solid waste disposal on land" (6A)

Methodology. To calculate the GHG emissions from SWDS, the IPCC methodology offers two approaches: 1) The default method (Tier 1) and 2) First Order Decay (FOD) method (Tier 2). Virtually, both of them were used to calculate GHG emissions applying default data similar to Ajara's climate conditions and data obtained in local conditions as well.

Activity data[4]. In 2000-2011 at different times 7 SWDS-s with total area of 30 ha were officially functioning in Ajara (Table 1.14.). According to environmental priorities, small landfills opened in 1989-1991 in Keda, Shuakhevi and Khulo were closed in 2010 and waste is being transported from there to the Batumi large landfill. Thus, as far as the number of population plays major role in the generation of waste in residential and commercial sectors, it is to be mentioned that during the period of 2000-2011 Ajara's population underwent two stages of alteration:

Table 1.14. Features of landfills functioning in Ajara in 2000-2011

#	Settlement/ SWDS	Opening year	Closing year	Status	Area, ha	Accumulated waste, m^3	Type of SWDS
1	Kobuleti	2007	-	Operating	2.00	206 993.0	Managed
2	Kobuleti	1960	2007	Closed	8.00	1 906 990.0	Unmanaged
3	Keda	1991	2010	Closed	0.05	14 000.0	Unmanaged
4	Shuakhevi	1990	2010	Closed	-	12 500.0	Unmanaged
5	Khulo	1989	2010	Closed	0.45	45 000.0	Unmanaged
6	Khulo (Beshumi)	2002	-	Operating	0.03	6 600.0	Unmanaged
7	Batumi	1965	-	Operating	19.20	9 120 000.0	Managed

In 2000-2004 it declined from 381.0 to 370.1 thousands, while afterwards the number of population steadily grew up to 390.6 thousand in 2011. At the same time the number of visitors, who make share in the generation of waste, has drastically increased from 83 000 in 2004 to more than 1 300 000 in 2011. The average duration of their stay in Ajara equals to 7 days, however, taking into consideration their significant number, this corresponds to the increment of region's population by 4.8-6.5%. Special survey conducted recently in Ajara has shown that average quantity of waste generated daily per capita is equal to 0.7 kg that is close to value determined for South European countries in similar geographic conditions (0.9 kg). The main component of waste in Ajara turned to be food products (63%), textile (11%), paper (8%), polyethylene (7%) and others.

Emission factors[5]. According to IPCC 1996 and 2006 Inventory Guidelines the following values of emission factors were taken to calculate emissions from solid waste:

- Methane correction factor (MCF) for Batumi and Kobuleti old landfills – 0.8, for Kobuleti new SWDS – 0.5 and for other sites – 0.4;

[4] Directorate for Environment and Natural Resources of Ajara A.R.
[5] IPCC 1996 revised guideline. http://www.ipcc-nggip.iges.or.jp/

- Degradable organic carbon (DOC) actually degraded fraction – 0.5;
- Methane fraction in landfill gas – 50%;
- Oxidation factor (O_X) – 0.

Values of other parameters were taken from the Guidelines as default values for climate conditions similar to Ajara.

Emissions from source category

Using the above mentioned landfill data and corresponding values of emission factors, methane emissions in 2000-2011 from Ajara SWDS-s have been calculated according to the number of population in relevant settlements and in the region as a whole (amended with data on the number of visitors). For Batumi two approaches - number of population and amount of assessed actual waste dumped to the landfill annually - have been applied. Results of second approach (amount of waste) are presented in the Table 1.15 for Batumi city.

Table 1.15. Methane emissions (Gg) from Ajara landfills

Landfill / Year	Kobuleti old	Khulo	Keda	Shuakhevi	Khelvachauri	Batumi*	Total in Ajara	Total in Ajara CO_2 eq.
2000	0.36	0.13	0.08	0.08	0.35	1.85	2.87	60.27
2001	0.35	0.13	0.08	0.08	0.37	1.88	2.90	60.90
2002	0.35	0.13	0.08	0.09	0.36	1.92	2.93	61.53
2003	0.35	0.13	0.08	0.09	0.36	1.71	2.69	56.49
2004	0.34	0.13	0.08	0.08	0.35	1.85	2.85	59.85
2005	0.34	0.13	0.08	0.08	0.36	1.85	2.86	60.06
2006	0.35	0.13	0.08	0.09	0.36	1.92	2.95	61.95
2007	0.35	0.13	0.08	0.09	0.36	2.09	3.13	65.73
2008	0.35	0.13	0.08	0.09	0.36	1.91	2.95	61.95
2009	0.36	0.13	0.08	0.09	0.37	2.09	3.16	66.36
2010	0.36	0.13	0.08	0.09	0.37	2.13	3.18	66.78
2011	0.36	0.13	0.08	0.09	0.38	2.19	3.24	68.04

* Calculations are made based on population number except of Batumi city, where actual waste produced and dumped is used.

1.5.2. Source-category "Wastewater handling" (6B)

General overview of the sector

This subsector in Ajara comprises 2 sources of wastewater: domestic/commercial and industrial. First of them includes residential buildings, shops, hotels, public category utilities and the second – food industry facilities.

Methodology implied the use of Tier 1 approach using available data on the wastewater from 4 cities/settlements, the Batumi brewery and sewage systems in Ajara.

The averaged for 2000-2012 data on domestic and commercial wastewater is presented in Table 1.16.

Table 1.16. Averaged for 2000-2012 data on residential and commercial wastewater[6] in Ajara

Settlement	Total amount of wastewater, m^3/yr	Total BOD, Kg	Total COD, Kg	Total amount of wastewater m^3/cap. yr	Number of population
Kobuleti	1 561 400.0	177 850.0	210 500.0	17.0	91 000.0
Keda	165 000.0	7 556.0	25 500.0	8.5	20 200.0
Shuakhevi	150 000.0	2 880.0	14 400.0	6.5	22 600.0
Batumi	20 891 600.0	269 568.0	2 038 870.0	165.0	123 400.0
Ajara	22 453 000.0	457 854.0	2 289 270.0	57.0	386 600.0

Notes: BOD – Biological oxygen demand; COD – Chemical oxygen demand;

Emissions from subsector

To calculate methane emissions from these amounts of wastewater the following emission factors were used:

Domestic and commercial wastewater

- Maximum methane production capacity Bo = 0.6 kg CH_4/kg BOD and 0.25kg CH_4/kg COD[7];
- Methane conversion factor MCF= 0.1.

Industrial wastewater

Bo=0.25 kg CH_4/kg COD (IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2000); MCF=0.1 (untreated systems);

For beer production – the degradable component = 2.9 kg COD/m^3 wastewater, generated wastewater = 6.3 m^3/t produce[8].

As to emissions of N_2O from discharge of human sewage to residential wastewater, the default value of emission factor 0.005 kg N_2O/N kg was taken according to IPCC methodology and value of daily consumption of protein 71g per capita according to FAO data[9].

Using the presented above initial data on wastewater handling and these values of emission factors, emissions of CH_4 and N_2O were calculated from Ajara's residential /commercial and industrial subcategories that are aggregated according to IPCC 1996 classification with data on emissions of CH_4 from Ajara landfills in the Table of total emissions from the sector (6).

[6] Directorate for Environment and Natural Resources of Ajara AR.
[7] IPCC 1996 revised guideline and GPG.
[8] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories 2000.
[9] FAO, http://chartsbin.com/view/1155

Total emissions from the sector

Data on total emissions of GHGs from Ajara's Waste sector are presented in Table 1.17.

Table 1.17. GHG emissions from Ajara's Waste sector in 2000-2011 (Gg)

Sub-category/ GHG	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
6A. Solid waste disposal on land (CH_4)	1 515	1 508	1 495	1 484	1 471	1 487	1 512	1 526	1 525	1 555	1 604	1 646
6B. Wastewater handling (CH_4)	0 140	0 139	0 138	0 137	0 136	0 137	0 139	0 141	0 141	0 144	0 149	0 153
6B1. Domestic and commercial wastewater (CH_4)	0 140	0 139	0 138	0 137	0 136	0 137	0 139	0 141	0 141	0 143	0 148	0 152
6B2. Industrial wastewater (CH_4)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.001	0.001	0.001
Total CH_4	**1 655**	**1 647**	**1 633**	**1 621**	**1 607**	**1 625**	**1 651**	**1 666**	**1 666**	**1 699**	**1 753**	**1 798**
CO_2 eq	**34 746**	**34 589**	**34 292**	**34 045**	**33 749**	**34 116**	**34 674**	**34 992**	**34 985**	**35 689**	**36 813**	**37 766**
6B3. Domestic and commercial wastewater (N_2O)	0.025	0.025	0.025	0.024	0.024	0.024	0.25	0.025	0.025	0.026	0.026	0.027
CO_2 eq	**7 750**	**7 750**	**7 750**	**7 440**	**7 440**	**7 440**	**7 750**	**7 750**	**7 750**	**8 060**	**8 060**	**8 370**
Total CO_2 eq (CH_4+N_2O)	**42 474**	**42 283**	**41 918**	**41 618**	**41 257**	**41 706**	**42 387**	**42 776**	**42 766**	**43 622**	**44 997**	**46 161**

2. Climate change in Ajara

2.1 Description of Ajara Climate

Notwithstanding not so large area, Ajara's nature is distinguished by its specific features and diversity. Direct neighborhood with the Black Sea, alternation of lowlands, gorges and high mountains stipulate existence of quite specific climate zones, location of which, according to metrological observations carried out until 1990s, are given in Fig 2.1. It is clear from the Figure that the most part of Ajara region is occupied by climatic zones 3 and 4 that are characterized by mild cold winter and long warm/cool summer. Here are also marked the highest points of Ajara –Mt. Kenchauli (2 992 m) and the Mtirala Mountain (1 334 m), where, according to different estimations, the total sum of annual precipitations exceeds 4 000 mm.

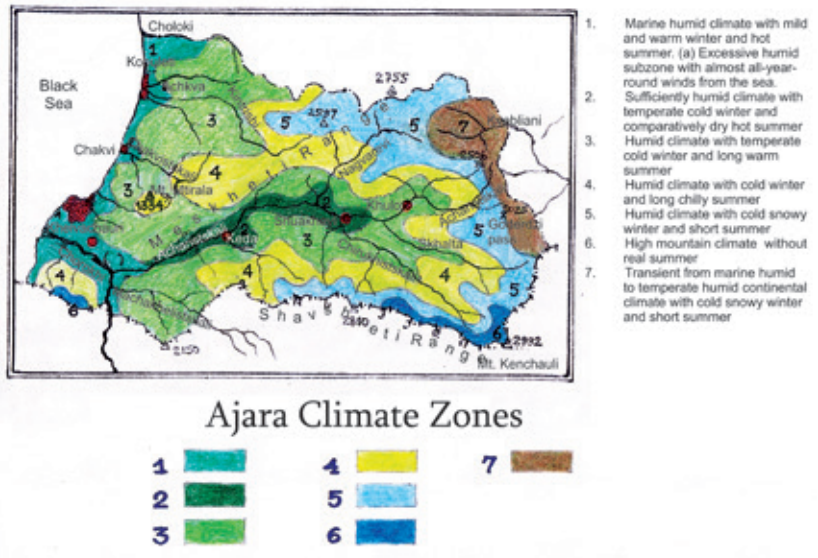


Fig. 2.1. Ajara climatic zones

Observations on climate data in Ajara region were carried out during different periods in up to 35 meteorological stations or post points. 6 out of these stations were selected, as they possessrelatively reliable data and long series. These stations are: Batumi (airport), Kobuleti, Chakvi, Keda, Khulo and Goderdzi Pass. Three of these stations (Batumi, Kobuleti and Chakvi) are located in the coastal zone, and Goderdzi meteo station is located on a highmountaneos place, at the altitude of 2 025 m above sea level. Khulo and Keda weather stations describe interim areas/zones, Keda meteo station being placed at 256 m elevation, and the Khulo station at – 923 m.

The average annual temperature at Ajara coastal zone equals 13-14.5^{0}C, the warmest place is Batumi with 14.5^{0}C average annual temperature. The coldest among the meteorogical stations is Goderdzi Pass (2.4 C^0). The coldest month is January and the hottest – August. İn accordance with height increase, the temperature falls down. The next Figure 2.2 shows different values for different heights. The graph is made based on the observations made at 6 mentioned stations during 1961-2010 (in some cases reconstructed).

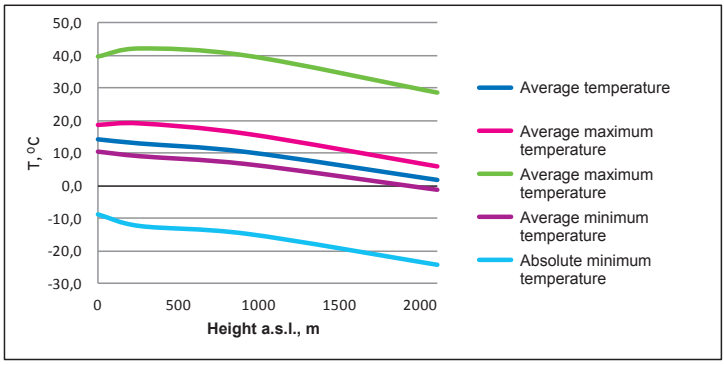


Fig. 2.2. Changes in temperature according to elevation in Ajara region

The sums of precipitation are changed in line with the changes in height. The biggest amounts of precipitation are observed in the coastal zone, especially in Batumi (2500 mm). Precipitation is decreased according to the height. The next Figure 2.3 demonstrates change of annual precipitation according to elevation. The graph is made based upon average data (in some cases reconstructed) obtained at 6 stations during 1961-2010 years.

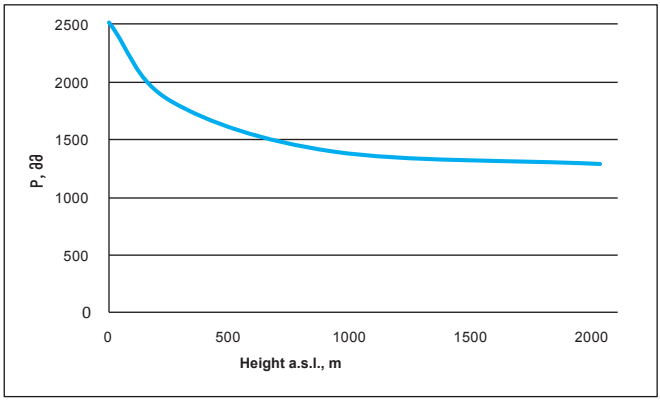


Fig. 2.3. Change of precipitation according to heights in Ajara region

Relative air humidity is high everywhere and varies between 70-90%. The highest humidity values are observed at the Goderdzi Pass – and make 88% on the average.

The mean wind speed is of local character, at Batumi airport area it equals 4.6 m/s, in Kobuleti – 2.6 m/s, in Chakvi 1.7 m/s. The wind speed in central areas of Ajara is lower compared to the coast, while at the Goderdzi Pass it reaches 4.8 m/s.

2.2 Current changes in climate of Ajara region

2.2.1 Methodology

In order to reveal current changes of climate parameters, the following seasonal and annual values have been assessed:

- Average air temperature;
- Average minimum and maximum of temperature (seasonal and annual average of daily maxima and minima);
- Absolute minimum and maximum of temperature (one value is selected from 25-year period annual maxima);
- Average daily amplitude of temperature (seasonal and annual average of differences between daily maxima and minima);
- Total sum of precipitation;
- Daily maximum of precipitation;
- Average and maximum wind speeds;
- Average relative humidity;
- Extreme climate indexes (except for the wind and humidity) have been assessed for the same parameters.

In order to increase reliability of obtained results, the above parameters have been assessed via double method: revealing of trend changes during 1961-2010 for each parameter and assessment of statistical reliability of these trends, and comparison of averages of two 25-years periods.

In order to increase the reliability of obtained results, climate indexes have been calculated additionally. Different kinds of climate indicators (indexes) were calculated for the assessment of climate change. The calculation methodology is elaborated according to IPCC recommendations. Since extreme values of climate parameters are more sensitive to climate change than their average mean values, additional extreme climate indexes have been calculated through which regulations of daily air maximum and minimum temperatures and amounts of precipitation change having extreme importance are defined (see Annex I).

2.2.2 Current change of climate

Methodology described in the previous chapter was used for Ajara territory and the results obtained demonstrated following changes in local climate:

In two 25-year periods considered in Ajara region, it can be seen that increase of average annual temperature is sslow, but stable. The increase in temperature is not homogeneous: it comprises 0.2^0C in Batumi, 0.5^0C in Kobuleti. There was no temperature change in Chakvi revealed by the difference method, though linear trend shows annual increase by 0.013^0C. The rise in temperature is observed everywhere in Spring and Summer, but Winter and Spring have become cooler. None of the stations has data regarding sustainable trends of absolute maxima and minima of temperature, though increase of average maximum and minimum are revealed in summer. The numbers of hot days and tropical nights are increased in the costal zone, that will affect health of the population and tourism industry.

Average annual temperature is significantly increasing in Keda. Warming is observed at every season. Summer, autumn and annual warming is confirmed with linear trend. Significantly are increased average maxima and average minima as well. There are no trends for climate change for higher mountaneous place (Khulo), though warming of summer, as for average temperature, as well as for average maximum and minimum, is noted here as well.

Like in the most places, linear trends of warming are observed at the Goderdzi Pass as well. The rate of average temperature change is the highest in summer and comprises 0.03^0C/yr (i.e. 3^0C in hundred years). Increase of temperature is revealed via increase of minima. Average minimum between two considered periods is increased every season. The maximum warming was observed in summer again. The difference in this period makes up 1.0^0 C. Warming trends according to these parameters are reliable for each season and are confirmed by linear trends.

No trend for precipitation change in Ajara coastal zone was revealed. The results differ between the 25-year periods. 10mm decrease was observed in Batumi, 85 mm increase - in Kobuleti and 121 mm increase - in Chakvi. At the same time, these changes are displayed in different ways according to seasons, this, once again, confirms the fact that these changes are of local, unstable character and no general trend exists. However, decreasing trends were revealed in Batumi and Chakvi for annual averages in winter.

The average increase of precipitation is noted during all seasons in the central part of Ajara. The annual increment between two periods comprises 16% in Keda and 11% in Khulo. However, it should be mentioned, that trends are expressed only for the years 1961-1985, after 1985 trends for precipitation are not noted. This means that increase of sum of precipitation during the two periods is caused by the increase of precipitation in the first period. At the same time, there is no such increase during the second period (when the climate change started to reveal itself). Meanwhile, the amount of maximum precipitation during the 24 hours is also increased. This might seriously affect thewaterfloods and mudflows creating one of the serious problems in the region.

Total precipitation on Goderzi Pass between the two periods shows significant decrease (206 mm -15%). Negative deviations up to 15-25% were revealed almost for all seasons except for winter, when the difference between two periods is positive, though not significant. Respectively, linear trend was revealed during all seasons,

where, according to the method of difference, decrease of precipitation is noted. İt should also be mentioned, that obvious decrease trend has not been revealed since 1985. Annual precipitation maximum has shifted from autumn to winter, and the minimum is still noted during spring period.

The tendency of increase of maximum daily precipitation causes increase of risks of fleshfloods and mudflows. Risk of mudflows still remains at the whole Ajara's coastal zone. At the same time risk of landslides in Kobuleti municipality increases. The risks of mudflows in Keda and Khulo are significantly increased, while risks of landslides remain unchanged in Khulo and significantly increase in Keda.

The risk of extreme mudflow in the neighbouring area of Goderzi Pass in decreased. It should be mentioned, that cases of increase of annual precipitation by 200 mm and more above climate norm, which is considered a criterion for landslides threat, have decreased against decrease of from 7 to 2 during the two periods.

Trends of wind speed changes carry the local charater. The average speed of wind in Batumi neighbouring area is decreased for all seasons, except for summer, but the rate of changes is not high (-0.014 m/sec per annum). Besides the decrease of annual average speed, wind speed potential in this region still remains high and the Batumi airport neighbouring areas could still be considered as one of the regions with high renewable energy resources.

The average wind speed is decreased for all seasons at Goderzi Pass, between two periods by 0.6 m/sec per annum. All tendencies of wind speed decrease revealed by method of difference are reliable and confirmed by the trends. The same trends are applicable for the maximum wind speeds as well. Notwithstanding all the parameters of revelaed reliable decrease as mentioned above, the average wind speed is still high (4.5 m/s in the second period) and that is why, like Batumi, the Goderzi Pass neighbouring areas can still be considered energy resource carrier region.

2.3 Forecast of climate change in Ajara region

2.3.1 Methodology

In the 4th report of IPCC, published in 2007[10], the forecast for the whole world regarding the possible changes in temperature and precipitation made by different models are summarized.

[10] IPCC, The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, United Kingdom and New York, NY, USA.: Cambridge University Press, 2007.

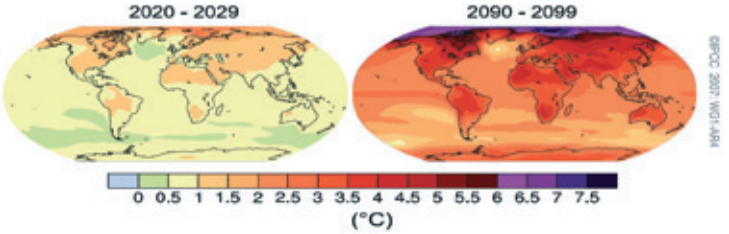


Fig. 2.4. Increases of temperature for the beginning and end of the 21st century against 1980-1999 average (scenarios A1)

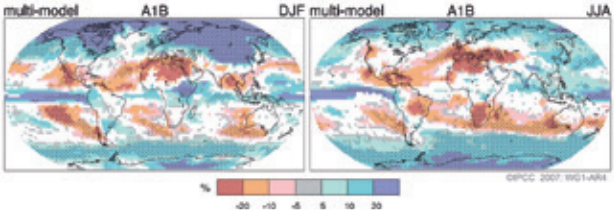


Fig. 2.5. Obtained change of precipitation for 2090-2099 against 1980-1999 average by balancing GCM results of A1 scenarios for the periods of winter (left) and summer (right). The increase is shown only in case when 66% of models agree in the sign of the change. That area, where 90% of models agree in the sign is marked (spotted)

The summing up of results shows that global models forecast warmer and dryer climate on the territory of the South Caucasus. Of course, this change might be revealed differently in various local areas of this territory.

One of the weaknesses of GCM is scale, which usually comprises hundreds of km. In order to study climate change impact on different ecosystems, climate forecast should be carried out on significantly smaller scale. There are several approaches for shifting of global climate forecasts on local level. These kinds of approaches include statistical models, regional models and the so-called synthetic models, which are obtained via correction of data of forecasted climate change.

Within the Second National Communication, regional downscaling dynamic model PRECIS as well as statistical programme package MAGICC/SCENGEN were used for forecasting of future scenarios.

All 17 global models of SCENGEN have been assessed against the baseline period (1961-1990) in order to identify the best GCM for Georgia's territory. Based on the result of this assessment, the best models have been selected for each season, each parameter and seperately for Eastern and Western Georgia. Based on combination of the results obtained from PRECIS and MAGICC/SCENGEN, a scenario was created for the whole territory of West Georgia that results in annual increase of temperature by 3.5^0C and decrease of precipitations by 6%.

Table 2.1. Scenario for temperature and precipitation for West Georgia by 2100

Season	Spring		Summer		Autumn		Winter		Annual	
Climatic elements	T^{0}C	Pmm	T^{0}C	Pmm	T^{0}C	Pmm	T^{0}C	Pmm	T^{0}C	Pmm
Baseline period	7.9	281	18.5	348	9.7	391	-2.3	377	9.1	1 197
Difference Δ	4.6	-40	5.6	-88	3.4	-53	3.6	104	3.5	-70
Difference %		-14		-25		-13		28		-6
2100	12.5	241	24.1	260	13.1	338	1.3	481	12.6	1 127

The approach used for forecasting of climate on Ajara territory is in compliance with the results of the IPCC 4th report, with the forecast made in the SNC of Georgia and with actual trends observed. In order to settle the obtained uncertainty the "ClimateWizard"[11] package was used, that implies similar approach as MAGICC/ SCENGEN, though it has better resolution (50 km x 50 km).

ClimateWizard is joint project of Nature concervancy, Washington University and South Missisipi University, through which consideration and comparision of forecats derived by different models becomes possible. It also enables to compare forecasts obtained by different global models on the selected area and create their ensemble.

The forecasts generated by the following global models were used to create an ensemble:

Model	Country	Organization
BCCR-BCM2.0	Norway	Bjerknes Centre for Climate Research
CGCM3.1(T47)	Canada	Canadian Centre for Climate Modeling & Analysis
CNRM-CM3	France	Météo-France / Centre National de Recherchés Météorologiques
CSIRO-Mk3.0	Australia	CSIRO Atmospheric Research
GFDL-CM2.0	USA	US Dept. of Commerce / NOAA / Geophysical Fluid Dynamics Laboratory
GFDL-CM2.1	USA	US Dept. of Commerce / NOAA / Geophysical Fluid Dynamics Laboratory
GISS-ER	USA	NASA / Goddard Institute for Space Studies
INM-CM3.0	Russia	Institute for Numerical Mathematics
IPSL-CM4	France	Institut Pierre Simon Laplace
MIROC3.2(medres)	Japan	Center for Climate System Research (The University of Tokyo), National Institute for Environmental Studies, and Frontier Research Center for Global Change (JAMSTEC)
ECHO-G	Germany/Korea	Meteorological Institute of the University of Bonn, Meteorological Research Institute of KMA, and Model and Data group.
ECHAM5/MPI-OM	Germany	Max Planck Institute for Meteorology
MRI-CGCM2.3.2	Japan	Meteorological Research Institute

[11] Girvetz EH, Zganjar C, Raber GT, Maurer EP, Kareiva P, et al. (2009) Applied Climate-Change Analysis: The Climate Wizard Tool. PLoS ONE 4(12): e8320. doi:10.1371/journal.pone.00083. http://www.climatewizard.org

CCSM3	USA	National Center for Atmospheric Research
PCM	USA	National Center for Atmospheric Research
UKMO-HadCM3	United Kingdom	Hadley Centre for Climate Prediction and Research / Met Office

For creation of climate change scenarios in Ajara the statistical median of results generated by the ensemble was used.

2.3.2 Expected change of climate on the territory of Ajara

In the Tables below forecasts of temperature and precipitation for A2 socio-economic development scenario in different locations of Ajara using the global model ensemble are presented.

Table 2.2. Forecats of climatic parameters in the Ajara coastal zone generated by ensemble of models

Seasons	T^{0}C					P, mm				
	Temperature for baseline period 1961-1990	Incriment against the baseline period Δ 2020-2050	Incriment against the baseline period Δ 2070-2100	Temperature 2020-2050	Temperature 2070-2100	Precipitation in the baseline period 1961-1990	Increment against the baseline period 2020-2050	Increament against the baseline period 2070-2100	Precipitation 2020-2050	Precipitation 2070-2100
Winter	7.1	0.9	3.3	8.0	10.3	697	6.3	2.6	741	715
Spring	12.1	1.3	3.7	13.4	15.8	370	3.4	-4.6	383	353
Summer	21.5	2.2	5.6	23.7	27.1	567	-7.4	-30.0	525	397
Autumn	15.6	1.6	4.4	17.2	20.0	852	-0.6	-11.6	847	753
Annual	14.1	1.5	4.2	15.6	18.3	2 486	0.4	-10.8	2 496	2 218

Table 2.3. Forecast generated by modeling ensemble for climatic parameters in Keda

Seasons	T°C					P, mm				
	Baseline period 1961-1990	Difference Δ 2020-2050	Difference Δ 2070-2100	Temp. 2020-2050	Temp. 2070-2100	Baseline period 1961-1990	Difference 2020-2050 (%)	Difference 2070-2100 (%)	Precip. 2020-2050	Precip. 2070-2100
Winter	4.3	1.0	3.3	5.2	7.6	570	6.3	2.6	606	585
Spring	12.2	1.3	3.7	13.5	15.8	293	3.3	-4.9	302	278
Summer	20.5	2.2	5.6	22.7	26.1	289	-6.7	-29.3	270	204
Autumn	13.7	1.6	4.4	15.2	18.1	550	-0.4	-10.4	547	493
Annual	12.7	1.5	4.2	14.2	16.9	1 702	1.4	-8.3	1 725	1 560

Table 2.4. Forecast generated by modeling ensemble for climate change parameters in Khulo

Seasons	T°C					P, mm				
	Baseline period 1961-1990	Difference Δ 2020-2050	Difference Δ 2070-2100	Temp. 2020-2050	Temp. 2070-2100	Baseline period 1961-1990	Difference % 2020-2050	Difference % 2070-2100	Precip. 2020-2050	Precip. 2070-2100
Winter	2.0	1.0	3.3	3.0	5.3	467	6.8	3.4	499	483
Spring	9.5	1.3	3.7	10.8	13.2	268	3.7	-5.3	278	254
Summer	17.8	2.2	5.6	20.0	23.4	221	-6.9	-28.9	205	157
Autumn	11.7	1.6	4.4	13.3	16.1	399	-0.5	-9.8	397	360
Annual	10.3	1.5	4.2	11.8	14.5	1 355	1.8	-7.5	1 380	1 254

Table 2.5. Forecast generated by modeling ensemble from climate parameters on the Goderzi Pass

Seasons	T°C					P, mm				
	Baseline period 1961-1990	Difference Δ 2020-2050	Difference Δ 2070-2100	Temp 2020-2050	Temp 2070-2100	Baseline period 1961-1990	Difference % 2020-2050	Difference % 2070-2100	Precip. 2020-2050	Precip. 2070-2100
Winter	-6.8	0.9	3.0	-5.9	-3.8	361	7.3	4.8	388	379
Spring	1.1	1.3	3.7	2.5	4.8	303	1.1	-6.3	306	284
Summer	11.1	2.2	5.7	13.3	16.7	342	-8.2	-29.6	314	241
Autumn	4.1	1.6	4.4	5.7	8.5	365	-0.7	-11.4	363	324
Annual	2.4	1.5	4.2	3.9	6.6	1 372	-0.1	-10.5	1 371	1 228

The analysis of the given tables[12] enables to make the following conclusions:

Average temperature. as we can see from the tables, by 2050 average annual increase in temperature by 1.5°C is expected on the whole territory of Ajara compared to 1961-1990 period. The increase will be marked during all seasons, though especially the summer will be warmed up (~2.2°C), that is in accordance with current climate change trends. The smallest increase will be noted in the winter average temperature (~0.9°C). By 2070-2100 climate change will become more active and the surplus of annual average temperature compared to 1961-1990 period will comprise 4.2°C, which has peak in summer season (5.6°C).

Average sums of annual precipitation for the years of 2020-2050 remain unchanged. Insignificant increase is expected (0.4%) in the coastal zone, comperatively more obvious increases are expected in central areas (Keda 1.4%, Khulo 1.8%) and small decrease on Goderzi Pass (-0.1%) that is in good agreement with current trends. In spite of insignificant changes in annual sums, seasonal distribution of precipitation is changing as well. Namely, summer precipitation significantly decreases (6-8%) and winter precipitation increases (6-7%). Climate change will have significant impact on precipitation during the years 2070-2100 that will be reflected in the decrease of annual precipitation (7-10%). Significant reduction is expected in summer (up to 30%), winter precipitation is decreased compared to 2020-2050 period, though it is still high compared to 1961-1990 (2-5%).

One more important parameter, the changes of which were assessed, is the potential evapotranspiration (PET), which defines amount of water that can be used by the ecosystem for evaporation and transpiration. For calculation, modified version of Tronetwait equitation[13] is used.

Fig. 2.6 Increments of potential evapotranspiration for 2020-2050 compared to 1961-1990.

[12] These tables show differences (increments) between the average of the referred and baseline periods, including final average values for these periods. Differences in precipitation are given in %, baseline and final averages – in mm.

[13] Wolock, D. M. and G. J. McCabe. 1999. Explaining spatial variability in mean annual runoff in the conterminous United States. Climate Research 11:149-159

For 2020-2050 periods the possible rise in temperature will cause increase of evapotranspiration by 12-13% (see Fig. 2.6). Increase of evapotranspiration under the condition of unchanged precipitation will cause increase of moisture deficit[14]. For the time being, there is no moisture deficit in Ajara (annual 5-10 mm). With regards to increased evapotranspiration this value will be doubled, though it will still remain low.

For 2070-2100 increased rate of temperature increase will result in the further growth of evapotranspiration. The evapotranspiration will be increased on average by 35% at the whole territory of Ajara (coastal zone 210 mm, the rest area 130-150 mm).

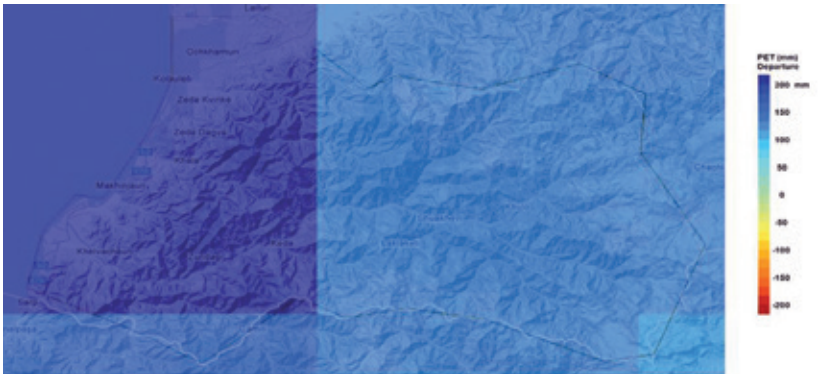


Fig. 2.7 Increment of evapotranspiration for 2070-2100 compared to 1961-1990

The moisture deficit will significantly be increased against decreased precipitation and will reach approximately 70-100 mm. It should be noted, that the most part of the above-mentioned deficit will occur in summer (50-70 mm).

3. Climate change vulnerability of Ajara area

3.1 Land Resources of Ajara Autonomous Republic

3.1.1 Overview of land resources

In the modern world, one of the most important tasks the humanity faces is protection and rational use of land resources. Protection of land/soil resources occupies the major part in the complex program of natural resource protection, since land is the main breadwinner of the nation. It should be noted, that the world population obtains 88% of food through soil/land cultivation. Such complicated process as exchange of substance and energy amongst earth crust and atmosphere, hydrosphere, soil, living

[14] Climatic moisture deficit is a metric quantifying moisture stress in a system. It is very closely related to the Aridity Index - higher moisture deficit reflects higher moisture stress. Deficit is calculated as PET minus precipitation (in mm) and set to zero if precipitation is greater than PET.

organisms in and on the soil, and human beings is carried out via soil crust on earth. The life of the majority of living organisms, including human beings, is possible where soil and climate conditions are appropriate.

Until 2004 gathering of information on land usage in Ajara and land registration was carried out by the State Department for Land Management of Ajara. The registration balance was later approved by the Board of Ministers of Ajara Autonomous Republic and sent to the State Department of Land Management of Georgia. At the beginning of each year, the State Department for Land Management of Georgia, after discussing it at the steering council, approved the land balance that was later sent for further approval to the State Commission of Land Usage and Protection of Georgia. Currently, gathering of information on land utilization is not being carried out in Ajara. The gathering of information was ceased in 2004. According to the balance data of 2004 the land fund existing in administrative borders comprised 290 000 ha, i.e. 4.2% of the total area of Georgia. Agricultural land comprises only 25% of the total area of Ajara. Distribution of land resources according to their types and activities being carried out on them is given in the Table 3.1.1.

Table 3.1.1. **Data on land balanceon 1 January 2004 (in hectares)**

#	Lands per purpose	Lands under private ownership	Lands under state ownership	Including		Total area	Utilization outside the administrative borders	Utilization by others within the administrative borders	Total administrative borders 7-8+9=10
				Agricultural lands	Non-agricultural lands				
1	2	3	4	5	6	7	8	9	10
1	Total area	21 772	272 740	159 471	113 269	294 512	11 903	7 391	290 000
2	Agricultural land	20 284	56 658	55 087	1 571	76 942	10 504	6 424	72 862
3	Among them: arable land	7 319	2 990	2 772	218	10 309			10 309
4	Perennials total:	6 745	9 154	8 755	399	15 899			15 899
5	Fruit trees	552	210	190	20	762			762
6	Grapes	57	31	30	1	88			88
7	Tea	188	5 430	5 421	9	5 618			5 618
8	Citrus	5 354	2 413	2 385	28	7 767			7 767
9	Mulberry	1	21	21		22			22
10	Laurel	5	36	36		41			41
11	Candlenut	2	362	361	1	364			364
12	Nut	3				3			3
13	Others	583	651	311	340	1 234			1 234
14	Long Fallow land	280	1 456	1 456		1 736			1 736
15	Mowing	5 528	1 631	1 395	236	7 159			7 159
16	Pasture	412	41 427	40 709	718	41 839	10 504	6 424	37 759

1	2	3	4	5	6	7	8	9	10
17	Meliorated lands		24	24		24			24
18	Forests	11	178 022	73 554	104 468	178 033	500		17 7533
19	Protecting stripes		662	368	294	662			662
20	Shrubs	218	8 612	8 527	85	8 830			8 830
21	Waters		3 240	1 263	1 977	3 240		2	3 242
22	Marshlands		805	567	238	805			805
23	Occupied by roads		3 379	2 112	1 269	3 379		7	3 386
24	Occupied by constructions	1 259	3 228	1 243	1 985	4 487			4 487
25	Utilized by all the rest		18 108			18 108	899	958	18 169

By the decision #1363 of the Parliament of Georgia dated 26 June 2009 and 2011, the borders between self-governing Batumi and Khelvachauri municipalities, on the one hand and self-governing Batumi and Kobuleti municipalities, on the other hand, were changed. As a result of the changes, the area existing in Batumi administrative border increased up to 6 494.31 ha into account of Khelvachauri and Kobuleti municipalities. Accordingly, land balance data of Ajara Autonomous Republic was partly changed.

On 1 January 2004 only 30% out of 72 862 ha of agricultural land was transferred to the private use within the reform in Ajara Autonomous Republic. Land reform works were carried out in high speed in the mountainous regions (Keda, Shuakhevi and Khulo), though in Kobuleti and Khelvachauri regions these works were not carried out in the same pace as reform land funds in specific villages were approved by non-qualified local land reform commissions based on old ownership data. The land reform process was also impeded by the fact that the council of ministers being in force by that time suspended and did not approve selected 4 037 ha and 488 ha of reform funds submitted for approval in 1998. All the above resulted in and supported the secret illegal privatization process, appropriation of lands on the so-called "ancestral" motives.

The existing situation was partially regulated by the law adopted on 11 July 2007 - "Law of Georgia on recognition of ownership rights on existing land plots being in the possession of individuals and legal entities", according to this law part of land fund was transferred to the individuals and legal entities. The transferring process is still in process.

As a result of Ajara's complex geomorphological structure, diverse climate conditions and rich plant cover, the types of soil common in the region are very diverse. The types of soils in Ajara and fields of their utilization are shortly described in the introduction part.

As a result of improper economic actions done by population, erosion-landslide processes, pollution of soil by different materials, soil degradation, climatic and anthropogenic impacts, the republic losses lands. Protection of land resources is very important in such land scarce republics as Ajara, where the density of population comprises 130 persons per 1 km^2. That is why one of the priorities for Ajara is the

protection of land resources. Namely, it is vitally important to protect and sustainably utilize agricultural lands, as well as to carry out preventive activities against soil degradation, landslides and erosion in high mountains, as well as on the whole area of the Black Sea coastal zone. Numerous different factors affect soil degradation process in Ajara, starting with anthropogenic pressure and finishing with climate change. For instance, one of the reasons of land loss is the change of its agricultural implication and its non-agricultural utilization. The loss of lands is reinforced by the extreme natural impacts.

Ajara soils suffer from intensive economic pressures and as a result their quality indicators have changed. The most part of the lands has been degraded, mainly due to the decrease in nutrition elements, worsening of fertility, deterioration of the structure, reduction of humus. By 2005, 40% of Ajara lands were characterized with high, 21% - with middle and 39% - with low natural fertility indicators. After economic utilization the percentage of humus in soil was reduced by 21-27%, humus storage - by 19-22%, with containment of humus – by 24%. Annual loss of humus varies from 0.5 to2.0 tons per hectare. Together with the mentioned anthropogenic influence and improper agricultural practice, loss of humus is caused by water erosion that is characteristic of Ajara soils.

In intra-mountainous and partly, in coastal Ajara, main sources for living for the population in terms of economic income are annual plant crops (corn, potatoes, beans, vegetables) in plant-growing and small-size nomadic cattle system in cattle-breeding. Due to such conditions as slope inclination, intensive precipitations, increased erosion, violation of the dominant hand labor, large part of arable land becomes useless.

Due to the complicated area and climate conditions, more than 2 400 ha, i.e. more than 33% of agricultural land suffers from various types of erosion. According to the levels of erosion, from the total of 10 309 ha within Ajara borders 2 700 ha (28%) of arable land suffers from weak erosion, 2 500 ha (24%) – from an average erosion and 788 ha (8%) (Kobuleti 120 ha, Khelvachauri 128 ha, Shuakhevi 142 ha, Keda 173 ha, Khulo 215 ha) – from strong erosion. Thus, eroded arable land comprises 5 988 ha, i.e. 58%. As a result, especially in this region, namely, in the upper part, so-called soil migration is noted, when the population leaves indigenous homes due to the impossibility of using soil for agricultural purposes.

The pictures below show typical examples of eroded agricultural lands in Ajara.


Photo 3.1.1. Khulo, the village of the Geladze

There has been observed an activation of an erosive process in alpine and sub-alpine zone as well. . Due to the intensive exploitation, forests area has been lowered by approximately 150-200 meters, the ecological environment has been changed as well. Subalpine and alpine zone covers the area of 37 759 ha, which occupies most of the summer pastures; where up to 14 000 nomadic families live. This area is also used for grazing of their up to 55 000 small-size livestock, this, of course, together with the benefit, has negative impact on the ecology of subalpine and alpine zone. Negative factors include excessive settlement, erosion, mudflow and landslide events, letting excessive number of cattle and herd graze on pastures, soil decomposition and damage, wood-cutting, etc. Summer pastures of sub-alpine and alpine zone from the west and east have ravines. As a result of intensive precipitation huge part of the forest is lost and erosion is in process.

During the recent 50 years, in sub-alpine and alpine zones, particularly in Beshumi, the unique green cover, spruce, fir, pine and beech stands, was totally chopped off. Only a small oasis of preserved forests is remained, which is now thinned out, degraded and has lost their natural ability for self-renovation. There are stubs at the altitude of 2 200 meters. As a result, the alpine zone was lowered by 200-250 meters. There are numerous unroaded paths on the pastures for livestock. There are also soil damages, bogging and reduction of soil fertility. Below are given some of the typical pictures:


Photo 3.1.2. Khulo, Beshumi Mountain **3.1.3. Khulo, Sakamacho Mountain**

Millions of cubic meters of humus layer are washed away annually due to soil erosion, which, through the rivers from the mountains, is brought to the Black Sea. The scales of erosion increase every year. Hundreds of hectares of agricultural land lose their main function, thus creating more problems to the population who already suffer from land scarcity - there is 0.06 ha per person.

Soil cover is also affected by landlsides that have become very active in the last period. Nowadays, landslides are caused by both natural and anthropogenic factors.

Soil pollution is also a serious problem for Ajara. Soil pollution is not directly linked to climate change; however there are some points of intersection. The pollution of the soil is caused by natural and anthropogenic factors. One of the main factors for soil pollution is acid precipitation. In the seaside of Ajara, 150-170 days per annum are rainy. According to the researches carried out, 70% of the precipitation is acid that reinforces the process of aciding of soils.

Emissions from the transport sector pollute not only the air, but also the soil. In the technological process of fuel production, lead is added to oil in order to reduce detonation. The emission contains double amount of lead and other hazardous gases that pollute neighboring areas of the highways. Different types of radioactive elements, including Strontium 90 and Cesium – 137, that come together with the precipitation, pollute the soil.

The soil is also polluted by the utilization of fertilizers, especially by the use of nitrogen in high doses. In case of tea and subtropical cultures, the evaporation of ammonium nitrate in the atmosphere is 28.1% and evaporation of urea - 49.9%. The excessive use of nitrates causes accumulation of nitrates and product contamination occurs. Like the use of high concentrations of mineral fertilizers, soil contamination occurs when utilizing herbicides against weeds and citrus.

Proper use of mineral fertilizers and pesticides does not cause contamination of soil or agricultural products. Attention should be paid not only to proper use of mineral fertilizers and pesticides, but also to the appropriate transportation and accurate storage in order to prevent further contamination.

Contamination of soil is a very important anthropogenic factor. Industrial, construction, municipal and other types of wastes contaminate the soil. Municipal wastes are collected and transported by cars from the densely populated areas (cities, small towns) and are disposed not far to the populated areas. In addition, the municipal wastes contain a variety of synthetic fabrics, rubbers, plastics, glass, paints and other types of waste. Temperature and precipitations cause chemical reactions in these components of wastes in the open air, which emit various toxic acids and pollute the environment. It is necessary to implement the proper waste management practice.

Considering the conditions described above, challenges that Ajara faces now are: soil protection, rehabilitation of fertility and rational utilization of land.

3.1.2. Impact of climate change on land resources of Ajara

Negative impact of climate change on Ajara lands is revealed in different directions, namely, in intensive precipitation and in erosion caused by change in precipitation's annual distribution, and in degradation (secondary bogging up). Such extreme events as landslides and mudflows that are described under the chapter of extreme geological events (3.2) also have significant impact. Impact of current changes on the Black Sea Coastal zone (increase of sea level, intensive growth of waves) is also important; the issue is discussed under Chapter 3.3. This chapter mainly discusses impact of climate change on agricultural lands and erosion processes.

Land Erosion

In Ajara, as in the whole Caucasus region, soil erosion is broad and widespread. Erosion is a combined process caused by surface water flows generated by rains and snow melting, dissolution, dispersal and washing of land to the rivers and oceans. There are two types of erosion in the nature: normal, i.e. geological erosion and accelerated, i.e. destructive erosion. Normal, i.e. geological erosion is a natural process, against which humans are powerless, at the same time, it is harmful and causes a lot of damage. Accelerated erosion, i.e. destructive erosion is mainly caused by incorrect and improper agricultural activities, resulting in partial or complete loss of soil fertility.

Mainly water erosion is the problem in Ajara. This type of erosion is typical for steep slopes that are not covered by plants and where the soils are easily washed away. Water erosions may be surface or rill. Surface erosion occurs on different types of slopes, when the water pressure washes away the humus layer of the soil. At the early stage, it is not visible and can be noticed only by changed color of the upper layer of the soil. Later, the soil loses nutrition elements and moisture-holding capacity. In case of rill erosion, 10-20 centimeter deep grooves are formed, which, over time, turn into ravine, and later, into larger ravines? The more permeable the soil is, the higher is the resistance to erosion.

Autonomous Republic of Ajara, especially the seaside, is characterized by distinctive climate indices, which increase the probability of water erosions and its strength. The average annual rainfall reaches 2 500 mm, 55% of precipitation occurs during the vegetation period and 45% - in winter. It is noteworthy that a large number of precipitation falls during a period, when agricultural land is not protected by arable cultures, this greatly increases the risk of erosion. The analysis of the elements of climate change in Ajara over the past half-century showed, that there are also changes in the regime of precipitation in addition to temperature changes. Although the trend of changes in the totals of annual precipitations on the coastal zone is not clear and the totals even decreased by 15-20% in all seasons (except winter), annual reiteration of abundant and extremely abundant precipitation (respectively, day-night $\geq$50 and $\geq$90 mm) in the costal as well as in the mountainous zone has increased significantly, however, it has not changed much in the high-mountainous zones (see Annex I, Table 1 and Chapter 2). In addition, total increase of precipitation by 11-16% in Ajara was

observed in every season. Accordingly, the current favorable conditions support and strengthen water erosions and the risks of landslides and mudflows increase. Soil conditions are also favorable for secondary bogging.

Currently, critical condition of soil surface is additional threat to water erosion. Soil surface degradation is caused by 3 major reasons - rain erosions (during intensive rains), melting of snow in the slopes, and irrigation of the inclined slopes in the summer. Other climatic factors, including the total number of precipitation and its duration, intensity and arrival time, affecting the soil erosion should also be noted. During rain, soil absorbs the water first. When all pores of the upper soil layer are saturated with water, the force of gravity moves water to the lower layers, i.e. the infiltration occurs. Slopes are less infiltrated and lateral flow predominates.When the intensity of precipitation is higher than the speed of infiltration, erosion starts. Heavy rains intensify erosion. In Ajara, especially in the coastal zone, the totals of precipitation comprise 2-2.5 mm per minute. Together with the intensity, the size of the rain drop is also very important, especially in case of newly cultivated slopes. The fall of large drops removes particles of the soil from surface via the force of gravity and as a result of long-lasting impact, supports intensive wash-off of the surface.

Intensive rains in Ajara wash-off the lands on slopes (soil water erosion) and as a result several tons of fertile soils are washed away from each hectare of arable land and soil degradation occurs. The degradation indicator in Ajara is in the range of 30-35%, which 2-3 times more than the indicator determined for other regions. As mentioned above, in the last 10-20 years in Ajara, as well as in other regions, as a result of global warming the reiteration of abundant rainfall has, definitely, increased. This makes the problems, caused by water erosion even more serious (soil fertility depletion, land loss, landslides activate, stronger mudflows).

Energetic basis of soil's water erosion is kinetic energy of the rain. It is established that the particles of the soil washed away from the slope are positively correlated with index, which is called "the erosion potential of precipitation". In Georgia, multiyear average of the index changes in the interval of 3-120 units. Its highest values (40-120) are characteristic to humid subtropical zone of western Georgia, while in the east of the arid zone it changes in the interval of 10-30 units, as for the high mountains, it falls down sharply to 3-5 units.

The index for erosion potential of precipitation was assessed in Keda region and for the past century the trend turned out to be significantly increasing. The trend is shown in Figure 3.1.1.

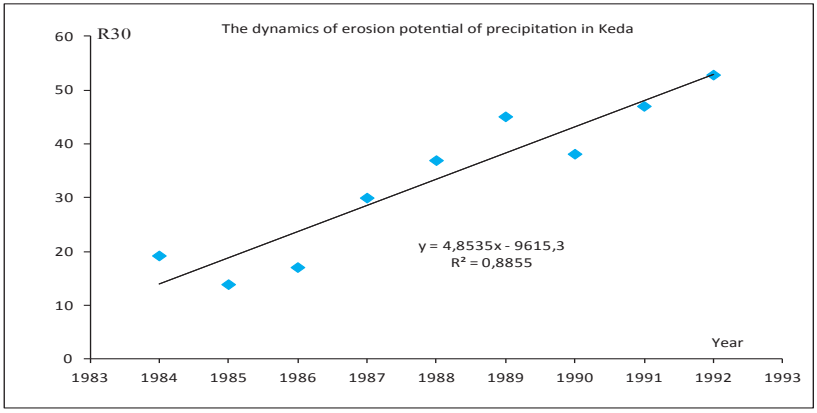


Fig. 3.1.1. The dynamics of erosion potential of precipitation in Keda

The erosion potential of the precipitation is directly linked to the intensity of the rains. Researches carried out in this regard showed that in the past fifty years, as the climate gets warmer, erosion potential of precipitation has increased from 12.2 to 18.2 units, i.e. by 50%.

The second significant factor causing soil erosion is related to the slopes. The steeper is the slope; the higher is the risk for erosion. The length of the slope is also very important. The higher the slope is, the more is the soil washed out. In such cases the erosion is caused by the melting of snow. It should be noted that 48% of the agricultural land is located on the slopes, with inclination exceeding 5^0 and 21% - on the slopes with inclination exceeding 10^0. Consequently, the increase of days with intensive precipitation, caused by global warming, create serious problems to the maintenance of the stability of the earth cover and accordingly, to the development of agriculture. In Ajara water erosion is intensively developed in mountainous areas, where the land is mainly used for corn, vegetables and potatoes. In some cases the inclination of slopes reaches $35\text{-}40^0$.

Any type of soil erosion is affected by the plant cover. Soil erosion occurs less on the land covered with natural plant than on the areas with agricultural activities for annual srops. Erosion is especially strong in cases of annual plants.

And finally, the process of erosion is much determined by the anthropogenic activity. Improper cutting of trees, utilization of lands for annual plants without preliminary erosion-preventive measures, road constructions and other kinds of activities accelerate erosion process. Erosion process strongly depends on the characteristics of mountain rocks, on which the soil is formed, as well as on the thickness of soil and other factors.

The pictures below show the plots that were washed away by the water erosion.

Photo 3.1.4. Shuakhevi, the village of Laklaketi

Soil degradation

Due to incorrect antrophogenic interference and negative climate change impact, the soils are massively degraded, especially in Kobuleti and Khelvachauri municipalities, and, in certain cases, in mountaneous Ajara. The lands (soils) are mainly degraded due to secondary bogging and contaminated due to different kinds of wastes (oil products, construction and domestic wastes). The soil degradation is accelerated by illegal cut of forest, improper agricultural practice (overgrazing, intensive land cultivation, ploughing on slopes, etc). Among the processes related to climate change, floods and draughts significantly contribute to soil degradation. Due to various reasons, melioration and drainage systems are out of order in Ajara and as a result there are serious impact of draughts in high mountaneous regions and intensive floods in lower regions cause secondary bogs. Taking into consideration all the above, it is important to rehabilitate irrigation systems in draught areas and renovate drainage systems in intensively flooded places. According to the 2010 data, 8 482 ha of irrigational land is washed out, 6 963 ha of which is agricultural land. In Khelvachauri region, the total amount of washed-out land comprises 1 836, out of which 1 093 ha is agricultural land. In Kobuleti municipality 3 550 ha in total is washed out, 2 343 ha of which is agricultural land. The rivers are mainly used as sources for irrigation. Irrigative areas are mainly placed in the mountaneous regions, where irrigation is carried out by letting the water flow. There are irrigation canals with total length of 235.9 km, via which 1 888 ha of areas was irrigated. The rest 4 978 ha was irrigated by inner local canals. Most part of irrigation and drainage systems are damaged and out of order and need to be repaired and rehabilitated. Due to the destruction of irrigation and drainage systems, more than 1 800 ha of agricultural land is shrubed and bogged. Especially in the areas of Pichvnari, Choloki, Togona, Lekiani, Saberikacio, Tikeri, Abukuli-Nairmali, Ochkhamuri, Kvirike, Bobokvati, Tsikhisdziri, Dagva, Gvara, Kakuri and Kobuleti neighbouring areas. Also, due to the draughts, agricultural lands are split into pieces.

The pictures below show seperate fragments of degraded lands in Ajara lowland.

Photo 3.1.5. Lekiani (arable land is used for landfill)

Photo 3.1.6. Kobuleti (Secondary bog)

Bogging of agricultural lands is mainly caused by non-cultivation of lands and absence of drainage systems (which was a result of the collapse of the Soviet Union and subsequent chaos existing in the country), on one hand and on the other hand, by intense and excessive precipitations (especially in autumn). As for soil contamination, the process is entirely anthropogenic. As an example, we can bring the case with Chakvi: during the construction of tunnel, thousands of cubic meters of mining spoil were disposed on 12 ha of agricultural land (tea plantation) without removing humus layer in advance. 1.0 ha of arable land in Lekiani is used for the landfill ignoring the requirements set forth by land law and environment protection regulations. Up to 1.5 ha of arable land is degraded in Pichvnari area due to archeological excavations and fertility rehabilitation works had not been carried out there (see photo 3.1.6.).

974.48 ha of agricultural land (mainly arable and tea plantation) in Kobuleti municipality is degraded due to secondary bogging, 170 ha out of which is strongly bogged up, 541.9 ha is averagely bogged up, and 262.8 ha is insignificantly bogged up. 38.72 ha are degraded due to the different types of pollutants related to the anthropogenic activities such as industrial processes, oil production, construction, etc. Total degraded area in the municipality comprises of 1 013.2 ha. The same situation is in Khelvachauri municipality, where 27.23 ha of agricultural land is degraded, among which 5.0 ha is bogged, the rest 22.23 ha is contaminated with construction, household/residential waste and other wastes.

In Khelvachauri municipality the irresponsible taking off of grass cover from arable land for greening the touristic areas is to be blamed one of the main causes of land degradation, especially at the territory adjacent to the Airport, in the Kakhaberi and Gonio areas. At the same time, at the territories belonging to Charnali and Akhalsheni settlements, mining areas were allotted for the arrangement of gardens and parks in Batumi and for other constructions, where after finishing the works reclamation measures were not taken as it is required

Areas turned into swamp at the Kakhaberi Lowland are shown at pictures below.

Photo 3.1.7. Territories degraded due to anthropogenic activity

Bogged plots on Kakhaberi lowland is shown in the photos below.

Photo 3.1.8. Kakhaberi, neighbouring area of the airport

662 ha of wind protective forest in Kobuleti and Khelvachauri municipalies have been cut off, due to this wind erosion is also observed.

Recently, due to the global warming, the intensive melting of snow has activated the process of extreme events resulting in land erosion. The total degraded área in Ajara currently comsprises 3 703.95 ha, 1 343 out of which is bogged (170 ha with strong bogging, 546.9 ha with average bogging and 262.58 ha with light bogging), 360.95 ha is degraded due to contamination (construction, domestic and oil products wastes), 2 000 ha is degraded due to overgrazing.

3.1.3 Expected impact of climate change on the land resources of Ajara

One of the elements of climate change parameters causing land degradation, increase of precipitation (by 0.4%) is expected in Ajara coastal zone in 2020-2050. More significant increase (1.4-1.8%) will be observed in central regions and insignificant decrease (0.1%) - in the area of Goderzi pass. This trend is actually continuation of the current trend. According to this, we can assume that the current situation will carry on this way. However, it should be noted, that this conclusion will affect only annual sums of precipitation. As per extreme precipitation, the amount of days with precipitation of more than 10 mm (especially in the coastal zone) will sharply increase, but the amount of days with more than 20 and 50 mm precipitation will significantly decrease, accordingly, we can assume that the situation will not be complicated. Though, taking into consideration the current conditions of the soils, we can forecast, that even insignificant increase of precipitation might be crucial. For the soils in a better condition, sucha a small increase might not have been so dangerous.

The climate change will have more affect in 2070-2100 on precipitation that will be expressed in decrease of annual sums by 7-10%. The significant decrease is expected in summer (up to 30%), the amount of precipitation for the winter season will decrease compared to 2020-2050 years, though compared to 1961-1990 years it will still remain high (by 2-5%). In these conditions, we can presume, that the processes of erosion, landlsides and secondary bogging will be comparatively stabilized, though the decisive role will be given to the intensity of precipitation and amount of precipitation days, the forecast of which for 2100 has not been made yet.

As mentioned in the previous chapters, erosion potential is considered to be the most important parameter in the process of water erosion in Ajara, the dynamics of which for the years 2020-2050 is shown on Figure 3.1.2.

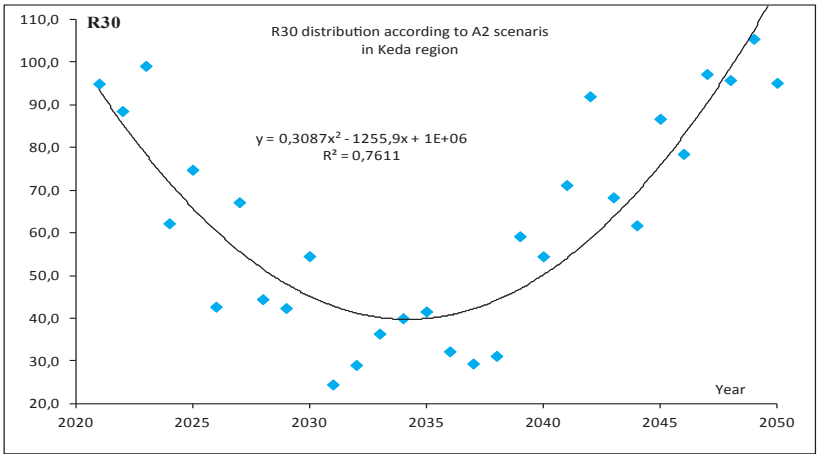


Fig. 3.1.2. Forecast of erosion potential of precipitation in Keda

The trend of index of erosion in Keda in 2020-2050 demonstrates the second-level parabolic distribution and eventually, it reaches 110 units, while it never exceeded 60 in the first period (1983-1993).

3.1.4. Recommendations

Taking into consideration the laws of Georgia ("Law on soil conservation and fertility restoration-improvement", "Law on Environment Protection") and existing situation and expected negative impact of the climate change, following activities should be carried out in order to prevent land degradation in Ajara:

1. Taking into consideration the complex regional conditions, protection of soils/lands from the extreme geological events (flooding, mudflows, avalanches, landslides) and erosion processes should be considered number one priority by the Ajara government;
2. Detailed database on the soil types should be created. The database should be based on the agrochemical and qualitative studies of the soils (mainly determining the indicators of crucial elements - nitrogen, phosphorus, potassium, that are essential for humus and plants);
3. Fertility restoration activities should be carried out for the amortized tea plantations and other soils freed after rooting out amortized crops, including improvement of soil fertility and increase of sustainability measures for which widely used mineral and organic fertilizers with natural additives should be used, this resource is quilte large in the country;
4. Modern practice of registering and processing information on total land balance, its usage and conditions should be brought in;
5. Taking into consideration the erosion reasons and types spread in Ajara the following actions need to be taken in order to protect soil from further degradation: soil protecting seed recycling, strip-alternating sowing on the slopes, creation of buffer zones, protection of land from erosion via agro technical facilities, cultivation of land, creation of water cutting channels, etc;
6. Rehabilitation and optimization of state owned and inner (community owned, private owned) irrigation systems should be made via modern irrigation technologies having water regulatory regimes, followed by slope and shore protection works, regulation of surface water systems, forest melioration activities;
7. State-wide importance and top priority should be given to continuous research and monitoring of erosion-landslide processes, forecasts and methodological comprehension; determination of the possible level of anthropogenic impact on the soil, etc.;
8. Rules and regulations should be followed in the sub-alpine zone in order to avoid further damage and erosion of the existing pastures, relative regulations should be established on grazing, pasture rotations should be used, etc.;
9. It is necessary to carry out agro technical measures in order to protect endemic species of vegetation and fertility of soils in sub-alpine and alpine zones;

10. For stony lands it is necessary to clean the soils from stones permanently and carry out different rehabilitation activities for soil improvement;
11. In order to maintain agricultural lands and protect soil, it is necessary to establish agricultural cadaster; degraded and eroded lands and soils should be registered;
12. Assessment of vulnerability of land resources to the impacts of climate change on agricultural lands; reduction of its negative impacts;
13. It is necessary to develop a strategy on land maintenance and sustainable development in Ajara, which will consider spacial development plan of the region as well as potential impact of climate change.

3.2. Natural Disasters in Ajara

3.2.1. Overview of geological hazards in Ajara

Owing to the diversity and complexity of geomorphological structure, as well as to the proximity to the sea, Ajara is one of the outstanding regions in Georgia by the frequency and intensity of natural disasters. Long and heavy precipitation including abundant snowfall stipulates high recurrence here of floods/flesh floods, landslides and mud torrents, snow avalanches and natural disasters related with these extreme events. This list should be supplemented with the land erosion processes in the seashore and along the river banks. During the last decades the intensification of these processes is evidently observed, bringing growing number of victims and greatly damaging region's economy and natural ecosystems. The cause of this is thought to be the climate change with its concomitant negative manifestations (more frequent heavy precipitation, sea level rise), increase in tectonic activity and growth of anthropogenic loading on the natural environment.

Along with climate factors the development of disastrous geological processes in Ajara is conditioned by the geomorphological structure of the surface and its vegetation cover, seismic and tectonic processes and the degree of anthropogenic loading.

Due to complex relief, diverse landscape and climate conditions the development of exogenous geological processes historically always took place in Ajara, though in the last period natural growth of population (making 800% for the past century), limited area of land that could be assimilated and increasing anthropogenic impact has brought geoecological complications to the brink of crisis.

From the anthropogenic loading especially provoking the worsening of geological state of the environment on the background of growing frequency of weather extremes, the following should be mentioned: agricultural activity, assimilation and cutting down of geologically hazardous slopes, building of heavy houses, construction of local roads, development of riparian groves and eroded river banks, narrowing of river with constructions or their blocking up by construction waste, etc. Extremely grave are the results of massive and illegal logging at the slopes having significant inclination, construction of temporary roads for carrying-out of timber, creation of artificial drains as a result of timber sliding down, uprooting of tea plantations on

large sloping areas, overgrazing of alpine meadows, destruction of grassy cover, etc. Up to now at the territory of mountainous Ajara, the technogenic loading index varies in the range of 0.7-0.9, while considering the sensitivity of geological environment; this value must not exceed 0.4-0.5.

In the meantime, the majority of hazards to the population of Ajara are related to the landslides and mud torrent processes, the frequency and intensity of which has substantially increased during the last two decades. While in 1970-es, according to the damage liability and danger to landslips and debris flow, Ajara was attributed to the medium and significant risk category (with index value 0.3-0.5); up to 2000 this region was transferred to the high and extremely high hazards category (risk indices 0.5-0.9). The situation is aggravated even more by the fact that more than 80% of mud-torrent forming hotbeds are related to the periodic revival of landslide processes and thus their hazard risk closely depends on the scale of landslide processes activation.

In the past century manifestation of landslip-mud torrent processes in Ajara was featured by certain cyclic recurrence with maxima in every 5-6 years. In the last period, due to the rise in heavy precipitation frequency and activation of seismic processes, this cyclicity has sharply deteriorated and landslide-mudflow processes are observed over the usual level almost each year. The variability in the number of cases of these processes in Ajara during the period of 1967-2009, along with the statistics on other extreme events is presented in Table 3.2.1[15].

Table 3.2.1. Quantitative features of natural geological hazards in Ajara

Years of observation	Landslide, Rock fall (number)	Transformation of high intensity mudflows (number)	Washing down of river banks, km	Settlements periodically appearing in hazard zone (number)	Motor roads (km), communications (number)
1967-68	700.0	210.0	-	185.0	14/-
1976-80	148.0	105.0	-	58.0	8/-
1982	368.0	175.0			
1983-86	112.0	34.0	39.9	85.0	26; bridge-80
1987-88	414.0	312.0	20.4	176.0	16; bridge -5
1989-91	405.0	100.0	18.1	60.0	26.5; bridge -3
1992-95	75.0	110.0	44.1	63.0	19.4; bridge -13
1996	112.0	20.0	15.2	65.0	8.3; bridge -2
1997-98	101.0	136.0	20.9	117.0	10.9; bridge -7
2004-2005	241.0	332.0	18.6	230.0	27; bridge -16
2006	59.0	13.0		95.0	58; bridge - 3
2007	45.0	8.0	23.0	45.0	27
2008	300.0	125.0	31.0	165.0	
2009	410.0	220.0	25.0	185.0	37.1
Total in Ajara	3 490.0	1 900.0	256.2	1 231.0	267/135

[15] Ministry of Environment and Natural Resources Protection of Georgia, National Environmental Agency

By separating the presented landslide-mudflow data into 2 nearly equal groups – till 1987 and after then, it could be derived that in the last period the number of landslides has grown by 63% and the number of mudflow transformations – by 162%. This determines the fact that at present more than 70% of Ajara's population are constantly at the risk of natural disasters.

To 2010 more than 5 000 landslides – mud torrent events, washing down of ordered riversides and coastline cases, permanent localities of snow avalanche descent have been detected in Ajara. Out of 330 settlements 75% are at hazard risk periodically, causing the rising statistics of mental disorders among local population living under the constant stress. Hundreds of hectors of arable land are being put out of action, hundreds of kilometers of motor roads and their communications become deformed and require rehabilitation. Taking into consideration that at different periods of time the same settlement or object is being detected repeatedly, total sum of cases exceeds their actual number in definite space of time.

Based upon the results of monitoring natural geological disasters in Ajara for the last 25 years, the map of region's geological hazards was drown (Fig. 3.2.1.), at which the data on spread of tectoseismogenic and triggered by atmospheric precipitation (climatic) landslides, washing out of sea shoreline, debris flow gorges, landslips, mudflows and land erosion evident manifestation areas are combined with the detection of high risk areas affected by natural disasters.

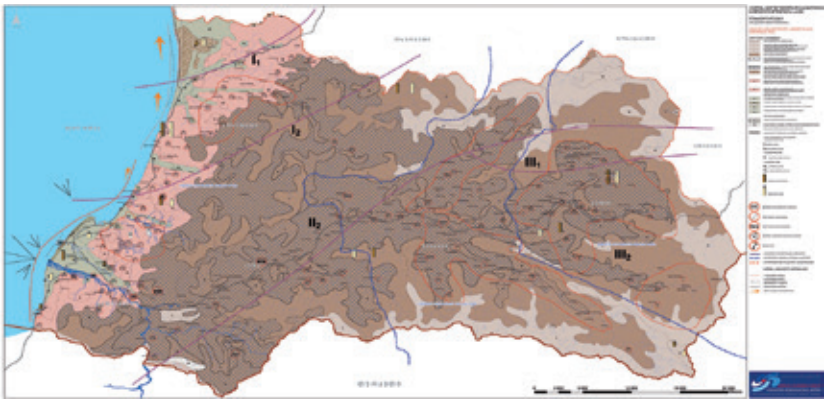


Fig. 3.2.1. Distribution of natural geological hazards at the territory of Ajara

The analysis of this map shows that the majority of landslide-mudflow processes are spread at the western flanks of Meskheti Range (Khelvachauri and Kobuleti municipalities) notable with the exceptional abundance of precipitation. Sufficiently high is the recurrence of these processes at the territory of Shuakhevi and Khulo municipalities as well, where especially should be marked out basins of small rivers entering into the upper reaches of R. Ajaristskali watershed. Relatively rare are these processes in the central part of Meskheti Range and at the northern slopes of Shavsheti

Range that partly could be associated with the low density of population in these areas.

One of related with abundant, precipitation natural disasters, causing considerable hazard to Ajara's high mountain settlements in winters with heavy snowfall are snow avalanches. In 1970-1971 winter seasons at the time of catastrophic snow avalanches descent, only in one village of Khulo municipality the avalanche has victimized 22 persons, demolished great number of dwelling houses and different constructions. The avalanche perilous hot-beds are registered at the territory of Ajara's all five municipalities, though in the lower zone, at the territory of Khelvachauri and Kobuleti municipalities, the number of avalanche prone settlements is small and makes correspondingly 3 and 4. In the Keda municipality the number of such settlements is 14, in Shuakhevi – 21 and in Khulo municipality this number reaches 45. According to available data till 2000, from the 87 avalanche prone settlements in 14 of them avalanches have caused victims and destruction of buildings, in 32 – the destructions and in 27 – damages. The remaining 14 settlements are potentially avalanche prone. For the last 10 year span, considering rising frequency of natural disasters, these numbers, apparently, would have grown.

The recurrence of snow avalanches at the territory of Ajara varies to the great extent (Table 3.2.2).

Table 3.2.2. Recurrence of snow avalanches in snow abundant winters in different zones of Ajara

Specification of zone	Altitude range (m a.s.l)	Number of avalanches per one winter	Avalanche affected area (% of Ajara's total territory)
Lowland and plans	0-200	0	18
Foothills and low mountains	200-600	<5	30
Medium mountains	600-1 000	5-10	22
High mountains	1 000-2 000	10-15	16
Alpine zone	>20 000	>15	14

During the maximum recurrence of avalanches (in snow-abundant winters) they do not appear only at 18% of Ajara's total territory, where the inclination is less than 150. In high mountains of the Meskheti Range the frequency of avalanches per one winter exceeds 10, and in Alpine zone – 15 cases.

During the minimum recurrence of avalanches (in snow-scarce winters) snow slips are not observed in low and medium mountain zones, and more than 15 cases take place in high mountain area of Meskheti Range which represents 14% of the total territory.

The duration of snow avalanche period also varies in a wide range (Table 3.2.3.).

Table 3.2.3. Duration of avalanche period in snow abundant winters in different zones of Ajara

Specification of zone	Altitude range (m a.s.l)	Duration of avalanche danger period per one winter (days)	Avalanche affected area (% of Ajara's total territory)
Lowland and plans	0-200	0	18
Foothills and low mountains	200-600	<50	18
Medium mountains	600-1 000	50-100	23
High mountains	1 000-2 000	100-150	21
Alpine zone	>20 000	>150	20

At the High Mountain and alpine slopes of Meskheti and Savsheti Ranges the maximum duration of avalanche season during snow abundant winters exceeds 150 days. High mountain areas across Ajara are featured with maximum duration of 50-100 days and in medium maintain zone the duration of avalanche season is less than 50 days.

3.2.2. The impact of current climate change on geological processes

From the geological processes the highest hazard probability for population and infrastructure utilities is related with extreme events provoked by meteorological elements namely by heavy precipitation, manifested in large excess deviation from the climate norm. In particular, for the Ajara region it has been established that:

- In annual respect the excess of precipitation by about 100 mm is not causing any significant disturbance in natural geological disasters activity;
- The excess of annual precipitation by 100-200 mm over the climate norm triggers significant rise in natural disasters activity;
- The activity of natural geological hazards climbs to its maximum at the excess of precipitation by 200-400 mm.

This regularity is true both in cold and warm periods of the year. In the spring, after snow abundant winter the excess flooding causes extensive washing down of riverine areas and other natural disasters. At the same time, the slow melting of deep snow cover initiates heavy soaking of upper layers of ground, that results in the activation of landslide-mudflow hot-beds and significant rise in snow avalanche recurrence. As to the warm period of the year, torrential rains are frequent in precipitation abundant Ajara, which readily are transforming into landslide-mud torrent processes in gorges with great inclination and corresponding geological conditions. An example of such chain of events is the activation of landslide-mudflow processes in the gorge of R. Ajaristskali in September 2009, when the precipitation sums more than twice overpassed climate norms (Table 3.2.4).

Table 3.2.4. Deviation of monthly sums of precipitation in September 2009 over the 1961-1990 climate norms

Meteorological Station	Kobuleti	Keda	Khulo
Monthly sums of precipitation (mm)	563.8	227.6	207.0
Deviation from the norm (%)	207.0	160.0	219.0

It has to be pointed out that during this month, the daily maxima did not increase, but the number of days has grown with the daily sums of precipitation exceeding 100 mm.

At the same time it has been revealed that the slow-down of natural geological disaster processes in the region is closely associated with the deficit of atmospheric precipitation.

The manifestation of global warming at the territory of Ajara started from 1990-es. Maximum rise in annual air temperature ($+0.5^0$C) is recorded in Keda and minimum rise ($+0.1^0$C) in Khulo. For the last 25 years (1986-2010), at Ajara meteorological stations the average air temperature has grown by 0.3^0C compared to the same preceding period (1961-1985). This resulted in the define alteration of the heavy precipitation regime governing most natural disasters in the region.

Ajara takes first place among the regions of Georgia with abundance of precipitation. Average duration of precipitation here equals to 1 400-1 500 hours, and its maxima annual sums can reach 3 000-3 500 mm in coastal zone and 2 000-2 5000 mm in mountains. Corresponding multi-year averages make 2 600-2 700 mm in the lowland and 1 200-1 700 mm in mountain areas. In river gorges protected from wet winds (e.g. in the Shuakhevi Hollow), precipitation sums fall down to 800-1 000 mm. For the last 25 years the maximum increase in precipitation (16%) has been recorded in Keda while at the Goderdzi Pass the 15% decrease has been observed.

The distribution of days with heavy precipitation (≥30 mm) at the territory of Ajara is shown in Fig. 3.2.2, from which it comes that most part of abundant precipitation falls in the mountain areas of Western Ajara (seashore and adjacent mountains). With lesser recurrence of heavy precipitation are featured upper reaches of R. Ajaristskali and extreme eastern part of the region embracing northern slopes of Arsiani Range.

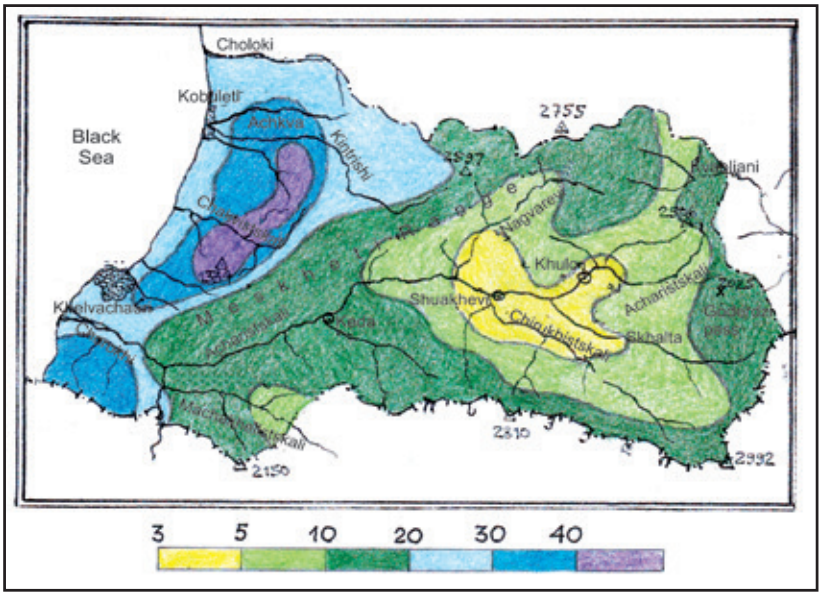


Fig. 3.2.2. Number of days with precipitation exceeding 30 mm[16]

Some features of heavy precipitation according to long term observation series of Batumi and Khulo weather stations are presented in Table 3.2.5.

Table 3.2.5. Features of heavy precipitation in Ajara

Meteorological Station	Mean daily maximum, mm	Observed daily maximum, mm	Continuous duration of precipitation, h	Maximum intensity of rain in 5 min span, mm/min
Batumi	127.00	261.00	118.00	2.84
Khulo	61.00	133.00	100.00	0.00

It could be seen from this Table that considered indices in Batumi significantly exceed that of Khulo. The same pattern is revealed in the seasonal distribution of the number of heavy precipitation days (Tab. 3.2.6).

Table 3.2.6. Distribution by seasons of days with heavy precipitation (≥30 mm)

Meteorological Station	Winter (day)	Spring (day)	Summer (day)	Autumn (day)	Year (day)
Batumi	6.6	2.0	5.1	10.4	24.1
Khulo	1.3	0.6	1.8	6.6	10.3

[16] Climatic and agroclimatic atlas of Georgia. Institute of Hydrometeorology, Tbilisi Technical University. Tbilisi, 2011, p.54.

Under the influence of global warming heavy precipitation indices in Ajara underwent certain changes (Tab. 3.2.7).

Table 3.2.7. Alteration of heavy precipitation indices in Ajara in the period of 1961-2010

Meteorological station	Daily sum ≥30 mm	Daily sum ≥100 mm	Daily sum ≥30 mm	Daily sum ≥100 mm
	Total number of cases (day)		Average daily precipitation in the period (mm)	
1961-1985				
Batumi	676	26	54	124
Khulo	198	2	45	120
1986-2010				
Batumi	650	34	54	129
Khulo	243	3	46	113

In this table along with heavy precipitation day's cases of extremely abundant precipitation (≥100 mm) are considered, the number of which in the period of 1961-2010 made 5 in Khulo. Hence, in this data category the variation of indices is not provided statistically. As to other data sets, for the last 25 years a slight reduction (about 4%) in total number of heavy precipitation cases in Batumi is observed, accompanied by the significant (more than 30%) rise in the number of extremely abundant precipitation. Total number of heavy precipitation cases has increased essentially (by 23%) in Khulo as well. Insignificantly (by 4%) has grown the average daily sum of extremely abundant precipitation in Batumi[17].

At the same time it has to be noted that in the span of considered period the trend of annual precipitation change in Ajara coastal zone has not been revealed. As to the central part of the region, the rise in sums of precipitation by 11-16% is observed in all seasons during the second half (1986-2010) of the examined period. As an exception stands the Goderdzi Pass, where the precipitation has decreased by 15%. Concerning the heavy and extremely abundant precipitation, obtained data has revealed that, at the virtually invariable background of precipitation's natural variation, evidently has increased the recurrence of heavy (Khulo) and extremely heavy (Batumi) precipitation, causing the activation of landslide-mudflow, snow avalanche and erosion processes in the region, as well as the growth of flash-flood and frequency of flooding.

3.2.3. Projected impact of future climate change on geological processes

As to the forecast of possible alteration of snow avalanche frequency and duration period in relation with the expected climate change in Ajara, on the bases of investigations conducted for different avalanche prone regions of Georgia, it has been derived that in case of 2^0C decrease of temperature and 20% growth of atmospheric precipitation, the snow avalanche risk in Ajara may rise up to 100%. However, and that seems more realistic, in case of 2^0C increase of temperature and 20% decrease in precipitation, almost in all climate zones of Ajara the avalanche hazard index may

[17] Data from the National Environmental Agency, the Department of Hydrometeorology

fall down to zero. Although, according to recently obtained climate change forecast for Ajara, till 2050 the air temperature in the region will not increase by 2^0C and precipitation in avalanche hazardous zones for the time being is increasing; hence the decline in avalanche risk is not expected. To 2100 in Khulo and at the Goderdzi Pass, the mean winter temperature is anticipated to increase by 3.3 and 3.0^0C respectively, accompanied with the growth of precipitation in the range of 4-7%. Consequently it could be derived that till the end of current century the avalanche danger in Ajara presumably will decrease.

As to the landslides and mud torrent, the intensity of which is directly related to the increase of number of heavy precipitation days and mean annual or seasonal sums of precipitation, according to existing forecast, the extreme geological events are expected to intensify as the significant increase in the number of heavy precipitation days (≥90 mm) is projected in Keda municipality in the interval of 2020-2050 (Annex I, Table 2).

Among other geological hazards related with climate change, the rise in seashore washing off intensity and acceleration of soil water erosion are considered for Ajara that is discussed in relevant sections 3.1 and 3.3.

3.2.4. Recommendations

The recommendations which are to be introduced immediately at this stage are discussed in project proposal 6.1.2.

3.3. Ajara Coastal Zone

3.3.1. Overview of Ajara Coastal Zone

The anthropogenic impact and large-scale technogenic loading on Ajara shoreline have negatively affected the morphodynamic processes going on in Ajara coastal zone, manifested in washing away of seashore and the destruction of facilities built at the waterside. Technogenic and anthropogenic loading particularly affected the most active strip of shoreline - the beach. Beach is the natural coast-protecting mechanism, which upholds from destruction and washing off private and state property disposed at the seaboard, natural, historic and cultural complexes. In Ajara the beach, and seashore as a whole, represent the top priority tourist and recreational resource. Hence, in the process of using this resource, it is necessary to use rational approach that guarantees coast stability and maintains recreational and dwelling territories. In this process, one of the most important components is the assessment and envision of risks related to climate change.

Ajara coastal zone is a vivid example of altered interaction between the sea and the land resulting from the anthropogenic impact. Till the second half of 19th century this interaction was mainly regulated by the mighty flow of R. Chorokhi sediment, which created the river delta and fed seashore in northern direction up to the mouth of R. Natanebi. In the second half of 19th century, the outfall of R. Chorokhiwas

placed in a single bed by the dams. This provoked a loss of significant part of R. Chorokhi alluvion in the underwater canyon located in front of the mouth, causing the decrease in the annual amount of coast-forming material from 2.5 million m^3 down to 400-500 thousand m^3. The following upset of natural equilibrium was initiated by the construction of Batumi Portin 1890-es, the mole of which virtually stopped the transport of alluvion to the north and stipulated its piling at the Batumi Cape. This process of accumulation turned out to be limited by another underwater canyon existing near the cape that takes up all sediment reaching the enlarged coast of the cape. Third and the most sensitive impact on the Ajara coastal zone were produced by the construction of a cascade of hydropower plants on the R. Chorokhi in Turkey. This process, which began in the end of past century, practically ceased the transportation of alluvion to the delta and stopped its flow along the coast. As a result of these processes, active seizure of land by the sea started in the Ajara coastal zone, causing one of the most acute problems in Ajara, which has scarce land resources, in general, and in particular, in its 53 km long coastal zone.

The implementation of sea coast protection measures in Ajara started from 1950-es. In the Makhinjauri-Kobuleti coastal zone different coast-protecting constructions were built with reinforced concrete, which eventually fell into disuse and distorted the coastline, as well as caused the rupture of sediment flow along the coast.

Protection of coast by rigid hydro technical constructions has not solved the main challenge for Ajara seacoast protection – deficit of sediment in the coastal zone still exists.

Since 1981 a new method of coast forming process management was introduced in Ajara, aimed at the restoration and further regulation of natural processes in the coastal zone in the framework of a single lithodynamic system. The method provided mining of beach-forming material from the bed of R. Chorokhi and underwater accumulative slopes (Batumi Cape, R. Chorokhi outfall). According to this measure, about 1.3 million m^3 of beach-forming material was brought in at the Adlia shoreline in 1982-1991, resulting in the widening of beach areas. This process was caused by the fact that the Adlia section represents a transit zone for the sediment flow along the coast and significant part of piled material was moved to the north, taking part in the formation of Batumi beaches. No coast protection measures were taken since 1991 and as a result, from 1991 to 1995 the 18-25 m wide seashore territory was washed off and from 1991 to 2000 more than 12 ha of beaches was captured by the sea at the Gonio-Adlia (part) section.

Till 1980 the coast protection activities in technogenic form were carried out at different sections of Ajara sea coastal zone: at the Makhinjauri, Chakvi and Kobuleti shores, where the wide spectrum of hydrotechnical constructions was used: vertical, wave repelling and stepped walls, boons, spurs, piles, huge reinforced concrete blocks, iron rabbets, broken stone bermas, construction waste, etc. Since 1981 all technological approaches of coast protection measures were based upon the consideration of geomorphological and recreational features of the coast. These measures were implemented by the specialized entity “Saknapirdatsva” (Seashore Protection Department of Georgia), which had vast capabilities. During the last

20 years, a number of efforts were undertaken to reanimate these activities. Coast protection measures were restored at the Sarpi-Adlia, Chakvi and Kobuleti sections. The disposition of sections in the Ajara coastal zone is shown in Figure 3.3.1, while the brief information on the present situation at these sections and on measures necessary for its improvement is presented in Annex II.

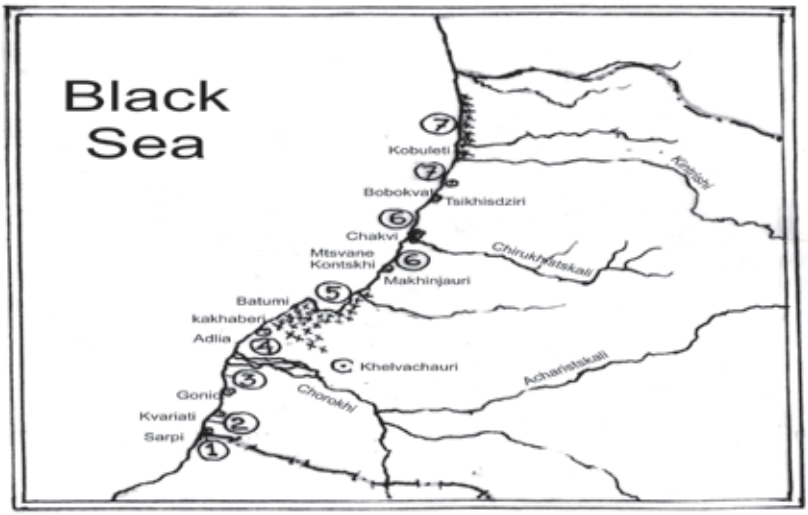


Fig 3.3.1 Sections at the Ajara sea coastal zone

1-Sarpi coastal zone; 2-Kalendere Cape; 3-Kalendere Cape-R.Chorokhi mouth; 4-R. Chorokhi mouth – Batumi Cape; 5-Makhinjauri Cape-MtsvaneKontskhi (Green Cape); 6-Green Cape-Tsikhisdziri; 7-Tsikhisdziri-Kobuleti-R.Choloki mouth.

The data given in the Annex II show that almost at all sections of Ajara sea coastal zone (except Batumi seashore), coastline is washed away with more or less intensity. To retain the shores and infrastructure facilities arranged at them, it is most effective to artificially nourish the beaches with appropriate inert material. This method produced good results at the Adlia, Makhinjauri, Bobokvati and Kobuleti sections. The introduction and continuation of this practice is necessary at the Kalendere Cape – R. Chorokhi mouth, Adlia, Green Cape – Tsikhisdziri and Kobuleti sections. Great danger is posed to the construction of multi-storey buildings at the territory of Batumi Cape - the coastline, weakened by the landslides occurring in the upper reaches of nearby underwater canyons, might not endure the huge of weight of such construction.

3.3.2. Climate change impact on Ajara coastal zone

The current impact of climate change on the Ajara coastal zone mainly was assessed using observational data on some indicators, the alternation of which could be caused only by global climate change and is not related to local anthropogenic influence. These indicators are: sea level rise relative to the land (eustasy); Storm intensity, seasonal distribution and direction; regime of sea surface water temperature.

The rise of sea level relative to the land is one of the main indicators of the Black Sea coastal zone vulnerability to climate change, which undergoes notable alteration in recent period. In particular, according to observations carried out in the past half-a-century (1961-2011), in the last 20 years, the increment of sea level at Ajara coastline exceeded 20 cm. The extreme value of level variability reached 50 cm annual amplitude. The annual course of sea level variability also changed its regime: till 1989 the autumn-winter minimum and spring-summer maximum were observed, that changed since 2006 with winter-spring maximum and the summer-autumn minimum (Fig. 3.3.2).

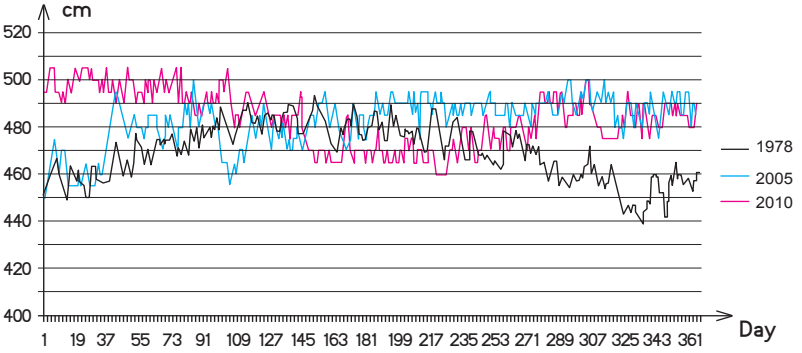


Fig. 3.3.2. Annual course of sea level variability in Batumi

The results of observations conducted for the past half-a-century on storms in Batumi show that since 1970-es up to now the sharp increase in storm quantitative features is taking place: the number of 5 force stormy days increased nearly twice, the same of 6 force days – three times, a case of 7 force storm was observed and the number of 4 force stormy days slightly decreased (Table 3.3.1).

Table 3.3.1. Variation in the number of different force stormy days in Batumi during the period of 1961-2011

Year	Force and number of different force stormy days in Batumi during the period of 1961-2011							
	4 force		5 force		6 force		7 force	
	N	%	N	%	N	%	N	%
1961 - 1970	295	81.95	59	16.39	6	1.67	_	
1971 - 1980	499	80.75	117	18.94	2	0.33	_	
1981 - 1988	485	88.03	64	11.62	2	0.37	_	
1997 - 2000	69	60.53	42	36.85	2	1.76	1	0.86
2001 - 2011	413	73.89	125	22.37	21	3.76	_	

In the last decade current climate warming changed the interannual distribution of storms as well: in 1961-2000 storms mainly occurred in late autumn and in winter, while in the last decade heavy storms took place in mid-summer as well. The rise in the frequency of gales provokes intensification of erosion processes in the sea coastal zone. e.g., in 2005 one 6 force storm which lasted for 25 hours has washed off 18 m of waterside in Adlia at the territory close to the Airport.

Global warming has also affected another indicator of vulnerability – temperature regime of sea surface water. In particular, the temperature regime, defined according to 2000-2009 observations with minimum (+7^{0}C) in February – March and the maximum (28-29^{0}C) in July-August, started to alter its course in 2010, when the sea surface water temperature reached 33^{0}C. This anomaly was caused by the heat wave intrusion from Europe, where extremely high temperatures were holding on for 2 weeks. For this period of time, number of rainy days has also decreased significantly in Ajara coastal zone. The same course of temperature was repeated in 2011 when the sea surface temperature reached 30^{0}C and retained extreme value for rather long time than in 2010 (Fig. 3.3.3). As a result of these processes, the populations of mussels and oystershave massively perished in summer of 2010 in Ajara coastal zone.

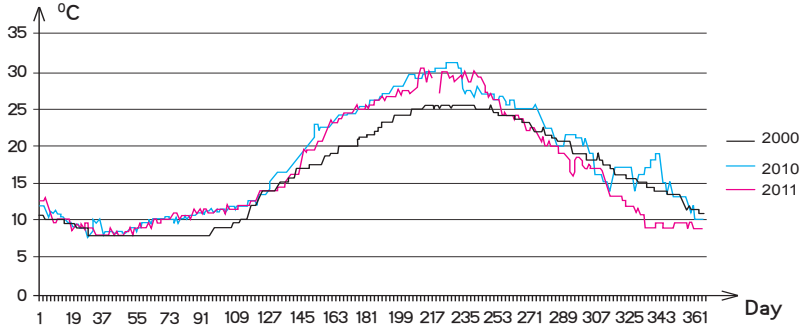


Fig. 3.3.3 Annual course of sea surface water temperature in Batumi in 2000, 2010 and 2011

3.3.3. Anticipated impact of climate change on the Ajara coastal zone

The discussed above indicators for the assessment of processes going on in the sea coastal zone and trends of their change will be presumably altered slightly more in the current century under the impact of global warming. Along with the anticipated permanent sea level rise at the rate of 2-3 mm/yr and the increase in the frequency of heavy storms, the further activation of erosion processes under the anthropogenic loading is expected. This will even more aggravate problems discussedabove.

The strengthening of dynamic impact of storms on the coastal zone is causing the necessity to intensify the coast protection activities. E.g. at the Adlia section of coastline, where at present 100 thousand m^3 of inert material is brought in annually, for the protection of new boulevard the piling of 150 thousand m^3 of material will soon become necessary. The provision of new wave parameters will be required while designing the coast protective hydrotechnical constructions.

The list of measures which are to be conducted in Ajara coastal zone, taking into account the anticipated impact of climate change, is also given in Annex II.

3.3.4. Recommendations for the Ajara's coastal zone

The list of measures which are to be conducted in Ajara coastal zone, taking into account the anticipated impact of climate change, is also given in Annex II.

3.4. Forestry sector

3.4.1. Overview of Ajara forest sector

According to the State Register of Ajara Forest Fund, at the territory of the region that equals to 290 000 ha, Forest Fund occupies 192 488 ha that makes 66% of the total area. From this area 162 103.7 ha (84%) is managed by Ajara's Environment Protection Administration, 13 693 ha belongs to the Kintrishi Nature Reserve, 770 ha – to the Kobuleti Park. The endemic and relict plantations of trees dominating the forests are population's the main source of timber and firewood and represent the major natural resource of the region.

Main areas occupied by forests are functionally distributed in the following way:

- Soil protection and water regulating – 128 070 ha (67%);
- Shore protection strips for water objects – 5 869 ha (3%);
- Subalpine forests – 7 084 ha (4%);
- Protective forest areas adjacent to settlement – 12 422 ha (6%);
- Zones of potable water's watersheds – 1 991 ha (1%);
- Green zone forests – 6 668 ha (3%).

Total Forest Fund includes following areas of agricultural and economic prescription: natural forest – 187 849 ha; artificial forest – 796 ha; burned and lost groves – 59 ha; fields and forest farms – 626 ha; tilled – 51 ha; hay fields – 59 ha; pastures – 1 281 ha; orchards, vineyards and others – 18 ha.

The remaining 865 ha are occupied by settlements, shingly riversides, marshes, rocks, other useless lands. Forests are thinned out at the area of 2 789 ha equaling to 1.5% of total forest area.

The specific composition of Ajara forests is diverse and contains about 400 kinds of trees and shrubs, from which beech, chestnut, spruces and abies are spread at the majority of areas. Data on main kinds of plants, the area under which exceeds 1 000 ha, their average age and total stock of phyto-mass assessment are given in Table 3.4.1.

Table 3.4.1. Areas under dominant kinds of plants in Ajara forests, their average age and stockpiles of phyto-mass

#	Species	Total area, ha	Average age, year	Total stock of phyto-mass, thousand m^3
1	Abies	19 213.0	120.0	12 734.5
2	Spruce	24 223.0	84.0	14 086.1
3	Pine-tree	1 587.0	53.0	541.9
4	Beech	80 255.0	130.0	42 484.0
5	Oak	6 807.0	70.0	1 204.5
6	Hornbeam	6 656.0	70.0	2 090.5
7	Chestnut	26 324.0	71.0	10 126.8
8	Alder	11 818.0	52.0	2 844.7
9	Rhododendron ponticum	8 683.0	29.0	402.5
10	Cherry-laurel	1 988.0	41.0	56.3
	Total	187 554.0		87 571.8

Data presented in this table concerning 10 major species with sufficient precision (0.2-0.6%) describe overall spread and phyto-mass stock of plants in Ajara forests.

Besides species listed in Table 3.4.1, areas exceeding 100 ha in Ajara forests are occupied by nut-tree (241 ha), aspen (231 ha), linden (132 ha), cryptomeria (116 ha) and eucalyptus (106 ha). Relatively less area is under white acacia, maple, bamboo, persimmon, box-tree and others.

The majority of coniferous species (95.7% of total area) are concentrated on the territory of Shuakhevi and Khulo municipalities, while significant part (31.6%) of deciduous kinds occupy Keda municipality, as well as sufficiently large areas (total 52%) in Kobuleti, Khelvachauri and Shuakhevi municipalities. Mean annual increment of timber producing species equals to 493 thousand m^3, or 1.2% of total stockpile.

Owing to the paramount importance of Ajara forests for environment protection and economic activity of local population, logging for export at the territory of Ajara is prohibited by low.

As it was mentioned above, Ajara forests are only supplier of timber and firewood to the population. By this reason, annually, according to municipalities, permits are issued on social logging, accounting to 100-150 thousand m^3 of timber per annum, equal to 0.2-0.4% of overall reserve. In particular, in 2009 130 478 m^3 of timber has been allotted, from which 81 100 m^3 was assimilated.

The assimilation level of legally admitted logging in Ajara is not high. E.g. in 2009 it equaled to 62% that is caused by the absence of access roads and difficulties in pulling out of timber. At the same time in this year 522 cases of illegal logging have been registered in which 2 646 m^3 of timber was cut down costing 21 310 laris. The damage to the environment was estimated at 148 935 laris. The volume of illegal logging obviously is increasing with the elevation of the territory. In recent years the average volume of illegal cutting in Kobuleti forestry made 329 m^3, in Keda forestry – 464 m^3 and in Khulo – 684 m^3. Illegal logging predominantly takes place in the vicinity of roads, thus aggravating the anthropogenic loading on the environment caused by the construction of roads and triggering crumbling of roadsides, activation of landslides, etc. On the other hand, without constructing of access roads, it's impossible to pull out legally logged timber that causes the decay of waste and correspondingly facilitates the spread of vermin and diseases in forests. According to available data, in 2006-2011 six-year period, 463 454 m^3 of timber and firewood has been cut down in Ajara forests, from which 35 580 m^3 or 7.7% of assimilated wood remained not pulled out, in the form of waste. This means that annually, on average, 6 000 m^3 of timber is decaying in the forest, stipulating the absorption of oxygen from the atmosphere and the emission of greenhouse gases (carbon dioxide and methane), which contributes to the global warming.

It should be mentioned here that since 2010 the volume of illegal logging in Ajara has significantly declined. This is a result of legislative amendments, introduced this year, which essentially increased the penalty for poaching in forestry.

Along with above mentioned functions, Ajara forests play important role in absorbing major greenhouse gas – carbon dioxide from the atmosphere and enriching air with oxygen. In carrying out of relevant assessment, the density of major plants dominating Ajara forests was calculated in the first place. On the bases of existing data, it was derived that the density in the region of absolutely dry wood for deciduous kinds may be equal to 0.56 t/ m^3 and for coniferous kinds 0.43 t/m^3. According to 2005 Ajara forest fund inventory data, the annual increment of wood for deciduous and coniferous kinds makes on the average 2.3 and 3.8 t/ha respectively. Considering these values and other indices taken from different references, it was revealed that in 2000-2011 the mean carbon uptake rate in Ajara forests was equal to 0.88 tC/ha per annum and the corresponding removal of CO_2 made – 3.2 t CO_2. Thus, the forest cover on the territory of Ajara as a whole annually absorbs 167.4 thousand tons of carbon dioxide.

As it could be seen from Table 3.4.1, the forests in Ajara are sufficiently old, what

caused the spread of different diseases among the plants in the last half-a-century. Total area of forests enveloped with illnesses is reaching 11 788 ha that makes 6% of overall forest fund. In the lower zone of the region, mainly in Kobuleti, Khelvachauri and Keda chestnut groves, from the phytopathological diseases most frequent is *Chriphonectria parasitica*, while in higher zones, in Kobuleti, Shuakhevi and Khulo spruce and abies groves, the enthemological pests are spread. In particular, in coniferous forests of these municipalities *Dendroctonicus micans*, *Isp tipograohus L and Ips acuminates Eichh* are dominating. They cause the worsening of wood quality and loss of trees stability. From the rotten fungi are to be mentioned *Phellinius pinivar, Abietis and Armillaria mellea*. These pests and diseases are causing massive drying of trees. The results of monitoring of sicknesses in Ajara are given in Table 3.4.2.

Concerning the spread of diseases the situation is especially grave in Ajara chestnut groves.

Table 3.4.2. Results of the inventory of thinned out, eroded and sick plots in Ajara forestry

Forestry	Total area, ha	Among them sick area/ ha	Eroded/ degraded area, ha	Thinned out area, ha	Composition	Taxation of accounted trees		
						Number (trees)	Mean diameter (cm)	Average stock (m^3)
Kobuleti	23 790.8	3 800.0	32.0	245.0	cn, sp, ab	954 825.0	-	57 4 915.0
Khelvachauri	23 470.8	1 800.0	-	132.0	cn	79 489.0	-	56 550.0
Keda	37 679.5	1 117.0	4.0	145.0	cn	125 592.0	-	71 420.0
Shuakhevi	39 980.3	3 754.0	-	662.0	sp, ab	720 540.0	-	880 664.0
Khulo	37 182.2	1 317.0	-	1 605.0	sp, ab	143 364.0		108 066.0
Total	162 103.6	11 788.0	36.0	2 789.0		2 014 810.0		1 691 615.0

3.4.2. The impact of current climate change on Ajara forestry sector

The problem of waste decay and concomitant spread of pests and diseases is aggravated by the climate warming which began in Ajara from 1990-es under the influence of global warming. It is well known that the rise in temperature and growth of precipitation facilities the propagation of vermin and illnesses in forest ecosystems.

As a result of survey carried out in Khelvachauri and Keda chestnut groves, it has been found that the drying of chestnut trees has both group-hotbed and dispersed character. On the total area of chestnut groves (18 897 ha), by 2010 the dried and drying plants occupied 20% of total area (5 209 ha) comprising 209 725 m^3 of wood, and this area is annually widening. In recent period Kobuleti and Keda municipalities experienced the highest increment of air temperature (up to 0.5^0C) at the territory of Ajara. Increase of number of very hot days and tropical nights, rainy and heavy precipitation days

was highest in this in these municipalities. Even though the relation between climate change and spread of mentioned above diseases is not yet investigated in Georgia, close correlation is evident. Along with the rise in mean annual air temperature the spread area of sickness is gradually climbing into the high mountain chestnut groves (Shuakhevi, Khulo).

Unfortunately, no case of retreat of mentioned above diseases has been noted yet. For the present, the abatement of *Chriphonectria parasite* (the chestnut cancer propagation) is possible only by adequate care and conduction of sanitary loggings. If this measure is not carried out in proper time, the drying up of chestnut groves will, presumably, get of a larger scale. The mentioned disease is already revealed in other species as well (oak, hornbeam) though for the time being it has not caused their drying up.

Chestnut trees of more than 1990 m^3 volume, which wrecked and fell in past years, should also be added to the sick chestnut groves, as they are the hotbed for the propagation of pests and diseases and contain an increased hazard of forest fire origin considering growth of number of very hot days and tropical nights.

It ought to be mentioned as well, that in dried up chestnut groves the evergreen underbrush, consisting of *rhododendron ponticum* and cherry-laurel, is being activated hampering the sprouting and growth of chestnut saplings. At the same time, disposed under the snow cover, evergreen underbrush facilitates the origination of snow-slips. On such plots the undergrowth is to be cut according to necessary rules by strips or windows and 1.5-2.0 m high chestnut trees are to be planted.

The survey has indicated that relatively new diseases – *Cameraria ohridella deschka, Tischeria companella HB=Tischeria Ekabladellia Bjerkander and Cylindrokladium buxicola* have emerged with various intensity in Ajara forests in 2006-2010 period. Considering climate warming, this can disastrously endanger the relict and endemic host species. In particular, the above mentioned sickness of box-tree embraced 55-65% of Kintrishi protected landscapes and up to 60% of box-tree populations in the Mtirala National Park in the last 2-3 years. This illness with relatively low intensity is spreading out in the gorges of rivers Chorokhi, Machakela and Ajaristskali as well.

Sufficiently complicated situation is being created in Ajara coniferous forests. Presently at 5 870 ha (13% of total area) most part of plants are dried up, fallen or heaped up, containing 421 000 m^3 of wood or 2.5% of total stock. In hot periods of summer, along with the promotion to vermin propagation, this sharply increases risk of forest fire.

The analysis of 2006-2011 timber production data in Ajara has revealed that during this 6-year period 10% of deciduous (23 199 m^3) and 5% of coniferous (11 530 m^3) trees were abandoned in forests as a waste. Corresponding numbers for illegal cutting in the same period made 507 and 343 m^3, totally- 850 m^3 of waste.

As to the problems created by climate change in subalpine forests, it should be mentioned that for the last 50 years the upper boundary of forest in Ajara has shifted down by 300-400 m. This is mainly caused by washing down of soil under the graves and development of erosion processes during heavy rainfall in upper reaches of river

basins. At present, in the subalpine zone 2 790 ha of area is registered, where the forest still retains natural self-restoration capacity. However, this process is impeded by the grazing of livestock and by anthropogenic impact. For the solution of this problem, it is necessary to fence the thinned out plots and take the measures facilitating natural renovation of forests.

3.4.3. The impact of future climate change on Ajara forest sector

According to the projection of climate change on the territory of Ajara, to the middle of current century the rise of mean annual temperature by 1.5^0C is expected, and to the end of the century – by 4.2^0C. At the same time significant increase in the number of hot days and tropical nights is anticipated, that will facilitate further activation of vermin and diseases in Ajara forests.

As to precipitation, after the insignificant rise by 1%, their decrease by about 10% is expected to the end of the century, although according to the forecast of such extreme indices as R (50) and R (90)[18], the number of days with such heavy precipitation will either decrease or slightly increase.

Based upon these projections it could be expected that forest fire hazard and plant diseases risk in Ajara will increase while the extinction of subalpine forests and lowering of their upper boundary hazard will decline.

3.4.4. Recommendations

The decreased above anticipated changes are partly provided in the "Ajara AR Regional Development Strategy" prepared in 2010, according to which strategic directions in forestry sector are as follows:

- Complete inventory of forest fund and detailed analysis of its agro-ecological and socio-economic aspects;
- Preparation of initiatives for the perfection of legislative base on forestry;
- Raising of professional skill level of forestry sector employees;
- Creation of suitable conditions for the attraction of private investments in forestry sector;
- Finding of investments for the elimination of vermin and plant sickness hotbeds;
- Construction of new roads in the allotted tree-felling areas, specially allocated for the provision of population with firewood;
- Expansion of activities aimed at promoting reforestation, afforestation and natural self-restoration of forests. Combating pests and diseases, intensifying forest fire protection measures.

In the climate change strategy of Ajara, these activities are supplemented with the survey of climate-related illnesses, their monitoring and preparation of adequate recommendations. In the framework of the present report relevant project proposal has been worked out.

[18] Amount of one day precipitation is given in parentheses (mm)

3.5. Ajara's Protected Areas

3.5.1. Overview of Ajara's protected areas

Protected areas play an important role in the mitigation of climate change and thus it is essential to facilitate their adaptation to ongoing climate alteration. The forest ecosystems of protected territories are significant sink of GHGs, at the same time preventing other ecosystems from the negative impact of climate change or essentially lessening it. Ajara's protected areas are keeping ecological balance in the basins of rivers Kintrishi, Chakvistskali, Korolistskali and Machakhelisstkali, that in its turn mitigates the development of erosion and landslide processes and negative consequences of flash floods not only in mountain, but in plain terrain areas. Ajara's protected territories are safeguarding the stability and purity of potable water at the large part of the region including the city of Batumi. At the background of climate change the protected areas, as localities free of anthropogenic loading, represent essential reserves for the preservation of biodiversity.

Same to other localities, climate change at the protected territories is being manifested mainly in the rise of temperature and precipitation. However, the impact of climate change here is taking place without serious anthropogenic loading that eliminates the increase of its negative influence. Therefore, it can be assumed that specific display of climate change, its impact on habitats and species hard to determine climate change share in existing environmental problems, as almost all ecosystems are experiencing substantial anthropogenic pressure. In the frames of protected territories the impact of anthropogenic factor is much smaller compared to other localities and hence, the distinction between climate change and anthropogenic influence is considerably easier. The monitoring of climatic successions of biodiversity and natural ecosystems at the protected territories is important because it could be used to assess climate change impact outside the protected areas as well.

The unique features of Ajara's geography determine great number of protected territories, the total area of which (39 036 ha) exceeds 13% of region's overall area. Protected areas are disposed in Ajara coastal zone and in western part of mountain terrain (Fig. 3.5.1).

Fig. 3.5.1 Protected areas of Ajara Autonomous Republic

Main features of protected areas are given in Table 3.5.1. Ajara's protected territories are created to preserve the Kolkhida refuge species of flora and fauna which are unique in the world. This is caused by the fact that during Ice Ages Kolkhida served as a refuge for territory relict species, the rare diversity of which has reached up to now.

Table 3.5.1. Ajara's protected areas

Protected area		Established in	Category (according to IUCN)	Area (ha)		Location
Kobuleti (Ispani) Protected Areas	Kobuleti Nature Reserve	1999	I	238.03	603.47	Kobuleti Municipality, adjacent to city of Kobuleti
	Kobuleti Managed Reserve	1999	IV	365.44		
Kintrishi Protected Areas	Kintrishi Nature Reserve	1959	I	10 703	13 893	Kobuleti Municipality, in 20-25 km from Kobuleti, in R. Kintrishi gorge, between vil. Tskhemlovani and Mt. Khino. Lower altitude 250-300 m a.s.l, higher altitude at alpine meadows at 2 600 m a.s.l.
	Kintrishi Protected Landscape (Managed Reserve)	2007	V	3 190		
Mtirala National Park		2006	II	15 806		Kobuleti-Chakvi Range, in 12 km from the sea, covering Kobuleti, Khelvachauri and Keda municipalities
Machakhela National Park		2012	II	8 733		R. Machakhelistskali basin, Khelvachauri and Keda municipalities

The territory of Kobuleti Wetlands is an important site of biological and landscape heritage. About half of its area is occupied by sphagnum-grassy marsh "Ispani-2", the vegetation cover of which is preserved in natural state. This Nature Reserve, along with the Kolkheti National Park, is included wetlands, protected under the Ramsaar Convention.

Most part of Kintrishi Protected Areas is covered with forests and shrubs dominated by biomass of beech, chestnut, hornbeam and rhododendron. Among them the share of relict, relict-endemic and endemic kinds is outstandingly high. The aim of creating Kintrishi Managed Reserve is to develop ecotourism, as far as the strict regime of nature reserve excludes such activities.

The Mtirala National Park, according to the diversity of its landscapes, is divided into 3 functional zones. Namely:

- Strict protection zone (about 17% of the territory), which includes especially sensitive ecosystems and those parts which have not experienced significant anthropogenic changes. They do not contact directly with economic space and even the research and monitoring activities are strictly controlled here;
- Visitors zone (54% of total area), intended mainly for nature conservation and visitors, having relevant infrastructure;
- Traditional use zone (29%), the principal function of which is to let the local population to continue the traditional (controlled) use of forest resources. The territory of National Park is almost by 100% covered with forests and bush, dominated by beech, alder, chestnut and rhododendron kinds. Territory of the Park includes Mt. Mtirala (1 334 a.s.l.), at the top of which annual sums of precipitation reach 4 000 mm, being the record value for the entire territory of the Caucasus.

The territory of Machakhela National Park is also occupied nearly by 90% with forests and shrubs, among which the share of relict and endemic kinds is sizable. In verdure cover the kinds of beech, chestnut and alder are prevailing. 75% of the territory is attributed to virgin and less altered areas. The National Park directly borders protected area in the neighboring Turkey – the Jamili Biosphere Reserve that creates favorable conditions for the transboundary conservation of unique ecosystem in the watershed of R. Machakelistskali.

The development of tourism in Ajara's protected areas has begun since 2007. That year the Kobuleti Protected Areas were viewed by 215 visitors. In 2008 hundreds of visitors were hosted by Mtirala National Park and Kintrishi Managed Reserve. In 2011 Ajara's Protected Areas were visited by nearly 33 thousand guests.

3.5.2. The impact of current climate change on Ajara's Protected Areas.

The status of protected areas excludes any serious anthropogenic influence on natural ecosystems at the local scale. For this reason these territories are the best indicators in revealing the impact of climate change on processes happening in these ecosystems, their habitats and species.

Sadly, Ajara's protected areas, with the exception of Kintrishi Nature Reserve, have a short history of functioning. As it is seen from the Table 3.5.1 this period for them does not exceed 12 years. At the same time, the "strict" status of Kintrishi Nature Reserve significantly limited and in some cases excluded carrying out of monitoring and research activities at its territory. Thus, the scarcity of information on biodiversity in Ajara's protected areas does not allow identifying completely specific forms of climate change impact.

Within the boundaries of Ajara's protected areas the impact of climate change on natural ecosystems could be considered to be argued only for verdure diseases and the brook trout.

In particular, the change in temperature and precipitation – humidity regime, going on in Ajara's forests during the last two decades, has affected their sanitary and ecological state. For the last period the spreading of existing diseases and detection of new illnesses are revealed in protected areas. From the old diseases are to be mentioned *Chriphonectria parasitica, Dendroctonus micans, Ips typographus L, Ips acuminaties Eichh and Phellinius pinivar.* From the relevantly new diseases must be named *Cameria ohridella Deschka, Tischeria companella Hb* and, the most important, *Cylindrokladium buxicola.* This last illness, for the last 2-3 years has embraced about 60% of box-tree populations at Kintrishi protected areas, Mtirala and Machakhela National Parks. In more detail this item is discussed in section (3.4) devoted to Ajara forests.

Historically the brook trout (along with its outgoing form – the Black Sea salmon) was the most widely spread kind of fish in Ajara rivers – Kintrishi, Chakvistskali, Korolistskali, Machakhelistskali and others, the most important and valuable species of local fishery. This was stipulated by the ideal hydrological, hydrochemical and hydrophysical conditions for trout-salmon spewing and obesity in Ajara Rivers. In recent years a sharp decrease in the number of this charismatic species is observed, which is caused, according to experts, by illegal fishing, regulation of river runoff and climate change. In compliance with their assessments, the population of brook trout in Ajara rivers has declined 3 times in the last two decades. The located up to 600 m a.s.l. most sections occupied with trout in rivers Machakhelistskali, Kintrishi, Chakvistskali and Korolostskali are disposed within the limits of protected areas (the Mtirala and Machakhela National Parks, Kintrishi Protected Areas).

The brook trout is a cold water loving form. Its optimal temperature range lies between 8^0C and 16^0C. For fry that index is even lower. This temperature regime defines the concentration of oxygen dissolved in the water, preferable value of which varies in the range of 9.5-12.5 mg/l. The rise in temperature brings the deceleration of oxygen

concentration in the water, due to which in hot summer months (July-September) populations of trout gathered in Ajara rivers move to their upper sections and head in cooler places. This results in limitation of space and food for populations, especially harming the trout fry due to typical for this form behavior and cannibalism. This factor is one of the main reasons for the depletion of brook trout as a result of climate warming.

Ajara's protected areas are seriously affected by such extreme geological events as landslides and flash floods. For the last 20-30 years more than 1 100 ha has been damaged and put out of use. In its turn, hardy ecosystems created at the protected territories can effectively prevent river banks and other areas from degradation and losses, as it was mentioned above.

3.5.3. The impact of projected climate change on Ajara's protected areas

The afore-cited data indicate that climate change can essentially affect natural ecosystems of Ajara's protected areas. According to data presented in Georgia's Third National Communication, the rise of mean annual temperature by 2-4^{0}C and increase in annual precipitation by 5-10% is expected at the territory of Ajara till the end of current century. These changes could seriously damage Ajara protected area's flora and fauna. In particular, the area of already spread diseases in forests will widen significantly that will especially endanger the chestnut and box- tree populations. The climate change will facilitate the specific alteration of forests owing to the intrusion and spreading of more heat-loving species as well as the lifting of forest upper boundary by some hundreds of meters. Seriously will be jeopardized populations of brook trout. Taking into account these hazards, a number of project proposals have been elaborated in the framework of present project, aiming to take concert measures against the spread of insects and diseases in Ajara's forests and to restore populations of brook trout in rivers (see sections 3.4, 6.1.5, and 6.1.6).

At the same time, before planning measures of mitigation and adaptation to climate change in Ajara's protected areas, the monitoring on biodiversity (species and habitats) and climatic processes in natural ecosystems should be established, including carrying out of joint observations on verdure diseases in close cooperation within floristries of adjoining regions (Guria, Samtskhe-Javakheti) and neighboring country (Turkey). These activities should be accompanied with taking measures against vegetation illnesses (both biological and integrated) at protected areas and bordering forestry plots, widening/creation of protected territories in high bio conservational localities of Ajara (Tikery Forestry in Kobuleti Municipality, Chirukhi areas in Shuakhevi Municipality, rivers Londari and Didghele basins, upper sections of rivers Ajaristskali and Kinkisha basins in Kintrishi protected areas).

3.6. Agriculture in Ajara

3.6.1. Overview of Ajara's agriculture

The diverse natural conditions of Ajara define its multifield structure of agriculture, though its scale creates numerous problems to the development of agriculture. Agricultural land occupies 72 862 ha of the total land fund (290 000 ha), out of which only 5% is plain. The distribution of land per capita is 0.19 ha, among which 0.03 ha is arable land. The main part of the region is occupied by steep mountains; in addition, precipitation is intense in the region (2 000-3 000 mm) causing erosion processes in soils; this, in its turn, decreases fertility of land and causes extreme geological events such as water flashes, landslides, mudflows and avalanches. As a result, amount of agricultural lands decreases: if in 1980 it comprised 78 718 ha, by 2010 it comprised 72 862 ha. 15 899 out of this is perennials, 10 309 ha is arable land, 7 159 ha is mowing, 1 736 ha is long fallow and 37 759 is pasture. Soil erosion processes are supported by production of annual crops without preliminary protective measures. In the same period the areas for the perennial plants decreased.

Notwithstanding the scarcity of lands in Ajara, until 1990 Ajara's agricultural sector produced 35% of region's Gross Domestic Product that accounted for 39% of country's Gross Domestic Product.

Since 1990, during political-economic crisis caused by transitional period, the effectiveness of the agricultural sector significantly fell down, productiveness of the cultures was reduced and product quality deteriorated, as a result, it became uncompetitive in the foreign markets. Due to the land reforms, the lands was given into the ownership to pheasants, however, in most of the cases, the lands plots were small, that did not support the creation of effective farms using modern technologies. Due to the absence of care, tea plantations and the most part of the citrus plantations were completely damaged, crop production was reduced by two-times and even more. According to the official statistical data, currently 50 231 families are engaged in agricultural sector, out of which 1 353 (3%) is left without the land plot; 48 878 (68%) owns the land plots with area from 0.2 ha up to 1.0 ha. Only 2% of the farmers possess land plots with more than 2 ha space. Each household has 4 family members. Due to ineffectiveness of agro production, only 39% of local population is provided by the local products. The data given on Table 3.6.1 show that only request on potatoes is satisfied with surplus. There is a big deficit in production of eggs and meat. Taking into consideration the fact, that during the summer season the amount of visitors and tourists usually increases 3 times, sometimes even more, the necessity for modernization of the agrarian sector is obvious.

Table 3.6.1. Indicators of provision of food products produced in Ajara for 2010

Description	Annual consumption, kg	Request in tons	Delivery in tons	Deviation in %
Bread and bread products	120.5	48 200.0	9 450.0	-80.7
Potatoes	96.7	38 680.0	48 550.0	17.8
Vegetables	146.0	58 400.0	18 000.0	-69.2
Fruit and fruit products	110.0	44 000.0	13 025.0	-70.4
Meat and meat products	73.0	28 200.0	5 700.0	-80.5
Fish and fish products	18.3	7 320.0	4 000.0	-46.4
Milk and diary products	434.0	173 600.0	59 600.0	-65.7
Eggs	14.6	5 840.0	216.6	-90.6

Ajara's agricultural sector is in critical condition due to the fact that in recent times the sector mainly focused on production of perennial subtropical cultures, while production of secure agricultural crops (cereals, vegetables) was shifted to the secondary place. Recent political and social-economic changes in the country requested the restructuring of the agricultural sector in order to grant priviledge to local products.

In order to achieve progress in Ajara's agricultural sector, selective works should be improved. Until 1990, stations for selection and testing of species, and licensed nursery economies functioned properly in Ajara. However, renewal and propagation of aborigine, endemic, relict and endangered plants lacked proper attention. For the development of agricultural sector and for the establishment of sustainable development, more than 0.5 million plants are needed. Besides, there is a huge demand on the Ajara grapes, pears, apples and other decorative and treatment plants on the international market. In order to fill the existing deficit, selective works, including establishment of multi-profile plant economies, should start. For the above-mentioned reason, in 2011 "Agro-service center" was created in Ajara that started working in the direction of improvement of the sub-tropical cultures.

According to statistics, production of all essential products increased significantly in recent 2-3 years.

The data of exchange of agricultural products is given in Fig. 3.6.1 in order to describe agricultural trends in Ajara. As we can see from this Figure, in the last 30 years, only productivity of potatoes (almost by 3 times) and tobacco increased, at the same time, changes in other agricultural products are still unstable.

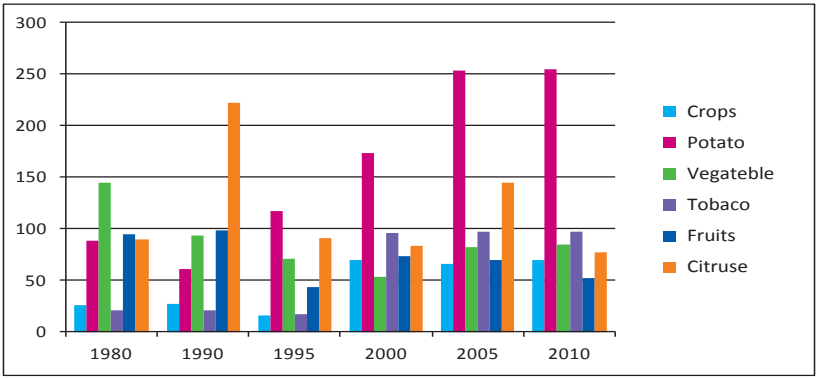


Fig. 3.6.1. Productivity (center/ha) of agricultural crops in Ajara 1980-2010

The following fields are developed in Ajara agriculture:

Citrus production.Tthis field started to develop in Ajara from the end of the 19th century. Due to climatic conditions it covers only areas of Kobuleti and Khelvachauri municipalities. By 1987 the citrus plantation area reached its maximum and comprised 8 945 ha, out of which 4 680 ha (almost half) fell on private sector. By 2010 total area decreased to 5 945 ha, 4 945 ha (83%) out of which falls on private sector. For the time being, most of the citrus plants are deteriorated and need to be replaced by Japanese breeds that can bring significant economic effect.

Tea-production. During Soviet times, tea production was considered one of the most important sectors in Ajara. By 1980 tea plantations occupied 7 500 ha of the region and on average 65-70 tons of tea leaves were harvested every year, out of which 16-17 tons of long leaf tea was produced. From 1997 significant reduction of tea plantations started that was followed by the loss of the tea areas. As a result, by 2010 instead of the existing 5 616 ha only 1 103 ha was left for tea, the rest of the areas was spoiled and not usable. Current common practice is to root out the old unusable tea plantations and plant other cultures instead. According to the policy of the Ministry of Agriculture of Ajara, up to 1 000 ha of tea plantations will be maintained in Ajara region that will be transferred to the private ownership. For this reason, up to 10 private companies were established in Ajara that produce tea leaves. Due to the reorganization of the sector in this way, tea production is no longer considered as the key field.

Fruit production in Ajara represents the traditional field. Plural-stone fruits, nuts, phanerogams and berries are equally developed here. Fruit production, in addition to being one of the significant sources of income, carries an important function of combatting land erosion and landslides in the mountaneous regions of Ajara.

In the 80-es, the fruit trees occupied 5 512 ha of the total area and up to 30 000 tons of fruit was produced. Currently the fruit area covers only 2 480 ha and harvest varies between 10-13 thousand tons. Ajara forests are rich with forest fruit and berries.

Grape production one of the oldest and tradition fields, though due to the improper attention paid to it, by 2005, the grapes areas, which comprised 470 ha by 1990, was reduced to 136 ha, and the production of grapes decreased from 2 000 to 500 tons. In order to improve the situation, it is planned to increase vineyards up to 250 ha by 2015, accordingly – production of wine up to 1 000 tons and wine material – up to 1 800 tons. Special attention will be paid to unique local species of grapes: Chkhaveri, Tsolikauri, Ojaleshi, Aladasturi).

Vegetable production has vast potential and is quickly developing. Intensive increase of tourism activities in the region causes such a quick development of the field. According to the preliminary calculations, in the nearest years, demand for vegetables in the region will increase to 100 thousand tons that 10-12 times exceeds the current production level. For achieving the above goal it is necessary to create small and large greenhouses. The work in this direction has already been started and in future, taking into consideration the forecasted climate warming, increase of its effectiveness is expected. However, slope degree and erosion coefficient of agricultural lands should be taken into consideration when improving the productivity.

From the ***crop cultures*** maize, soya and beans are dominants in Ajara. Due to the low level of agrotechnics, the maize harvest at the time being comprises 5-7 tons per ha, that is 3-4 times lower than potential harvest.

Insufficient attention is paid to the development of ***tobacco production***, though there is a deficit of the product on the international world market, this business has a good potential of development. Taking into consideration experience gained in the past, production of fermented blended tobacco has good potential.

Cattle-breeding in Ajara is one of the oldest traditions and fields supported by the numerous pastures and grazing existing in the high mountainous regions of Ajara. By 1985 the number of cattle comprised 131.6 thousand, pigs – 6.8 thousand, and sheep and goats - 10.8 thousand. After the significant decrease in 1990, in 2010 the amount of cattle increased, though the productivity is 3 times less compared to the world standards. In order to fill the deficit and maintain the minimal level of production the population is forced to increase the amount of cattle, what results in overgrazing of pastures within the conditions of improper management. In order to improve the existing situation, it is necessary to improve consistence of breeds, renovation of multiplication of cattle and instillation of the modern technologies, including activities to increase the level of pastures. It is also important to establish the modern, well-equipped slaughter-houses.

Apiculture. Problems in cattling negatively affected the apiculture sector as well, namely, impact is expressed in destruction of grey bees, significant decrease in honey production and low profitability of the field. Due to the existence of Alphine meadows and chestnut forests, Ajara apiculture has vast potential of development, though it is not sufficiently used. This is reflected in low productivity of the field, that comprises 7-8 kg per family.

Silk production. Before 1990, 100-150 ha in Ajara was occupied by mulberry and 30 tons of silk was produced per annum. Recently, as a result of destruction of

silk production facility, mulberry trees have been completely deteriorated and silk production was ceased.

In order to develop silk production, it is planned to bring in plants of mulberry trees or produce them locally and distribute these trees among local population. As a result, by 2015 up to 80-100 plants of mulberry trees will be created. Meantime, silk warm eggs will be also imported and manufacturing factories will be established. As a result of these actions, Ajara will get additional income.

Fishery is one of the oldest traditional fields in Ajara. In the last century, a state facility for fishery and fishers' cooperative operated in Ajara and it produced more than 15-20 tons of fish; also there was an economy that produced more than 2 tons of fish.

Since 1990-ies, ignorance of fishery sector resulted in a decrease of fish production to the minimum. Currently, fishing facilities can catch only 500-600 tons of fish. More than 80 private trout economies that ensure production of tens of thousands of fish every year partly fill existing deficit. .

Very important problem of Ajara's agricultural sector is fertility of soil and erosion. The harvest of agricultural cultures is on average 3-4 times less than in leading countries. This is caused by the fact that nothing has been done in this direction during the last 15 years. In order to support farmers to get harvest on their already small land plots, first of all attention should be paid to the increase of fertility by utilization of organic-mineral fertilizers.

According to the researches of the monitoring carried out recently in direction of plant protection, American White Butterfly still remains the main wreck for Ajara region. Within the citrus cultures Silver tick and different plant vermin still occupy 6-50% of the total area.

In viticulture the main disease still remains vine mould. From the potato and vegetable pests the dominant is Colorado Beatle and from weeds the rough leaf ambrosia and wild Solanaceae are spread most of all Chemical methods of combating with these diseases should be decreased and limited, and accent should be made on ecologically clean methods for the future.

Development of agricultural sector in the region should be supported by the flexible bank system as well. For the time being, most of the bank institutions keep away from financing of such small agricultural economies that is partly caused due to absence of insurance in this sector. Taking into consideration that effectiveness and success of agricultural sector mainly depends on the weather and climate, in order to reduce risks it is important to create effective insurance system and instill it in the region. Instillation of the above insurance system needs relevant support and approval from the government via changes in legal regulations.

In the development of agricultural sector in Ajara and increase of income for the locals, it is important to produce ecologically clean products and development of agro-tourism. The trend in this regard is visible, tourists are intersested to visit interesting places and taste ecologically clean local products. Ajara possesses huge potential in

this regard. Existence of cultural and biological economies guarantees that visitors from different countries will have opportunity to visit different sites and taste the local production.

3.6.2. Current impact of climate change on Ajara agricultural sector

The agriculture in Ajara is mostly affected by the following most important parameters of climate change: air temperature, amount of precipitation, amount of frost days and their seasonal distribution, duration of vegetation period, and totals of active temperatures. From the air temperature indicators special attention is paid to the totals of minimal and maximal temperatures on sub-tropical cultures due to their negative impact; from the precipitation – to the totals of precipitation by seasons and months and their distribution during the vegetation period taking into consideration the parameters. Notwithstanding the fact, that Ajara is more than enough provided with precipitation, during the vegetation period agricultural cultures still experience the lack of it. Due to the slopes, the soils are washed out during the precipitation, i.e. the erosion takes place.

Different climate change parameters are given in Chapter 2.1 and Annexes I and III.

From the review made in the first chapter we can consider that the main fuels of agriculture in Ajara currently are: citrus production, fruit production, vegetable growth and cattling.

For Kobuleti and Khelvachauri municipalities of Ajara Autonomous Republic citrus production is the key and the high priority field. Production of subtropical cultures here is aupported by the existence of the relevant climatic conditions, though it should be taken into consideration, that our sub-alpine zone represents the extreme Northern part of the world, climatic specifications of which are caused due to 2 factors: Black Sea, which in summer accumulates huge amount of warmth and disseminates it in winter, that mitigates climate and high mountains of the Caucasus that prevent the waves of cold winds from the North.

It is a confirmed that from the existing factors the major one affecting citrus growing is climate change and agro-technical activities. Comparison of the years 1981-1990 (socialism period) and 1991-2010 (individual production) has shown, that during the first period the average of harvest exceeded more than twice (14.8 t/ha) harvest of the second period (7.7 t/ha).

Notwithstanding the above, Ajara's sub-tropical zone is not completely protected from frosts, that is why citrus leaves and bushes are under risk to be frozen; as for the fruit, for its technical ripening the total of 4 000-4 500 active temperatures sum is needed. According to the Khelvachauri and Kobuleti meteorological stations, necessary temperature for the fruit to ripe is accumulated by 15-24 November. At this period of time (at least once in 3-4 years) cold weather and solid precipitation (snow, hail) is expected. This damages the fruit and lowers it competitiveness on those markets, where there is large choice of tangerine and oranges.

According to climatic data, the second period did not differ from the first in regards to any extreme deviations, though certain changes are observed in duration of vegetation

period, increase of very hot days and general warming tendency. Unfortunately, at the moment the direct link between the climate change and reduction of citrus harvest could not be established. The reduction of citrus production can be explained by insufficient attention paid to the plants. So, according to the existing data, it is difficult to argue on the impact of the already revealed climate change on citrus growing. Besides, during the last 20 years there were so many negative factors affecting the citrus growing that their impact turned out to be dominative compared to climate change impact?

Though, there are other problems that might have link to climate change. Some of the problems related to climate change revealed in citrus sectors in Kobuleti and Khelvachauri municipalities are given in Annex III, Table 1. From this table it can be clearly seen that the major problem in citrus field is climate change that is expressed by warming and insufficient attention towards this problem. At the moment the best way to combat the problem is instillation of early species of citrus. Kiwi culture is also considered to be one of the perspectives.

Warming provision problem is less stringent in fruit and grape production fields for Ajara, as for the lower, as well as for the higher zones. Fruit and grape spices are adapted to the local climatic conditions and they do not face problems related to ripping (see Annex III, Table 1).

Development of tourism sector in Ajara actualizes vegetable sector development in Ajara to provide fresh vegetables for the tourists and visitors. As mentioned above, at the moment only 39% of population is provided with the local products (Table 3.6.1), not mentioning the tourists. Within the current conditions of climate change special attention is requested for tomatoes (see Annex III, Table 1) that might be caused due to the climate change. Though, such researches have not been carried out.

As for the potato culture, in the mountainous and high mountainous conditions, currently this culture gives good harvest and there are profitable climatic conditions for the increase of the productivity.

For the assessment of climate change on potatoes Aqua crop program prepared by FAO was used, also – climatic data provided by Khulo Meteorological stations. The harvets of the potateoes was assessed only for Khulo municipality, for which potatoes are the leading culture. The model has shown that currently in Khulo region the conditions for potato production is beneficial and the harvest has increased by 10-13%, which is in compliace with the real statistics. Within the impact of the existing climate, the harvest of potatoes will remain in the same condition within certain period of time (the model does not envisage anthrophogenic influence, liketreatment methods, fertilizers, etc.).

Figure. 3.6.2 represents changes of potato harvest in the past.

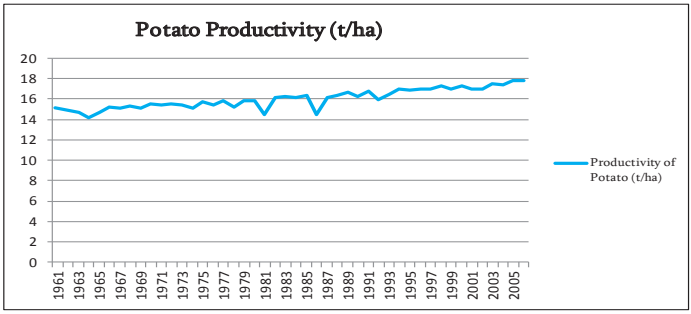


Fig. 3.6.2 Harvest of potates (t/ha)[19]

According to the statistical data, the average harvest of potatoes, based on which the model is calibrated, is created based on the indicators of 1997-2006 years (15 t/ha). According to the agricultural statistics, in 2007 and 2008 the average harvest in Ajara comprised 17-18 t/ha, that equals to 13% of the increase, though during the further years decrease was still started[20].

The current change of climate has already affected the cattling field. Due to the warming, intensive and frequent precipitations cause washing out of soils from the slopes that is followed by significant decrease of pastures.

The assessment of water deficit on pastures was made by FAO via using CropWat model and observations made on meteorological stations on Goderzi pass. The modeling has shown that the pastures in this region do not suffer from water deficit. This is reflected in the Figure 3.6.3.

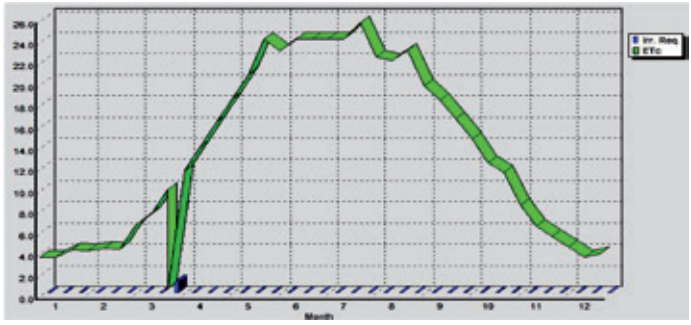


Fig. 3.6.3. Water requirement (green lines) and deficit (blue lines) in pastures in Ajara's alpine zone by months (average of the 1961-1990 years)

[19] This is date for the harvesting bases on the modeling without additional activities. In reality the harvest in these municipalities was increased by 18-20 t/ha (2000) and 27 t/ha (2011-2012). This is the info provided by the locals and is not in compliance with the official statistical data.

[20] Agriculture of Georgia, 2011. Statistical publication, Tbilisi, 2012. www.geostat.ge

By using the multi-criteria analysis method[21] the assessment of vulnerability of Ajara against climate change on agricultural sector was carried out for all 5 municipalities (Khelvachauri, Kobuleti, Khulo, Keda, Shuakhevi). In total 27 parameters were assessed. See the list of parameters and their explanation in Annex II. The assessment was made in three directions: impact of climate change on agriculture, vulnerability to climate change, and possibility of municipalities against adaptation. The climate change parameters were taken for two 25 year periods: 1961-1985 and 1986-2010 as given in the climate change scenarios. Observations of 2 meteorological stations were used Annex III, Table 4).

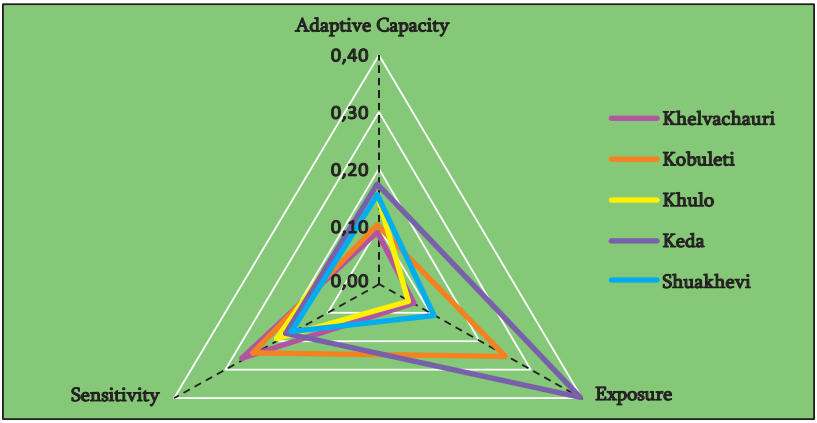


Fig. 3.6.4 Vulnerability of agriculture to climate change in Ajara taking into consideration adaptation capacities of municipalities[22]

For the assessment of climate change impact, the increase of floody days was used (when the daily precipitation exceeds 50 mm), also increase of days when the daily maximum temperature exceeds 25^{0}C (SU 25) and increase of droughts calculated by SPI index, i.e. during the period of 3 months, when the precipitation during these 3 months is less than usual.

Based on the assessment it was concluded that climate change impact (with all the above three parameters) was mostly observed in Keda Municipality, Kobuleti is on second place, almost the same indicators are for the rest three municipalities (with the following sequence: Shuakhevi, Khelvachauri and Khulo). These changes are very similar in Khelvachauri and Khulo municipalities.

Khelvachauri region turned out to be the most vulnerable to climate change by soils and biodiversity, after Khelvachauri come Kobuleti, Khulo, Keda and Shuakhevi. The big difference is not observed.

Regarding the adaptation potential, Khelvachauri and Kobuleti turned out to have

[21] The adapted version via this method was provided by EU project implemented by REC Caucasus. http://www.rec-caucasus.org/projects.php?lang=en

[22] Batumi and Khelvachauri are not discussed as the separate municipalities in Agriculture sector

the weakest adaptation potential (i.e. where the population is more intensive and infrastructure is more developed). Keda and Shuakhevi were assessed as having the highest adaptation capacity.

By the assessment of the all three parameters, it was revealed that agricultural sector is the most vulnerable to climate change in Keda region (0.75) and secondly in Kobuteli (0.60). All the other three municipalities are equally vulnerable to climate change.

The analysis of changes of climatic parameters made in 1980-2010 years has shown that it is very important to assess climatic risks in both, natural and anthropogenic systems, definition of vulnerability to the possible climate changes and implementation of the relevant adaptation measures.

Taking into consideration the leading role of agriculture in the economy of Ajara, it is important to prioritize the major fields and assess risks related to climate change.

Table 4 of the Annex III summarizes the major problems revealed in agriculture in Ajara according to the municipalities.

3.6.3. Expected future impact of climate change on Agriculture in Ajara

As per the possible impact of climate change by 2050, the yearly average, especially in warm periods, might make significant corrections into the indicators of quality and quantity of citrus. It is known that Western Georgia is on the margin of Mediterranean Sea pool and neighboring area. During the vegetation period the following cultures experience the lack of warm temperature totals: orange, grapefruit, lemon, etc. Namely, according to the existing data, ripping of oranges and grapefruit in Ajara is possible only 5-6 times every 10 years. According to the forecast made within the current project, increase of average yearly temperature by 1.5^0C is expected by 2050 in the coastal zone of Ajara, by 2100 by 4.2^0C. By 2100 Ajara's low regions will be equaled to the Mediterranean Sea region, from the climatic point of view, where the average yearly temperature currently varies in the area of 18^0C. All the above, including extension of duration period by one month by 2050 will create beneficial environment in Ajara's low lands to receive high quality and stable harvest of citrus.

Expected warming of climate in the first half of the century, will most probably have positive impact on fruit and grape production via increase of vegetation period. In the second part of the century the increase of temperature by $4\text{-}5^0$C and decrease of precipitation by 5-30% might cause serious problems to two agricultural fields. Providing cultures with moisture will be problematic and this problem will be aggravated by sharp increase of evapotranspiration in conditions of increased temperature. Taking into consideration this issue, essential expansion of irrigation systems will be necessary, as well as introduction of new breeds that have ability of adaption to new climate conditions.

Within the current climatic conditions, when riping of vegetables is possible only during 5 months (November – April) and only in the conditions of the greenhouses, the combating of the mentioned problem is connected with huge financial resources.

Within the expected climate change conditions, by 2050 increase of vegetation period in low and high lands will simplify the problem and will make it possible to reduce expenses by 10-20%. By the end of the century, the average temperature in the coastal zone will exceed 10^0C (Table 2.2).

By 2050 due to the further increase of temperature the complicated conditions related to tomatoes might worsen, that will raise the necessity of introducing new breeds that can adaptat to new conditions.

By 2050, in case of possible warming, dissemination of potatoes cultures will be possible in the high regions of Ajara (this process has already been started), though this process should be very well organized and planned to avoid problems that might be caused due to extreme events.

According to climate change scenario, (Table 2.4), during 2021-2050, the average yearly temperature will increased by 1.5^0C, precipitation - by approimately 2%. Due to these changes, the harvest of potatoes during 2021-2050 years will be less by 7% compared to the 1991-2005 years. The Table 3.6.2 shows the annual average for harvesting for the three different periods.

Table 3.6.2. Changes in harvest of potatoes in Khulo municipality in different periods

Period	Harvest of potatoes (tons/ha)	Water deficit (mm)
1960-1991	15.47	22.2
1991-2005	17.00	20.6
2021-2050	15.78	50.4

This forecast data in harvesting is in compliance with the same model prepared by the World Bank for the same periods and is averaged for the high-mountaneous regions of Georgia.[23] As per forecast of deficit of precipitation in future compared to the current period, the forecasted water deficit in the Table 3.6.2 is higher (60%) than in the assessment of the WB. This should be explained as follows: the data given here is local and refers to Khulo municipality, World Bank's assessments covers the whole mountaneous parts of Georgia. These resulrs are quite normal, taking into consideration difficulties related to the precipitations and dependness of the forecast on the local conditions.

The current negative impact of climate change on cattling is highlighted in Chapter 3.6.2. At the same time, according to climatic forecasts, the increase of temperature by $1.6\text{-}2.2^0$C in the mid of the current century should be beneficial for the cattling and will increase the productivity of the pastures. Regarding the reduction of precipitation by 1-8%, most probably, it will not have much affect on improvement of the pastures (here we mean that anthropogenic factor is excluded).

[23] Reducing the Vulnerability of Georgia's Agricultural Systems to Climate Change. Impact Assessment and Adaptation Options. Prepared by IEC for WB.

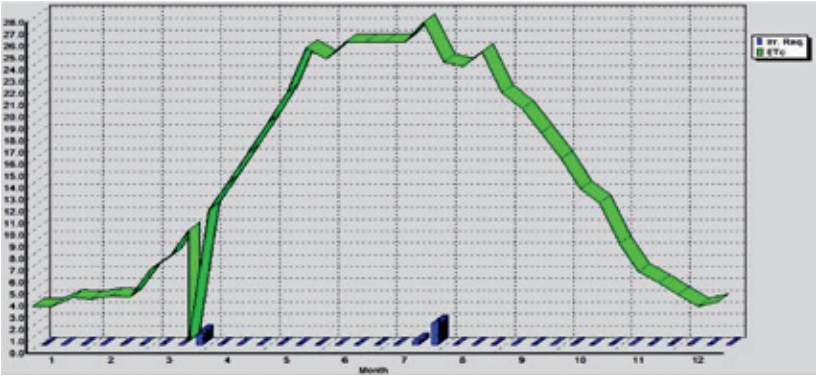


Fig. 3.6.5. Water requirement (green lines) and deficit (blue lines) in pastures in Ajara's alpine zone by months (average of the 2021-2050 years)

Generally, the vulnerability of agriculture was assessed according to the municipalities for the future period (2050). In this case multi-criteria analysis method was used, but changes in the future was taken into consideration only for climatic parameters, that increases mismatches, since in reality changes in other parameters will take place as well and potential of adaptation of the municipalities will be significantly increased. Taking into consideration this possibility, we get the following Figure:

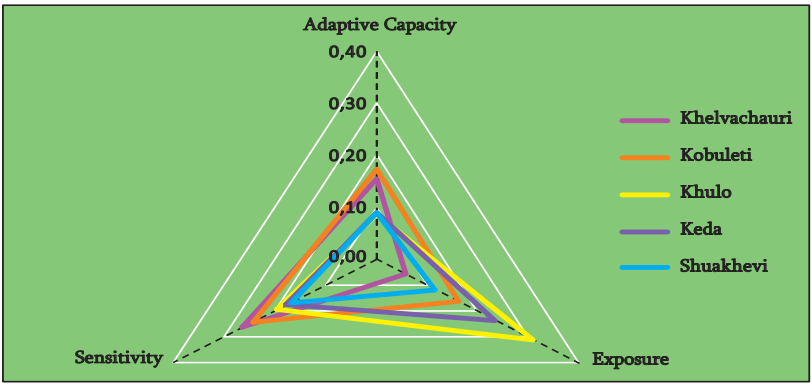


Fig. 3.6.6. The forecast of vulnerability of agriculture to climate change in Ajara region by 2050, considering the changes only in climatic parameters

Fig. 3.6.6 shows that by 2050 the parameters selected for agriculture will mostly affect Kobuleti municipality, and according to the totals of all the three indicators, the most vulnerable will be Kobuleti municipality (0.75), situation in Keda will be improved and it will be shifted into the least vulnerable category (0.31).

3.6.4. Recommendations

During the recent times the whole chain of activities supporting agriculture were carried out in Ajara aiming at supporting the creation of beneficial conditions for export of local agricultural products (free trade or beneficial rates with different countries and unities), reduction of taxes, etc. notwithstanding the above, there still are preventing factors and need for changes in legislation exists. These legislative changes first of all should cover the land reforms and regulations acts. Notwithstanding the fact that agricultural reform started in 1992 and should have been finalized by 1999, due to a lot of mismatches and breaches this regulation was not carried out. According to the Ajara regional development strategy (2010), in order to support effective utilization of land resources, activation of privatization processes should started, meaning that this process has not been finalized yet. Due to the low amount of land in the regions, most of the privatized lands are small, which does not support or make possible creation of farmers' unions or purchase of the hard machinery/equipment.

The analysis of the problems existing in the region confirms, that the leading problem is soil degradation caused by water erosion and reduction of fertility, contamination and neglecting of achievements of modern agro-technical equipment. In order to combat the problem it is necessary to establish united policy for land usage that will regulate issues related to land utilization, protection of soil from contamination, avoidance of land degradation and other concerns related to land. In this regard, the following recommendations have been outlined:

- Complete integration of environment protection and economic development planning;
- Elaboration of such approaches in land resource management and implementation that would create united, integrated system;
- Distribution of management of natural resources with strictly defined responsibilities;
- Development of new partner relationships and maximal involvement of all interested parties in decision making process;
- The legislation in regards to land management should be revised and updated in order to create relevant legislative basis for sustainable development of land management. The revised and amended legislation should ensure effective control and monitoring of law execution;
- Development of agricultural sector in the region should be supported by the flexible bank system as well. For the time being, most of the bank institutions keep away from financing such small agricultural economies, that is partly caused by the absence of insurance in this sector;
- Taking into consideration that effectiveness and success of agricultural sector mainly depends on the weather and climate, in order to reduce risks it is important to create effective insurance system and instill it in the region. Instillation of the above insurance system needs relevant support and approval from the government via changes in legal regulations;
- Creation of agro service centers in Ajara that would provide private land owners with service equipment, fertilizers and can provide assistance on

agro-chemical and veterinarian issues. It can also provide consultations with regards to juridicial and marketing issues. Agroservice centers can play significant role in the development of sustainable development of Agriculture in Ajara.

3.7. Healthcare sectore

3.7.1. Overview of Ajara's health sector

World Health Organization (WHO) provides a list of the diseases connected with climate change and named as climate-related diseases.[24] Those illnesses are: diarrheal diseases, also, in general, water-, food- and vector-borneillnesses, cardio-vascular and respiratory diseases, health problems caused by extreme events (including traumas, mental disorders and diarrheal diseases), pathological conditions caused by high exposure to sun and heat waves, and diseases associated with malnutrition.

The climate change trend in Ajara region has been observed during the last twenty years, which gives a chance to estimate the influence of each climate element on distribution and rate of above mentioned diseases; also it gives an ability to make a future projection on further distribution of climate-related illnesses. Results should be included into the development plan of two prioritized sectors – tourism and healthcare.

Distribution of climate-related diseases in Ajara region

Based on the study made in frame of the Third National Communication to the UNFCCC, the following climate-related diseases can be considered as the most important in Ajara: diarrheal diseases, and in general, infectious illnesses, including anthropozoonotic infections, mental disorders, traumas and cardio-vascular diseases (mainly arterial hypertension, ischemic disease, as they are considered the most health-sensitive problems).

3.7.1.1. General distribution of infectious and parasitic diseases

General indicator of distribution of parasitic diseases per 100 000 citizens in Ajara was estimated according to the data of 2009 and 2010 (Table 3.7.1)[25].

Table 3.7.1. Incidence (new cases) of parasitic diseases in Ajara (2009-2010)

Year	Incidence Ajara (adults)	Incidence Georgia (adults)	Difference Ajara-Georgia (%)	Incidence Ajara (children)	Incidence Georgia (children)	Difference Ajara-Georgia (%)
2009	1 702	1 440	18	6 152	4 593	34
2010	1 858	1 608	16	6 298	5 190	21

[24] http://www.who.int/features/factfiles/climate_change/facts/en/index.html
[25] Healthcare.National Center for Disease Control and Public Health.2010

As the Table 3.7.1 shows, incidence of parasitic diseases in both age categories in Ajara significantly exceeds the average number of incidences in whole Georgia. According to the general number of incidences, in 2009 Ajara took the third place, and in 2010 - the fourth place among other regions of Georgia.

The similar table was revealed for the mortality of parasitic diseases. (Table 3.7.2).

Table 3.7.2. Mortality of infectious and parasitic diseases, Ajara, 2008-2010

Year	Mortality Ajara	Mortality Georgia	Difference Ajara-Georgia (%)
2008	1.6	1.1	45
2009	1.2	1.0	20
2010	1.5	1.0	50

According to the mortality rate of infectious and parasitic diseases, Ajara took the first place in 2008 and the second place – in 2009 and 2010. This can be considered the sign of the heavy burden of above mentioned diseases and the poor management of the certain links of healthcare sector in Ajara.

3.7.1.2. Diarrheal diseases

Diarrheal diseases, the distribution of which is highly related to high temperature and its duration, are considered the main health problem in Ajara region. According to the incidence rate in 2009 and 2010, Ajara took the first place among other regions of Georgia; also the incidence rate is 4-5 times more than the average rate for whole Georgia (Table 3.7.3). The increase of diarrheal disease cases is particularly observed during the touristic season (June-September), 60-65% of all cases happen in this period. At the same time, it appeared that in major cases children under age of four become victims of this disease, which indicates, that this group is one of the most vulnerable groups to climate change (together with elderly people and people with chronic illnesses).

Table 3.7.3. Incidence of diarrheal diseases, Ajara, 2009-2010

Year	Incidence Ajara (adults)	Incidence Georgia (adults)	Ratio Ajara/Georgia (%)	Incidence Ajara (children)	Incidence Georgia (children)	Ratio Ajara/ Georgia (%)
2009	925	225	4.1	3 638	873	4.2
2010	14 768	2 626	5.6	9 368	1 743	5.4

It is significant, that along with diarrheal diseases there is high rate of tuberculosis, which may be connected with the specific climate (high moisture) in Ajara region. If we take in consideration the future trend of slight increase of humidity in Ajara, we can assume that this may increase the number of this particular disease. At the same time, this correlation is mainly indirect and needs additional studies.

3.7.1.3 Other infectious diseases

It is worth noting that in recent years the cases of such anthropozoonotic infectious sicknesses have been detected in Ajara, which are not specific to this region. Those are vector-borne diseases spread by certain vectors and animals. Those vectors need specific environment for reproduction – high temperature and humidity. As those climate parameters tend to increase by time in Ajara, the activity and the number of vectors are expected to increase as well. That is why the rate of infectious diseases such as Leptospirosis and Borreliosis increased during the last years[26].

Leptospirosis, which is considered as water- and food-borne disease and infects humans through animals, has been registered for 9 years in Ajara. From those 101 registered cases 43 belong to 2008-2010, and from 31 registered cases, 19 were officially proven by laboratory tests in 2011, and 12 were classified as a possible case of Leprospirosis. It is noticeable, that 5 of verified patients died, which proves the seriousness of this disease. In spite of the fact, that Leptospirosis is related to farming activities, its rate is fairly high during the touristic season (August-September), particularly at coastal zone: in Batumi and Kobuleti (Fig.3.7.1). As study revealed, the cases of Leptospirosis tend to increase in months with high maximum temperature. Correlation coefficient between the rate of disease and the maximum temperature was 0.58, which is considered moderate. No correlation was revealed between the number of Leptospirosis cases and the relative humidity.

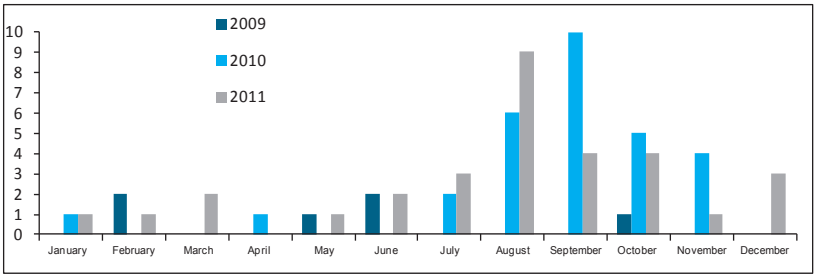


Fig. 3.7.1 Monthly and annual distribution of Leprospirosis in Ajara (2009-2010)

The first cases of Boreliosis (Lyme disease) were registered in 2009. In 2011 15 cases were proven by specific laboratory tests. This fact, also the increase of the incidence of Lyme disease, may be related to climate change, particularly – to increase of temperature in Ajara region. Also, the condition of health care system as well as urbanization, migration and "behaviour" of immune system (it cannot easily adapt to new environment including diseases) may be considered a contributing factor. Thus, unless healthcare system is mobilized and preventive measures are taken, annual increase of rate of Leptospirosis and Lyme disease is expected.

[26] National Center for Disease Control and Public Health of Ajara.

3.7.1.4. Other climate-related diseases

From other climate-related diseases mental disorders are found to be more unusually distributed in Ajara region. This group of diseases also contains the small group of illnesses known as Post-traumatic Mental Disorder, which shows connection with the traumas (physical as well as mental) and extreme weather events. The prevalence of mental disorders in Ajara for 2009-2010 is 1915, when average number for Georgia for the same time frame is 1 758 (with difference of 9%)[27]. According to the same type of assumption (498 and 218 accordingly), difference found in children appeared to be much (2.3 times) higher. Incidence of the disease in adults in Ajara region is 13% higher than in whole Georgia and in children even higher -by 58%. The same trend is found for traumas as well: as for 2009 the difference in prevalence in adults and children appeared to be 24 and 49%, and difference in incidence -6 and 48%. The main explanation for such a high number of prevalence and incidence in children may be the fact that Ajara region, compared with other regions of Georgia, is very much characterized by natural disasters (landslide, mudflow,)and this can be considered a reason for acute and chronic stress affecting mental status of a person. Taking in consideration the fact mention previously, besides taking preventive measures, it is highly desirable to establish the center for post-traumatic mental rehabilitation, which can be included into the Disaster Risk Redaction (DRR) management plan.

Regarding the cardio-vascular diseases, there is no strong evidence of high level of incidence and prevalence in Ajara region, at least compared with other climate-related diseases.

3.7.2. Influence of current climate change processes on distribution of diseases

In order to determine the connection between climate-related disease and climate change, correlation between climate-sensitive illnesses and climate parameters were estimated in different time frames (yearly, monthly)[28]. For annual estimation 1990-2010 years were picked, while monthly estimation was done for 2008-2010.

3.7.2.1. Diarrheal diseases

In order to estimate connection between distribution of diarrheal diseases and climate change in Ajara during last 20 year, we picked mean annual temperature for 1990-2010 years and distribution of diarrheal diseases per 100 000 persons (Table 3.7.4). The mean annual temperature was taken as an average for four meteorological stations (Batumi, Kobuleti, Khulo and Goderdzi pass).

[27] National Center for Disease Control and Public Health, Department of Statistics

[28] For specific diseases different years are picked, but mostly last 20 years are estimated. Such difference can be explained by the lack of statistics provided by the National Center for Disease Control and Public Health.

Table. 3.7.4. Connection of diarrheal diseases to mean annual temperature in Ajara (1990-2010)

Years	Mean annual temperature (^{0}C)	Increase (^{0}C)	Cases of Diarrheal disease, average number	Increase (%)
1990-1999	11.4	0.0	81.0	0.0
2000-2010	11.8	0.4	252.0	211.0

As it is shown on the Figure, in 20 years the cases of diarrheal diseases increased along with the temperature.

There is quite strong connection between monthly distribution of diarrheal diseases and mean monthly temperature in Batumi, Kobuleti, Keda and Khulo municipalities. The correlation within months in above mentioned municipalities is changing in the range of 0.6-0.9 and is 0.74 on average. Monthly correlation is particularly high during a touristic season (June-September), whena high distribution of diarrheal diseases is registered. In Batumi, as well as in other above mentioned municipalities, there no connection was revealed between distribution of diarrheal diseases and monthly precipitation.

3.7.2.2. Cardio-vascular diseases (CVDs)

Several specific CVDs are identified as the most sensitive illnesses to climate change. Those are: arterial hypertension, ischemic disease of heart, cerebral-vascular disease. In order to find correlation, following climate parameters were identified: average maximum temperature, average precipitation and number of rainy day[29].The analysis made for 2000-2010 revealed the following results:

- Incidence of cardio-vascular diseases has been increasing in the same way as the average annual temperature but the increase of CVDs is more dramatic than the increase of temperature. There were some connections revealed between incidence of hypertension disease and CVDs and maximum temperature and rainy days;
- There was some connection identified between ischemic diseases and maximum temperature and rainy days;
- There is also connectionbetween cerebral-vascular disease and number of rainy days. (correlation is 0.5).

Cardio-vascular diseases, unlike diarrheal diseases, are identified as less climate-sensitive illnesses, as it takes time for climate change processes to make some influence on cardio-vascular system and to identify the cases of CVDs. In spite of this fact, low positive connection between incidence of CVDs and monthly maximum temperature is identified.

[29] Cardio-vascular diseases are known as sensitive illnesses to temperature and humidity. That is why those climate parameters were picked for analysis.

3.7.2.3. Mental disorders and traumas

In order to determine the relationship between extreme events and mental disorders and traumatic diseases, repeatability of mudflows and landslides were taken in consideration. Correlation between mental disorders and extreme events is rather high: correlation with landslides is 0.6 and with mudflows – 0.65. The result can be understood in term of the fact, that stress caused by natural disasters may be a reason for mental disorders.

Traumas are in high correlation with mudflows and landslides and correlation coefficient is 0.7 and 0.85 respectively. The result can be understood as following: mudflows and landslides cause increase of number of traumatic diseases, worsening of health and sometimes - death.

In general, it can be stated, thatthe increase of lethal and traumatic cases, unsanitary conditions caused by the breakdown of water-provision and sewage systems, explosion of infectious diseases caused by the unsanitary conditions, increase of the number of post-traumatic mental disorder cases, and breakdown of healthcare infrastructure are correlated with floods and landslides.

3.7.2.4. Heat Waves

Heat wave is described as a prolonged period of excessively high temperature which may be accompanied with high humidity. In general, heat waves occur in summer and result in increase of mean daily temperature by 2-3^{0}C and last from several days to several weeks. There is another description of heat waves, e.g. in Netherlands it is known as a temperature regimen when temperature is 22^{0}C for five days or 30^{0}C for three days.

It is very important to estimate negative impact of heat waves on human health. Aggressive attack of heat waves was registered in Europe in 2003 when 35 000 people died. Only in France 15 000 people died from the negative impact of heat waves.[30]

As it was mentioned previously, heat waves are characterized with high temperature and humidity and have negative impact on human health. Combination of those two climate parameters gives Heat Index (HI), which thoroughly describes perception of the temperature by human body. It is known that in different humidity regimen perception of the temperature by human body differs. In other words - the Heat Index is a measure of how hot it really feels when relative humidity is factored with the actual air temperature.

National Oceanic and Atmospheric Administration (NOAA) has developed a heat index chart, where colors change according to the weather threat[31].

[30] Patrick Lagadec; Understanding the French 2003 HeatWave Experience: Beyond the heat, aMulti-Layered Challenge; Journal of Contingencies and Crisis Management, 2004.
[31] http://www.nws.noaa.gov/om/heat/index.shtml

RH (%)	Temperature (°C)															
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
90	28,04	30,73	33,75	37,08	40,72	44,68	48,95	53,54	58,45	63,67	63,67	75,06	81,22	87,71	94,51	101,6
85	27,85	30,22	32,89	35,87	39,14	42,71	46,58	50,76	55,22	59,99	65,06	70,43	76,1	82,07	88,34	94,91
80	27,67	29,74	32,1	34,74	37,67	40,88	44,37	48,14	52,21	56,54	61,17	66,08	71,28	76,75	82,51	88,56
75	27,48	29,28	31,36	33,69	36,3	39,17	42,31	45,72	49,39	53,33	57,53	62,01	66,75	71,76	77,03	82,57
70	27,29	28,86	30,67	32,73	35,04	37,6	40,41	43,47	46,78	50,34	54,15	58,21	62,52	67,08	71,89	76,95
65	27,11	28,46	30,03	31,84	33,88	38,66	38,66	41,41	44,38	47,58	51,02	54,69	58,59	62,73	67,09	71,69
60	26,93	28,08	29,45	31,03	32,83	34,84	37,07	39,52	42,18	45,05	48,14	51,44	54,96	58,69	62,64	66,81
55	26,74	27,73	28,92	30,31	31,89	33,67	35,64	37,81	40,18	42,75	45,51	48,47	51,63	54,98	58,53	62,28
50	26,56	27,42	28,45	29,66	31,05	32,62	34,36	36,29	38,39	40,68	43,14	45,78	48,59	51,59	54,77	58,12
45	26,38	27,13	28,03	29,09	30,32	31,7	33,24	34,94	36,81	38,83	41,02	43,36	45,86	48,52	51,34	54,33
40	26,21	26,86	27,67	28,61	29,69	30,91	32,28	33,78	35,43	37,22	39,14	41,21	43,42	45,77	48,27	50,9
35	26,02	26,63	27,36	28,2	29,17	30,26	31,47	32,8	34,26	35,83	37,53	39,34	41,28	43,34	45,53	47,83
30	25,84	26,42	27,09	27,87	28,75	29,73	30,82	32	33,28	34,67	36,16	37,75	39,44	41,24	43,13	45,13
Note: Exposure to full sunshine can increase HI values by up to 10°C																

Fig 3.7.2. Heat Index and level of threat by colors

The part of the chart, where Heat Index is in yellow box describes a temperature (estimated as a very warm temperature) with some threats (caution), but less dangerous than darker yellow boxes (hot temperature). Orange boxes (very hot temperature) and red boxes (extremely hot temperature) can result in extreme threat for human health.

According to Heat Index, it is possible to make very accurate estimation of the influence of temperature and humidity on human body (Table 3.7.5.).

Table 3.7.5. Categories of Heat Index

Risk category	HI	Possible heat disorders
No risk	26-27	Comfortable conditions for human body.
Caution	27–32 Very warm	Fatigue possible with prolonged exposure and/or physical activity.
Extreme caution	32–41 Hot	Heat cramps and heat exhaustion are possible. Continuing activity could result in heat stroke.
Danger	41–54 Very hot	Heat cramps and heat exhaustion are likely; heat stroke is probable with continued activity.
Extreme danger	54 or higher Extremely hot	Heat stroke is imminent.

In order to estimate the impact of climate change on frequency and length of heat waves, it was estimated the meaning of Heat Indexes within two similar time-frames: 1961-1985 and 1986-2010. The information for estimation was provided by Batumi and Kobuleti meteorological stations. Based on this information, the number of days according to certain categories for both cities was calculated. (Table 3.7.6.).

Table 3.7.6. Changes in total number of "hot' and "warm" days in two time - periods (Batumi and Kobuleti)

	Batumi		Kobuleti	
	1961-1985	1986-2010	1961-1985	1986-2010
Extremely hot	0	0	0	0
Very hot	0	0	0	0
Hot	1	6	1	0
Very warm	142	320	174	147
Warm	976	1 104	938	1 231

According to the indexes given above, it is possible to estimate the level of health threat for two municipalities of Ajara region. Green boxes given in Tables 3.7.5 and 3.7.6 describe warm weather, which affects human body very positively and donot pose any harm to health.

According to the Table 3.7.6, increase in frequency and length of heat waves is registered in Batumi and Kobuleti: in 1987-2010 compared with 1961-1986, number of "very warm" days in Batumi is increased by 125%, in Kobuleti – by 15%. The results may indicate that if the current climate change trend is maintained in Ajara and the number of hot days keeps increasing, it will negatively affect human health.

In order to estimate current and future impact of climate change on human health as well as to reveal the most vulnerable municipality to climate change in Ajara (among Batumi, Keda, Kobuleti, Shuakhevi, Khelvachauri, Khulo), multi-criteria analysis was made. This analysis was based on three main components: adaptive capacity of population, exposure of climate change, and sensitivity of health sector.

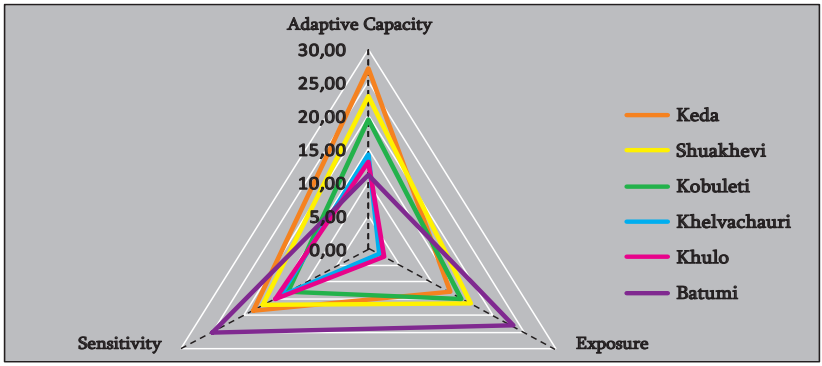


Fig. 3.7.3. Current level of vulnerability of Ajara's health sector to climate change by municipalities

According to the current climate change trends, Batumi appeared to be the most vulnerable, which is caused mostly by high indexes forexposure and sensitivity: 59.33. The second most vulnerable municipality appeared to be Keda with vulnerability index of 58.45, Kedais characterized by high indicator of adaptive capacity, but has much higher index of exposure (Fig. 3.7.3) compared with Batumi.

3.7.3. Future impact of climate change on healthcare sector in Ajara region

As study revealed, climate change can cause higher frequency of climate-related diseases, e.g. if during two decades average annual temperature increased by 0.4 and it resulted in increase of number of diarrheal diseases by 211%, it is more than expected that the number of diarrheal diseases will keep going higher as a result of continuous increase in annual temperature in future: for 2021-2050 temperature will increase by 1.8^0C (Batumi) and 2.1^0C (Kobuleti) during the summer season (the majority of diarrheal cases are registered exactly during the summer season), and annually – by 1.6^0C.

The increasing impact of heat waves in future is noticeable as well. As it was shown by future trend, the number of "very warm days" within 2020-2050 compared with base period of time (1961-1990), increases by 200% in Batumi, and approximately by 230% in Kobuleti (Table 3.7.7), which is associated with the increase of number of temperature-sensitive diseases (CVDs, diarrheal diseases, heat stroke, heat exhaustion, etc.), this itself is very dangerous for the groups that are most vulnerable to climate change: chronically ill persons, elderly and children.

Table 3.7.7. Changes in total number of "hot' and "warm" days in two time - periods in future (Batumi and Kobuleti)

	Batumi		Kobuleti	
	1961-1990	DifferenceΔ 2020-2050	1961-1990	Difference Δ 2020-2050
Extremely hot	0.00	0.00	0.00	0.00
Very hot	0.00	0.00	0.00	1.33
Hot	0.03	2.19	2.42	24.37
Very warm	5.53	22.65	28.35	36.03
Warm	36.20	2.26	33.81	24.70

Additional method – multi-criteria analysis was used to estimate future vulnerability of healthcare system to climate change. As above-mentioned analysis revealed, Batumi remains the most vulnerable part of Ajara, which can be explained by growing negative impact of climate change. As results revealed, Batumi remains the most vulnerable part of Ajara region, which can be explained by increase of climate exposure. Indeed, climate exposure has been increasing compared with current Indexes, which results in increase of overall vulnerability from 59.33 to 61.13. The same Index is decreasing.

Batumi is followed by Khelvachauri, where climate exposure has been increasing as well (Fig. 3.7.4).

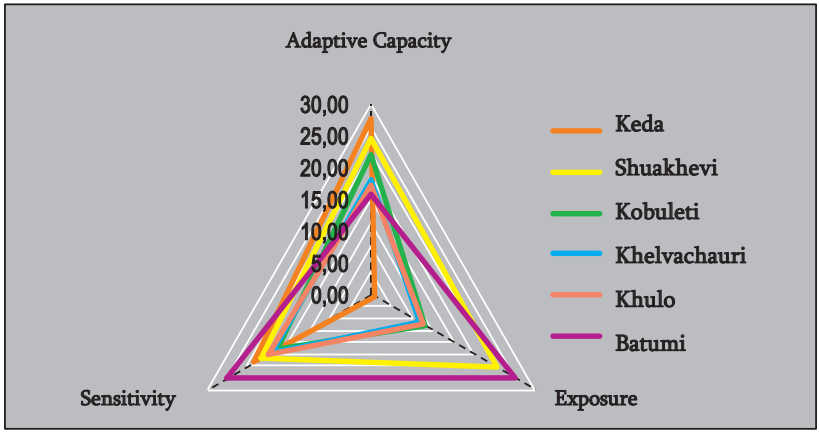


Fig.3.7.4. Future vulnerability of Ajara's health sector to climate change by municipalities [32]

Based on the results of multi-criteria analysis, it is clear that Batumi remains the most vulnerable city in Ajara region and even more – the level of vulnerability tends to increase in future, which creates the necessity of implementing adaptive projects in this part of the region. In addition to the fact that Batumi is the biggest city of Ajara region, it is also the most important part in terms of touristic potential.

3.7.4. Recommendation to decrease the vulnerability of health sector to climate change

In order to decrease the vulnerability of health sector to climate change in Ajara region, particularly in Batumi and Kobuleti, it is important to reduce risks of climate-related diseases, mainly of diarrheal diseases, anthropozoonotic (so-called "tropical") diseases, heat-induces pathological conditions (heat stroke, etc.), particularly in tourism sector.

Adaptation of health sector to climate change has to be directed towards mobilization and adaptation of contemporary medical services so that early diagnosis and prevention of diarrheal diseases and anthropozoonotic infections are possible. This will reduce the risks of these illnesses and create more comfortable environment for tourists.

It is also important to support the mobilization of health sector during the heat waves – during the days dangerous for health. In order to support the sector, it is crucial to train medical staff giving them the basic knowledge on risks caused by climate-related diseases.

[32] Changes are assumed only in climatic parameters

According to the fact that climate change is associated with the increase in frequency and severity of extreme events, it is expected that diseases connected with those events, e.g. traumas and mental disorders, may increase. In order to reduce the risk, it may be desirable that healthcare sector is included in the management of Disaster Risk Reduction and participates in the management of all phases of natural disasters. It is worth to stress the importance of provision of preventive measures against posttraumatic mental disorders.

In order to implement above-mentioned adaptive initiatives, it is important: to support development of protocols on climate-related diseasesand implementation of already approved ones; to raise awareness of medical staff and tourism sector servants on climate-related diseases by means of trainings; to develop Early Warning System (EWS) and to coordinate between different links of tourism sector, which is crucial for proper implementation of EWS.

3.8. Tourism

3.8.1. Overview of Ajara's tourism sector

In recent years tourism became one of the most dynamically developing sectors of Ajara's economy. If in 2004 the number of visitors comprised only 83 thousand, by 2011 this number had reached 913 thousand and by 2012 it exceeded 1 million people. Dynamics of the number of visitors, including tourists in Ajara for the period of 2004-2012 is given in Fig. 3.8.1.

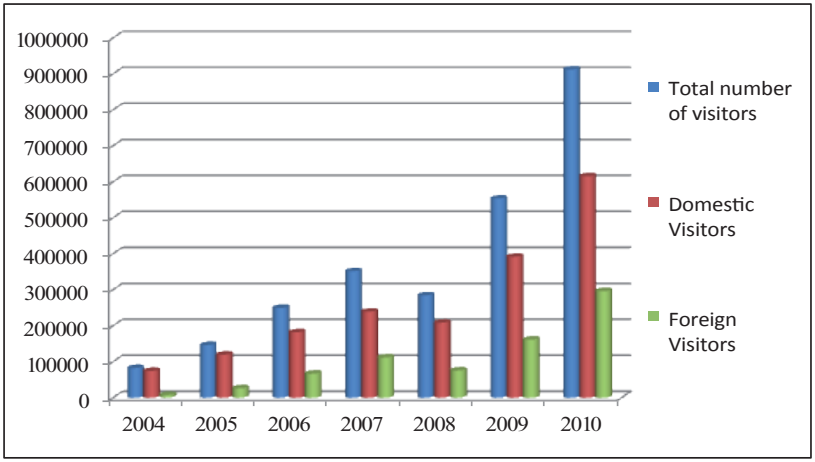


Fig. 3.8.1. Dynamics of visitors in Ajara in 2004-2010

In Ajara coastal zone climate conditions favorable for tourism, start in May and continue to October-November attracting majority of the visitors. Certain delay in the beginning of tourist season in spring is caused by vast thermal inertia of the Black Sea, the surface of which after winter cooling, has no time to warm sufficiently in March and April. The variation in number of tourists according to months in Ajara for 2007-2010 is shown in Fig. 3.8.2.

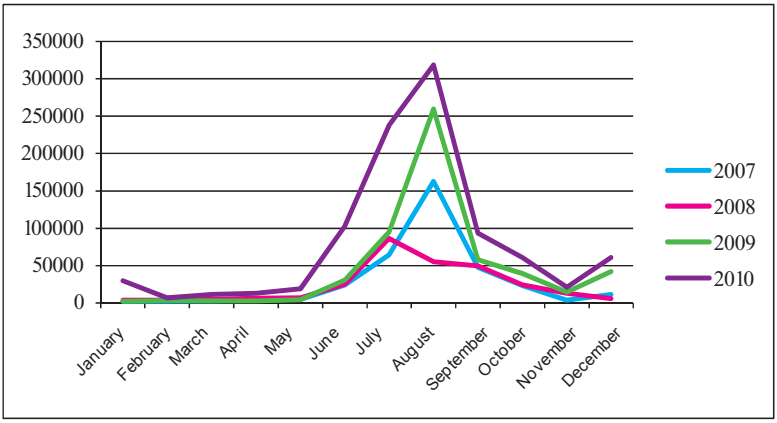


Fig. 3.8.2 Number of tourists in Ajara by months in 2007-2010[33]

Ajara resorts and resort sites, attracting the majority of tourists, are developed in the sea coastal zone and on adjacent territories; however, more than half of tourist sites are located in mountainous part of the region. The distribution of resorts and resort sites at the territory of Ajara is preserved in Fig. 3.8.3.

[33] Department of Tourism and Resorts of Ajara

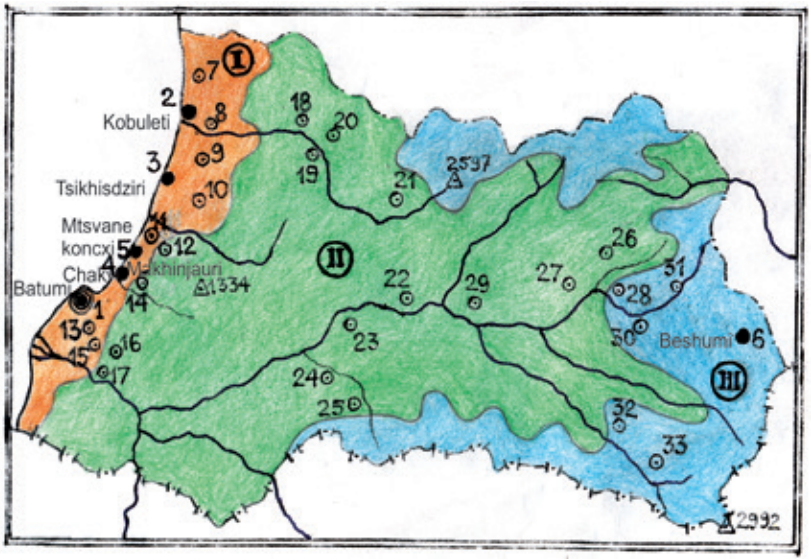


Fig. 3.8.3. Distribution of resorts (●) and resort sites (◦) at the territory of Ajara

Their elevation above sea level varies largely from 5-10 m (Batumi, Kobuleti, Makhinjauri) to 1 850 m (Beshumi, Mt. Khulo, Jinali) and makes 800-1 000 m on the average (Table 3.8.1).

Table 3.8.1. Ajara resorts and resort sites

Resort Sites	Resort Sites
Batumi (10)	Pichvnari (20)
Kobuleti (7)	Khutsubani (70
Tsikhisdziri (50)	Bobokvati (70)
Makhinjauri (5)	Chakvi-Buknari (50)
Mtsvane Kontskhi (Green Cape) (90)	Khechoketi (370)
Beshumi (1850)	Kapreshumi (310)
	Mt. Batumi(150)
	Anaria (350)
	Sameba (150)
	Tsiskara (1200)
	Makhvilauri (250)
	Makhata (750)
	Kintrishi (700)
	Tkemrgvala (750)

	Mt. Khino (1850)
	Sagoria (800)
	Garati (1000)
	Kokotauri (680)
	Namonastrevi (850)
	Bagauri (970
	Khulo (920)
	Mt. Sasadilo(1670)
	Shuakhevi (650)
	Mt. Ajara (1750)
	Danispareuli (1740)
	Tomasheti (1550)
	Jinali (1850)

Note: At the map: I – Sea coastal zone; II-Ajara mountainous part; III-High mountain alpine zone. In the Table: In brackets is given mean elevation (m) above sea level

Climate area, comprising of resorts in the sea coastal zone (I), is featured by humid marine climate with mild warm winter and hot summer. Main medical factors in this resort and tourist region are: warm sea, chemical microelements of marine origin in the air, high radiation balance, significant content of oxygen in the air, negligibly polluted clean air. Such climate is useful for treating cardiologic, neurological, pulmonological and arthritis diseases. It is also favorable for the development of recreational tourism. Annual duration of sunshine in Batumi equals to 1 958 hours on the average and to 1 815 hours at the top of Green Cape. Number of sunny days varies in the range of 295-300. The continuation can reach 8 hours in the middle part of R. Ajaristskali gorge, while in the coastal zone this value does not exceeds 4-6 hours and in the mountain zone makes 0-2 hours.

According to the combined impact of air temperature and humidity, 5 bioclimatic zones are singled out at the territory of Ajara (Fig. 3.8.4), which are featured by the following characteristics: (1) Hot summer and mild winter with the comfortable temperature and relative humidity (above 35%) in July; (2) Hot summer and temperately cold winter, with comfortable relative humidity of 30-35%; (3) Warm summer and temperately cold winter with comfortable relative humidity of 21-30%; (4) Warm summer and cold winter with comfortable relative humidity less than 21%, (5) Chilly summer and cold winter with the same relative humidity[34].

[34] Georgia SSR resorts and tourist resources. Moscow, 1989

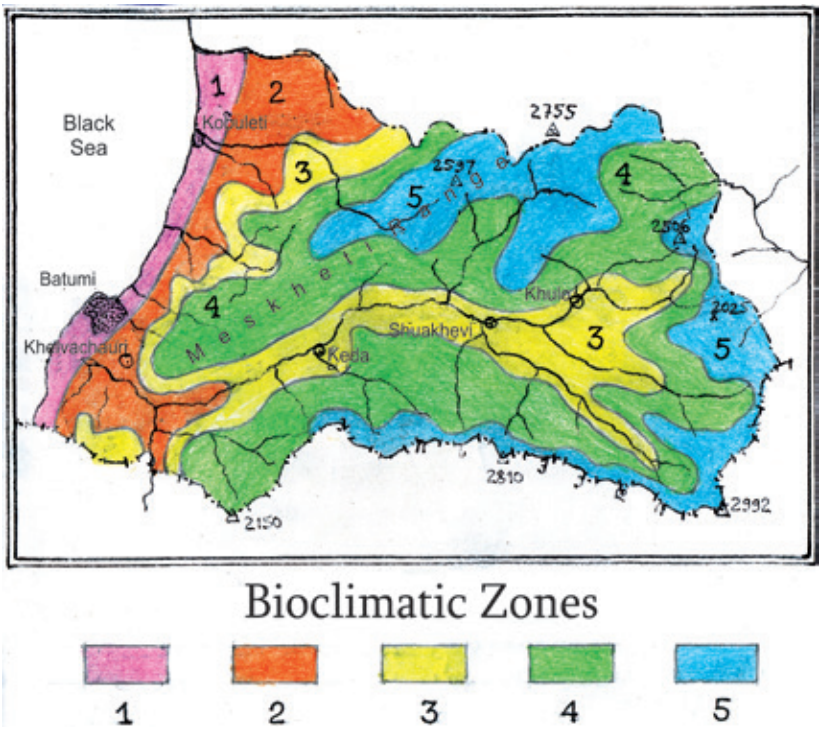


Fig. 3.8.4. The distribution of bioclimatic zones at the territory of Ajara

3.8.2. Impact of current climate change on the tourism sector

The impact of climate change on tourism in Ajara has been assessed using both the Tourism Climate Index (TCI) and the Heat Index (HI).

Compared to HI, the TCI contains more climate information. The TCI has been elaborated by the WHO to feature climate conditions facilitating the tourism in different regions or countries. This index is a combination of 7 variables describing air temperature and humidity, sums of precipitation, duration of sunshine and mean wind velocity. The TCI is assessed in marks from 100 to (-30) and includes such categories as "Ideal" (90÷100 marks) "Good" (60÷69), "Unfavorable" (30÷39) and "Unacceptable" (-30÷9). The TCI categories, pertinent to Georgia's conditions are given in Table 3.8.2.

Table 3.8.2. Tourism Climate Index Categories

N	TCI Category	TCI range (marks)
1	Very good	70÷79
2	Good	60÷69
3	Pleasant	50÷59
4	Acceptable	40÷49
5	Unfavorable	30÷39
6	Extremely unfavorable	10÷19
7	Unacceptable	-30÷9

To assess the global warming induced changes in TCI at the territory of Ajara for the past half-a-century, two equal spaces of time have been examined in the period of 1961-2010 and TCI average values were calculated using the data of Ajara's 4 meteorological stations. The results are presented in Table 3.8.3.

According to obtained data, in the Black Sea Ajara coastal zone (Batumi, Kobuleti),conditions favorable for summer tourist season (categories 1 and 2) in the initial period were observed from May to October including, while in the second period April has been added to these months. At the same time, some worsening of conditions was observed in August (Kobuleti) and November (Batumi).

Table 3.8.3. Distribution of TCI categories in Ajara by months for two periods: 1961-1985 (first period, Δ) and 1986-2010 (second period, +)

Meteostation / Month[2] TCI	Batumi (10 m)[1]					Kobuleti (7 m)					Khulo (923 m)					Goderdzi Pass (2025 m)				
	1[3]	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
March				Δ +					Δ +					Δ +						Δ +
April		+	Δ				+	Δ					Δ +						+	Δ
May	Δ +					Δ +					Δ +								Δ +	
June	Δ +					Δ +					Δ +							Δ +		
July		Δ +					Δ +				Δ +						+	Δ		
August		Δ +					Δ	+			Δ +						+	Δ		
September		Δ +					Δ +				Δ +							Δ +		
October		Δ +					Δ +						Δ +						+	Δ
November			Δ	+					Δ +					Δ +						Δ +

1- Elevation of meteostation above sea level.
2- In winter months TCI values for all 4 stations correspond to "Unfavorable" category (5) and hence, they are not included in the Table.
3- Numbering of TCI categories corresponds to Table 3.8.2 numeration.

In the Ajara's mountainous zone (Khulo) such change are not identified and "Very good" conditions existed from May to October inclusive. As for the alpine zone (meteorological station Goderdzi Pass), tourism climate conditions have improved in the second period both in July-August ("Pleasant" has altered to "Good") and in April and October, when "Unfavorable" conditions changed to "Acceptable" ones.

Thus, it could be derived, that for the last half-a-century, under the already recorded climate warming conditions, the tourism climate terms in the Ajara seashore have improved in spring and somewhat worsened in summer and autumn. Meanwhile, tourism conditions in all three seasons were improved in the alpine zone. It is notable, that the highest values of TCI were maintained in May-September in Ajara's mountainous zone (Khulo), which indicates that this zone has a big potential of tourism development.

Along with the TCI, certain degree of hazard to human/tourist health is described by Heat Index, which expresses the pungency of temperature perception by the organism at different values of relative humidity. In different humidity conditions, the same temperature affects human state in different way. The number and frequency of days with high HI have significantly increased due to global warming for the last two decades in all regions of the world. The high HI period called "Heat waves" have different duration and they strongly affect densely populated regions. One of such events took place in France in 2003. In the framework of this document preparation, the variation of HI in the past has been assessed for some resorts in Ajara (Batumi, Kobuleti). The internationally accepted values of this index and hazard categories caused by them are discussed in part 3.7 (Table 3.7.5).

For the assessment of climate change impact on the recurrence of HI in Ajara, the data of Batumi and Kobuleti meteorological stations have been used. The Heat Index values were calculated for two equal periods: 1961-1985 and 1986-2010. The results are given in Table 3.7.6 (part 3.7).

This Table shows that for the last 25 years the number of "hot" days in Batumi has significantly increased, while this did not happen in Kobuleti. In both cities the number of "very warm" and "warm" days has increased significantly, this essentially confirms the warming process in Ajara and the rise in the number of comfortable days. The assessment of HI trend in the past has indicated that the frequency of warm days occurrence most noticeably increased during 1986-2010 in the months of August and has approached the "very warm" days zone (light yellow area), which is already featured by some hazards, but this index has not yet intruded into this zone (Fig. 3.8.5).

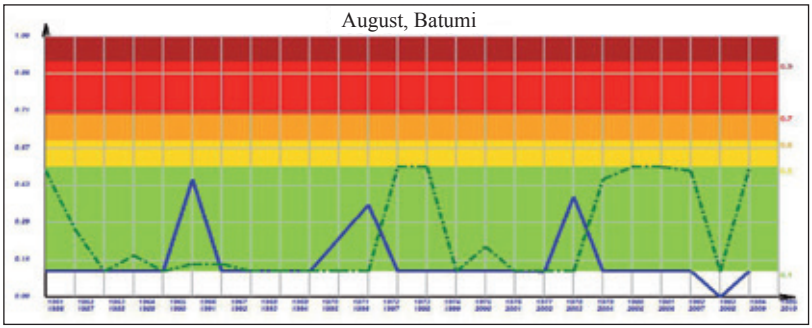


Fig3.8.5. [35] Intensity and occurrence probability of Heat Index in two periods (August, Batumi)

For comparison the picture of May is given for the same period (Fig. 3.8.6).

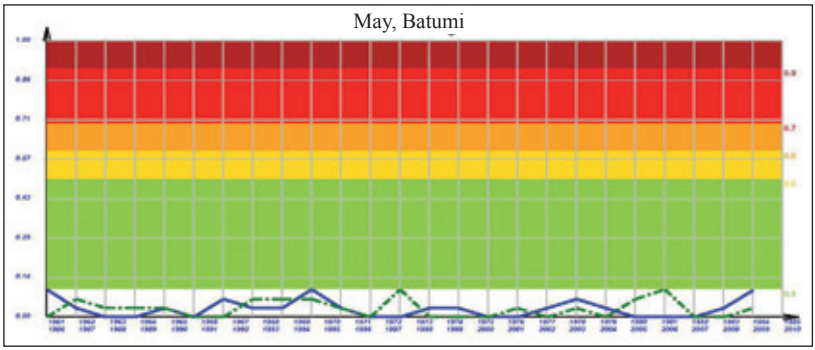


Fig. 3.8.6. Intensity and occurrence probability of Heat Index in the same two periods (May, Batumi)

The comparison between the same trends in the discussed two periods of time in Kobuleti turned to be impossible due to the absence of humidity data in the second period, though this trend for 1960-1990 is given in the next part.

[35] 1961-1985
1986-2010

3.8.3. Impact of anticipated climate change on Ajara Tourist sector

The expected change of TCI categories between the second assessed period of time and 2020-2050 projected periods has been assessed using the climate change forecast data till the middle of current century (Table 3.8.4).

Table 3.8.4. Distribution of TCI categories in Ajara by months in observed (1986-2010, +) and projected (2020-2050, *) periods

Meteostation / Month TCI	Batumi (10 m)[1]					Kobuleti (7 m)					Khulo (923 m)					Goderdzi Pass (2025 m)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
March				+ *					+ *					+ *						+ *
April		+ *					+ *					*	+						+ *	
May	+ *					+ *					+ *								+ *	
June	+	*				+ *					+ *							+ *		
July		+	*				+ *				+ *						+ *			
August		+	*					+ *			+ *						+ *			
September		+ *					+ *				+ *						*	+		
October		+ *					+ *					*	+						+ *	
November			*	+				+ *						+ *						+ *

It comes from this Table that as a result of climate warming, the worsening of tourism climate conditions is expected in the first half of current century in Batumi for all 3 summer months, manifested in the lowering of relevant categories by one step down. Instead, certain improvement of climate conditions is anticipated in November, when the category "Acceptable" may pass into the "Pleasant" category. In Kobuleti neither of changes is expected, while in Khulo its excellent conditions in May-September are supplemented with the projected pass of "Pleasant" conditions into "Good" category in April and October. In the alpine zone the improvement of tourism conditions are expected in September with the substitution of "Pleasant" with "Good".

Obtained results indicate that warming projected to 2050 will presumably cause the deterioration of tourism climate conditions in summer season in Batumi, accompanied by their improvement in mountainous and alpine zones. The stability of climate conditions in Kobuleti suggests certain advantage of the northern part of seashore zone over its southern part for the time being.

The possible change in the number of high HI days between 2020-2050 and 2070-2099 has been assessed as well. Corresponding Tables are given in part 3.7 (Table 3.7.7). Estimations have shown that in 2020-2050 the annual number of "very warm" days in Batumi may increase at least by 22 days, and of "hot" days –by 2 days. Nearly the same result is obtained for Kobuleti with the only difference that "hot" days were not earlier detected in Batumi, while in Kobuleti such cases have been recorded. As to the Goderdzi Pass and the "Beshumi" resort, here only the number of "warm" days is expected to grow.

Besides the number of days, the trends of HI recurrence in different months for 3 district periods (1961-1990, 2020-2050 and 2070-2099) have been assessed. Trends were estimated in 5 months from May to September using the Batumi and Kobuleti climate records. As an example, only those months are shown (July in Batumi and August in Kobuleti), for which HI in future is expected to approach the hazard limit.

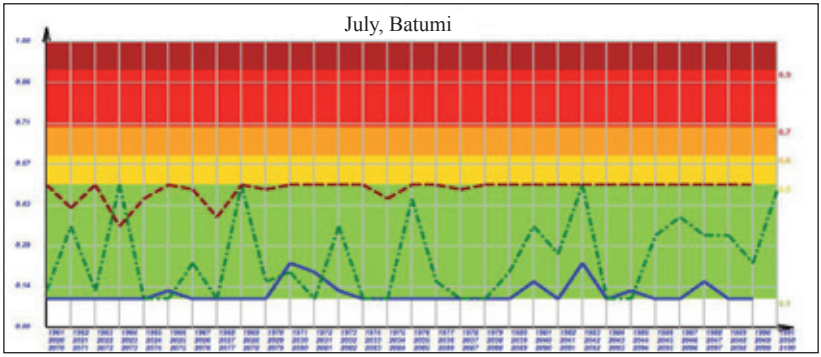


Fig 3.8.7. Intensity and occurrence probability of HI in three periods (July, Batumi)[36]

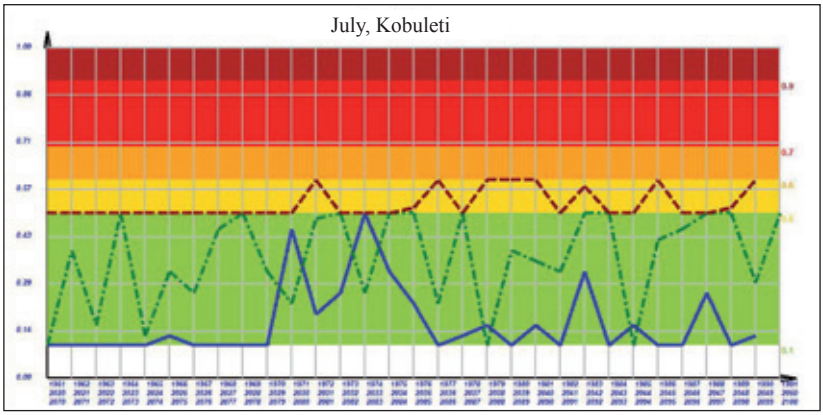


Fig 3.8.8. Intensity and occurrence probability of HI in three periods (July, Kobuleti)[37]

[36] 1961-1991
2020-2050
2070-2099
[37] 1961-1991
2020-2050
2070-2099

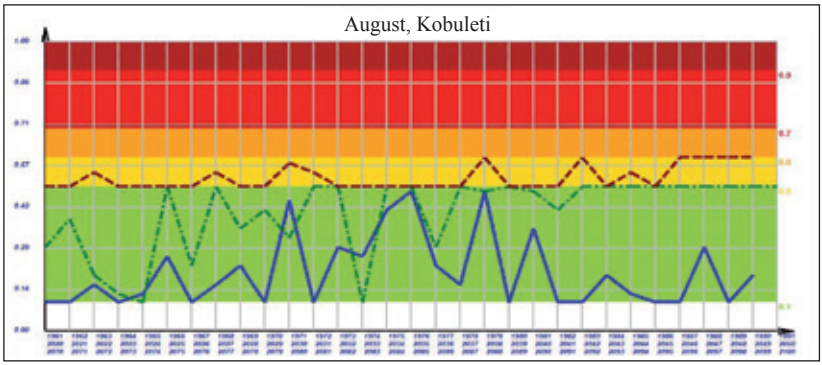


Fig 3.8.9. Intensity and occurrence probability of HI in three periods (August, Kobuleti)

As it is evident from these graphs, Kobuleti in future is expected to get hotter than Batumi. Virtually, in 2070-2100 the Heat Index may completely pass into the hazard zone, but until then although the warming goes on in Batumi and Kobuleti, it does not reach the hazard level. The conditions are sufficiently comfortable both for local population and tourists.

According to assessments carried out in different countries possessing the tourist potential, climate warming in regions having geographic and climate conditions similar to Ajara, may provoke a number of both positive and negative results, including:

- Prolongation of tourist season, accompanied by the extension of relevant services and infrastructure, growth of income and corresponding rise in the standard of life of local population. In case of Ajara, as it has been mentioned above, to the middle of current century in the sea coastal zone, this increment of season duration can reach one month and the tourist season may last till the end of November. Similarly, the improvement of comfortable conditions in May will be expected in the mountainous zone, and in alpine zone – the prolongation of tourist season in September.

From the anticipated negative results, following should be mentioned:

- The prevalence of extremely hot weather in July-Augustin the coastal zone, creating relatively uncomfortable conditions for tourists, though, this is expected only to the end of current century and even only in the Kobuleti area;
- The worsening of tourism and resort conditions in the coastal zone and sea-adjacent areas is anticipated as a result of increase in storm frequency, accompanied by hazards pertaining to high storm activity, intensive washing away of beaches as well as swamping and flooding of coastline;

- The increased danger of flash-floods and mud streams in mountain river gorges resulting from torrential rains in summer. This factor especially endangers tourist facilities, which are predominantly situated at river banks;
- In Ajara conditions, the rise of temperature during the tourist season can possibly provoke the rise in the number of diarrheal infection cases and the increase of heat wave recurrence, causing the necessity for the creation of early warning service. The growth in the frequency of health problems – traumas and mental disorders is expected as well. To cope with these problems it would be expedient to include the Health sector into the disaster management system. In the framework of current project proposal has been prepared in this direction (see section 6.1.8);
- In high mountain zone in case of the rise of mean winter temperature by about 2^0C to 2050, the shortening of ski season by 1-1.5 months would be expected, though according to forecast the precipitation in the same period could increase by about 30%, partly compensating negative results of the warming;
- Along with the rise in air temperature significant increase is sea surface temperature (up to ≥300 C) could trigger the massive dying off of shellfish and other species in the coastline, producing negative impact on the development of specific kind of tourism – the diving.

At the same time, the excessive warming of water in the coastal zone in recent years has caused serio.us discontent among holiday-makers.

Thus, the performed analysis makes it possible to conclude that in the meantime proper conditions for the development of tourism exist in all three climate zones of Ajara. According to the Tourism Climate Index and the Heat Index projected values it could be assumed that the middle of current century the further improvement of these conditions is expected, although some corrections would be necessary to introduce in the present tourism development strategy in Ajara.

3.8.4. Recommendations

In particular, the analysis of expected negative consequences makes it possible to recommend the provision of following measures in the Tourism development strategy since 2015:

- In compliance with the anticipated prolongation of tourist season the attention should be paid to the relevant widening of tourist infrastructure;
- Taking into account the expected acceleration of sea impact on the coastal zone, implementation of coast protection measures are to be envisaged in the vicinity of tourist utilities and sea level rise is to be provided in planning of new tourist facilities/infrastructure;
- Taking of protection measures nearby the tourist utilities in view of projected increase of flesh flood and mudflow risks in gorges of mountain rivers;

- Particular mobilization of Health sector in tourist service sector. Accounting for the expected rise of temperature in the summer tourist season capacity building or preventive and treatment measures to combat diarrheal and other diseases.

3.9. Water resources in Ajara

3.9.1. Overview of Ajara's water resources

Water resources of Ajara are diverse and contain rivers, lakes, swamps and underground waters. There are no glaciers and water reservoirs in Ajara. The rivers, in most cases, belong to rain feeding type. Though in the mountainous part the nourishment role of snow melting and underground waters is also big, due to what it is characterized by spring and autumn maximums. The most of the rivers belong to the system, which transfer rivers to the Black Sea via the river Chorokhi, part of the rivers – directly run to the Black Sea. Besides, due to extensive rains and snow melting a lot of temporary flows are created on the territory of the region. The hydrographic map is given in Figure 3.9.1.

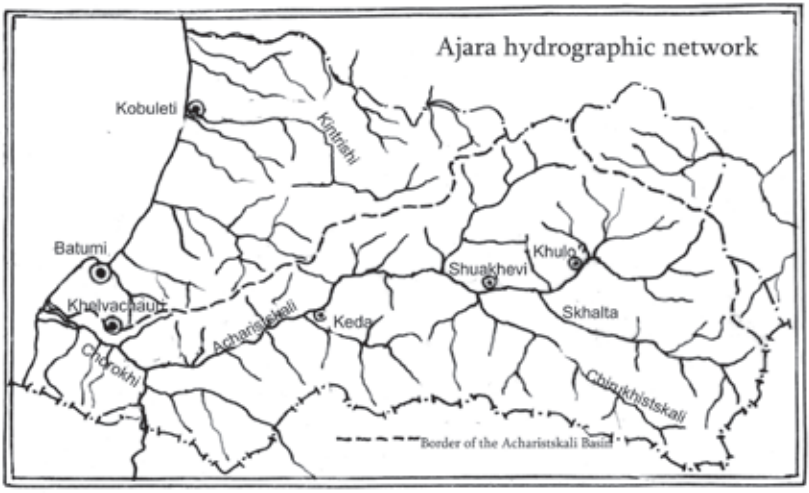


Fig. 3.9.1. Schema of Ajara hydrographical network

The incomplete list of Ajara rivers and their indicators is given in Table 3.9.1, where it is clearly seen that the most part of the rivers are included into 20 and less km and 20-29 km, and only 2 rivers exceed 40 km length.

Table 3.9.1. Ajara Rivers and their main parameters

#	Name	Area of water catchment km²	Length km	Average annual runoff m³/sec	Hydro-energetic potential, MW
1	Choloki	159.0	25.0	7.0	3.7
2	Achkva	37.0	19.0	1.7	0.0
3	Kintrishi	291.0	43.7	17.3	98.0
4	Kinkisha	36.0	16.7	2.0	9.5
5	Dekhva	45.0	18.2	2.4	5.7
6	Chakvistkali	120.0	25.0	10.3	49.5
7	Acharistskali	1 511.0	88.5	51.5	198.5
8	Machakhelistkali	369	19.5*	20.8	59.5
9	Chorokhi	22 100	31.3*	272.0**	-
10	Chorokistskali	329	38.0	10.9	65.7
11	Skhalta	223	28.0	7.5	28.7
12	Satsikhura	96	16.4	3.3	11.8
13	Chvanistskali	189	25.6	6.0	38.0
14	Merisi	131	21.5	3.5	45.5
15	Korilistskali	50	14.1	4.1	12.4

*Note:: * - within Georgia*

** * - Before building the cascades of hydro-electric power stations in Turkey*

It is also clearly seen from the Table, that hydro-energetic potential of the Ajara rivers, which is currently minimally utilized (23 MW), is quite high. For 4 rivers it exceeds 50 MW per each, in total it exceeds 626 MW.

Besides the rivers listed above, there are a lot of other rivers on the Ajara territory (Ochkhamuri, Acharistskali, Akvareta, Sagorela, Tbeti, Bartskhana and others), the parameters of which are not defined yet.

Lakes in Ajara are as on lowlands, as well as in the mountainous parts that are characterized by small areas and low depth. All the lakes of the mountainous part is less mineralized (Green lake, Sarichari lakes, Bozauris and Chirukh Iali lakes), but coastal relict lakes (Nurigeli lake, Ardagani lake, Gonio Lake and others) that some time ago were directly linked to the Sea, are quite mineralized, though at the moment they are under the process of becoming fresh.

From the swamps the biggest area (600 ha) is occupied by the Ispani swamp located in Kobuleti Municipality. Its depth comprises 7m and volume exceeds 100 mln m³. There are several lakes left in the coastal zone in the rivers of Chorokhi and Kakhaberi lowland.

Ajara is also very rich with underground waters. There are 42 mineral water sources registered in Ajara, most of which belong to the sulphate-carbonate group, 5 of them are thermal. The debit of the rivers in wide diapason varies from 600 to 240 000 liters a day. The most famous mineral water sources are: Makhinjauri (240 000 l/d,

thermal), Dumbadzeebi (200 000 l/d), Tomasheti (10 000 l/d, thrmal), Shubani (100 000 l/d, thermal), Shuakhevi (86 000 l/d) and others.

For obtaining underground fresh water up to 90 exploitation bore-wells operate in Ajara, each with debit of 11 l/sec. This ensures 864 000 m^3 total spending of fresh water in 24 hours that is 31 536 million m^3 per year.

3.9.2. Impact of current climate change on the run off of the river Acharistskali

The river Acharistskali was selected for the assessment of vulnerability to climate change of the run off of the rivers. This is the biggest river in Ajara (only 25 km of the biggest river Choroki is running on the territory of Ajara). The water collector reservoir (basin) comprises 1 511 square kilometers and covers almost half of the whole Ajara. The length of the river Acharistskali is 88.5 km. it takes the start from Arsiani at the altitude of 2 435 m and joins the river Chorokhi from the right. Main tributaries of R. Ajaristskali are rivers Satsikhura, Skhalta, Chirukhitskali and Merisi.

The river flows in narrow gorges and widens at the crossing. The significant part of the water collector is occupied by the mixed forest. Lower places are mostly occupied by leaf trees of up to 1 000-1 200 meters (oak, beech, and alder-tree). Up to 1 200 - 2 000 meters is occupied by fir pieces (fir and beech trees). Upper places are occupied by alpine meadows that cover 15-20 % of the whole water collector.

The river is mainly fed by snow, rain and ground waters, meanwhile the snow waters play significant role and their biggest share is accumulated at the beginning of the river. The water regime is characterized by Spring flooding, Autumn water-flashes and Autumn-Summer water deficit. Besides, the water of the river is used for irrigation as well.

During the different periods of time the observation was carried out on three hydrological check points. Currently none of them operates. Observations, made on Keda check point during 1957-1991 was used for the assessment of climate change vulnerability. The water basin area comprises 1 136 square meters, the average height comprises 1 470 km.

During 1957-1991 the annual average run off was increased on the River Ajaristskali, though the maximum of the run off was decreased. Fig. 3.9.2 shows the annual changes observed by Keda check point.

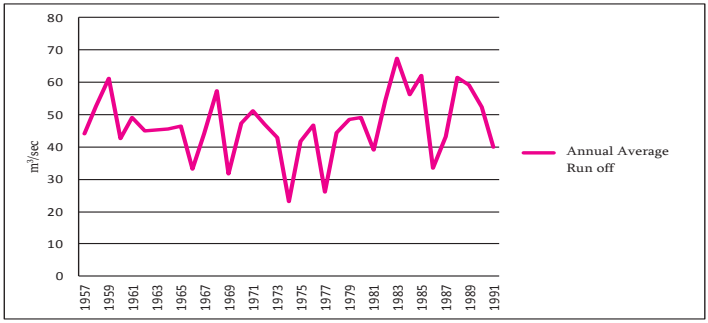


Fig. 3.9.2. Annual average changes of the run off of the river Acharistskali (1957-1991)

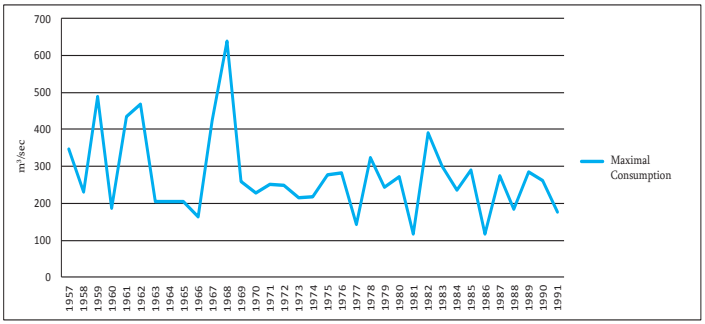


Fig. 3.9.3. Changes of the maximal consumption of the river Ajaristkali water (1957-1991)

The changes between the two equal sub-periods compared to the basic period 1961-1990 and changes in the run off according to the seasons are given in Figure 3.9.4. As we can see from this picture, during the 15-year period in 1976-1990 years the run off increased at every season compared to the previous period during 1961-1975. The biggest increase is observed in Autumn (30%) and winter (20%), small changes are also observed in Spring (10%).

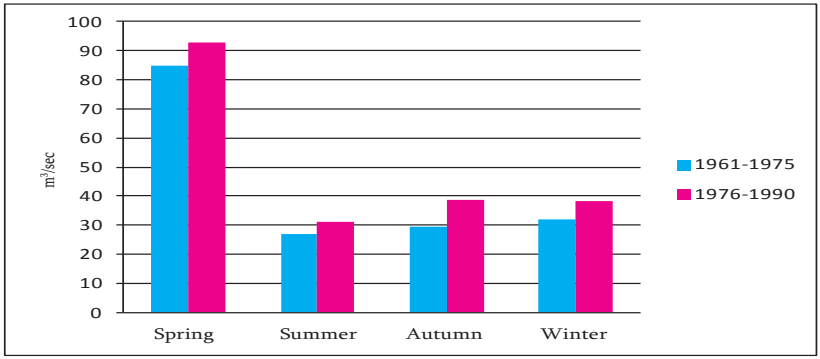


Fig.3.9.4. changes of the average seasonal run off observed in Keda check-point during the years 1961-1990

It should be noted, that these changes correspond to the period up to 1990, when the increase of the temperature was not so expressed in Ajara. Since 1990, when the climate changes were more expressed, no observations were made. This does not allow us to make assessment of the vulnerability of climate change of the run offs.

3.9.2. Possible impact of climate change on the run off of the river Ajaristskali

Hydrological model WEAP (Water Evaluation and Planning System)[38,39] was used for the assessment of the possible impact of climate change on Ajaristskali regime. For improvement of the model, data of the 3 hydro stations were used – for temperature, precipitation, humidity and wind speed. Also, the existing information on the scale, geological construction, types of soils and plant cover was used.

The model was calibrated and validated according to the data provided by Keda hydrological post (1961-1990). During the validation it was revealed that high run off of the rivers measured by Keda station during 1983-1985 was not in compliance with indicators made by the meteorological stations, and, accordingly, it was impossible to make explanation of these kind of run offs. In other periods modeled and observed indicators are close (possible deviation 2.4%).

For future description of the climate change scenario climatic modeling ensamble was used, which was also received for creation of climate change scenario in Ajara (please refer to the relevant chapter). Table 3.9.2 shows the changes in precipitation and temperature according to the mentioned scenario during the years 2020-2050 and 1960-1990.

[38] Yates D., Sieber J., Purkey D., Huber-Lee A., WEAP21 – A Demand-, Priority-, and Preference-Driven Water Planning Model, Part 1: Model Characteristics, Water International, Vol. 30, No. 4, pp. 487–500, 2005.
[39] Yates D., Sieber J., Purkey D., Huber-Lee A., WEAP21 – A Demand-, Priority-, and Preference-Driven Water Planning Model, Part 2: Aiding Freshwater Ecosystem Service Evaluation, Water International, Vol. 30, No.4, pp. 501-512, 2005.

Table 3.9.2. Possible changes of precipitation and temperature in Ajara according to the climate change scenario

station / month	Changes in mean annual temperature during 2020-2050 compared to 1961-1990, ^{0}C			Changes in annual sum of precipitation during 2020-2050 compared to 1961-1990, mm		
	Keda	Khulo	Goderzi pass	Keda	Khulo	Goderzi pass
January	1.01	1.02	0.99	12.60	11.10	11.50
February	0.81	0.80	0.78	11.20	9.60	4.80
March	1.15	1.15	1.16	5.20	6.80	6.40
April	1.21	1.23	1.21	8.60	7.70	4.80
May	1.60	1.61	1.63	-4.00	-4.50	-7.80
June	1.83	1.84	1.81	-1.60	-1.80	-3.40
July	2.45	2.45	2.51	-8.60	-6.70	-12.60
August	2.39	2.41	2.42	-8.90	-6.80	-12.20
September	2.17	2.16	2.11	-2.70	-2.60	-4.30
October	1.51	1.51	1.59	-7.0	-6.1	-5.4
November	1.07	1.07	1.05	7.2	6.8	7.1
December	1.03	1.04	1.03	11.9	10.9	10.2
Annual	1.52	1.52	1.52	23.8	24.4	-0.9

Using of this climate change scenario for the definition of climatic parameters has shown that in case of such scenario the average run off during the years 2020-2050 will not changed compared to the average of 1961-1990 (-0.3%), though seasonal dissemination is expected. Figure 3.9.5 shows seasonal and annual indicators provided by Keda hydro-meteorological station in 1961-1990 and 2021-2050 years.

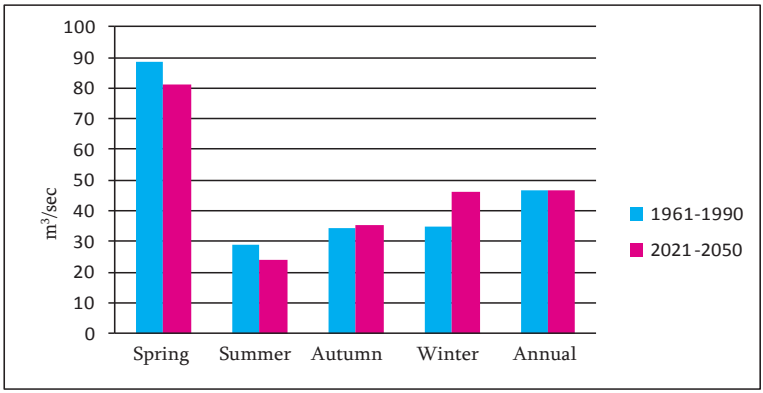


Fig. 3.9.5. River Ajaristskali seasonal run off in 1961-1990 (actual) and in 2020-2050 (forecasted)

As we can see from these pictures, the increase of Winter and Autumn run off will be continued (31% and 4%), but insignificantly reduced precipitation and significant increase in temperature will cause reduction of run offs (17% and 9%) in Spring and Summer. This change will have positive impact on hydro-energy, since energy producing potential will be increased in Winter. But it will have negative impact on agricultural sector, since the water resources for irrigation will be reduced in Summer. It should also be noted, that even though Spring run off will be decreased, increased precipitation in Winter in the form of intensive snow might cause risk of floods.

4. Greenhouse gas emissions mitigation policy and measures

4.1. The energy resources and supply

The hydro resources play important role in the natural assets of Ajara. The region has a powerful hydro-electric potential with diversity of seasonal distribution of river runoff (with one-peak, two-peak and almost even hydrographs), which creates favorable conditions for small river runoff hydropower plants. This is particularly important, because the geological and environmental conditions do not permit construction of reservoirs.

According to the Ajara Autonomous Republic (AAR) Regional Development Strategy, the total potential capacity of rivers equals to 1 000 MW, which can generate up to 8 760 million kilowatt-hours per year. For the last 20 years, 50-92 million kWh of power were produced, which makes up only 1% of total potential. If the hydropower plants defined within the strategy are constructed, the added capacity will equal to 239.1 MW with annual generation of 1 531.25 MWh. According to strategy, there are about 287 million U.S. dollars investment to be made for this.

According to the information from Georgian National Energy Regulatory Commission, 5 hydro power plants operate in the region with full capacity of 22.20 MW. There is only one medium-sized hydro power plant (Atshesi), others are small power plants.

Recently, the use of solar energy water heating systems were introduced in AAR. They convert solar radiant energy to thermal energy, which is proportional to the intensity of the solar radiation and area of the module and heats the running water in the collectors. These systems consist of two main parts: solar collectors and boiler (hot water tank).

The use of solar energy systems have been introduced to:

- Kintrishi Protected Area Visitor Center, which is equipped with a helio system for power supply and water heating;
- Rangers' house of Mtirala National Park, which is equipped with Helio system for power supply;
- One guest house (village Chakvistavi) of Mtirala National Park support zone, which is equipped with Helio system for power supply.

In order to ensure proper operation of solar energy systems, administration and staff of Kintrishi and Mtirala territorial units of the Agency of Protected Areas were trained in the use of these systems.

At this point the wind energy resources of the area are practically unused. The wind energy is considered to be most powerful in the vicinity of Batumi, where the average wind speed is 3 m / s and lasts longer than 5 220-6 240 hours per year, which amounts to 60-70% of the total time. This enables to deploy here both slow and fast wind engines.

Firewood is also an important resource in terms of energy resources, potential of its use is discussed in the forest section (3.4). Wood supply limits are set by the Ministry of Environmental Protection and the service is provided by the agency of Environment and Protection of Natural Resources of Ajara.

The AAR needs an average of 100-120 MW of electricity annually, taking into account seasonal and hourly peaks, which is supplied by "Energy-Pro Georgia". The distribution of electricity is performed from two main directions: from Didi Batumi substation, which is able to supply the region (with 4 110 kV transmission lines) completely. Additional 30-40 MW of power (with two110 kV transmission lines) can be received from Guria. The system provides 24-hour electricity supply, but the system is characterized by low voltage and requires substantial rehabilitation. The power sector is under the management of the Ministry of Energy.

The natural gas is supplied to the population by "SOCAR Georgia Gas Ajara" and "Ajara natural gas" Ltd. According to 2011 data, the "SOCAR Georgia Gas Ajara" had 50 337 costumers, whereas "The Natural Gas Ajara" had the total of 15 394 customers in Batumi and Kobuleti. The private companies, which supply gas to region, are selected upon the bid by the Ministry of Economy and Sustainable Development of Georgia.

The transport sector is governed by the laws adopted by the Parliament of Georgia, as well as treaties between the government and foreign countries and other legal acts of the Government, which regulate the transport activity on the whole territory of Georgia and other related issues.

4.2. Energy consumption in Ajara

Methodology

For the assessment of baseline (2011) CO_2 equivalent emissions from Ajara region and for the projection of future trends by 2030, the Long-range Energy Alternatives Planning System (LEAP) was used. LEAP is a widely used software tool for energy policy analysis and climate change mitigation assessment developed by the Stockholm Environment Institute.

In the process of creating the model for any energy sector, the first step is to elaborate the structure of the system, where the initial information about the system is inputted. Afterwards, the possible evolution scenario and different mitigation scenarios are

modeled and compared. The structure of Ajara and Batumi energy consumption is based on the year of 2011 and has been split into the following subsectors:

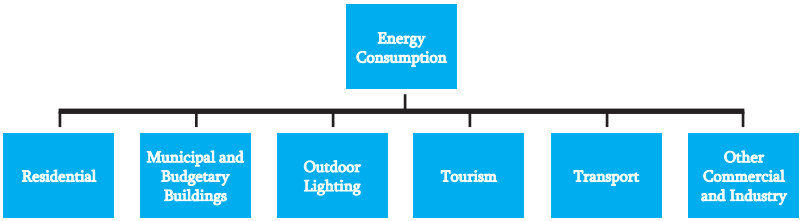


Figure 4.1. The structure of energy consumption in Ajara

Each of the energy consumption subsectors is considered separately bellow.

Residential sector (households)

There is a sharp contrast in energy consumption patterns between mountainous and lowland regions (mainly in towns and localities) of Ajara. Table 4.1 shows energy consumption in Batumi and the rest of Ajara.

Table 4.1. Energy consumption in the residential sector in Ajara (2011)[40]

	Electricity (kwh)	Natural gas (cub. m)	Firewood (Tons)	Gasoline (Tons)	Diesel (Tons)	Kerosene (Tons)	Liquid Petroleum Gas LPG (Tons)
Total Residential Sector:	**210 144 054.2**	**11 443 518.0**	**325 000.0**	**0.0**	**0.0**	**989.8**	**7 830.0**
Batumi:	**120 154 895.0**	**8 541 229.0**	**81 250.0**	**0.0**	**0.0**	**37.3**	**4 950.0**
Heating	21 115 412.0	1 622 833.5	65 000.0	0.0	0.0	32.0	0.0
Cooling	12 415 233.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Heating	25 312 489.0	2 306 131.8	1 625.0	0.0	0.0	0.0	250.0
Cooking	3 154 786.0	4 607 566.0	14 623.0	0.0	0.0	5.3	4 700.0
Lighting	28 654 139.0	0.0	0.0	0.0	0.0	0.0	0.0
Other:	29 502 836.0	4 697.7	2.0	0.0	0.0	0.0	0.0
Rest of Ajara:	**89 989 159.2**	**2 902 289.0**	**243 750.0**	**0.0**	**0.0**	**952.5**	**2 880.0**
Heating	73 154.0	348 274.7	158 437.5	0.0	0.0	850.0	0.0
Cooling	1 312 501.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Heating	1 152 488.0	754 595.1	12 187.5	0.0	0.0	65.0	750.0
Cooking	15 236 225.0	1 799 419.2	53 625.0	0.0	0.0	32.0	2 130.0
Lighting	58 154 721.0	0.0	0.0	0.0	0.0	2.5	0.0
Other:	14 060 070.2	0.0	19 500.0	0.0	0.0	3.0	0.0

[40] Department of Statistics; company "Energy – Pro Georgia" Company "SOCAR Georgia", Batumi city hall

Throughout the mountainous region, electricity and firewood are used intensively, the later being an indispensable resource for heating in the winter season. Firewood is used for domestic purposes significantly in summer season as well as for cooking and water heating, only partially replaced in some places by LPG. Most of the residential buildings in the region are well-built; however, there are also hut type dwellings, the number of which is gradually decreasing by offering comfortable accommodation to population from government or by negotiations with private investors.

60% of dwellings in Ajara have wood or mixed (wood and stone) construction, which creates a problem of heat preservation. This factor is more signified by the length of winter in the mountainous region - six to eight months.

In general, the majority of dwellings in region is devoid of any kind of central heating system and has a high heat loss factor, which increases energy consumption for heating in winter and for cooling in summer season.

Municipal and State Buildings (Budgetary Sector)

Budgetary sector includes energy consumption in municipal buildings, state buildings located on the territory of the Ajara, kindergartens, schools and similar institutions. The Table 4.2 depicts the energy consumption in this sector according to the 2011 annual data.

Table 4.2. Energy consumption by budgetary building sector in Ajara (2011)[41]

	Electricity (kwh)	Natural gas (cub. m)	Firewood (Tons)	Gasoline (Tons)	Diesel (Tons)	Kerosene (Tons)	Liquid Petroleum Gas LPG (Tons)
Total Budgetary Sector:	**37 587 746.0**	**845 383.2**	**1 950.0**	**0.0**	**856.1**	**450.0**	**27.5**
Including:							
Heating	9 838 183.0	109 899.8	1 322.1	0.0	500.5	275.0	0.0
Cooling	7 541 456.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Heating	962 351.0	143 715.1	42.9	0.0	355.6	1.0	6.2
Cooking	4 651 230.0	524 137.6	585.0	0.0	0.0	174.1	21.3
Lighting	12 235 562.0	0.0	0.0	0.0	0.0	0.0	0.0
Other:	2 358 964.0	67 630.7	0.0	0.0	0.0	0.0	0.0

According to this data, electricity and wood are those energy carriers that are mainly used for heating, while the share of natural gas consumption remains low for the time being.

Outdoor Lighting

Electricity consumption for outdoor lighting can be significant in densely populated areas. Its infrastructure projects require significant investment and therefore, cities, towns and villages are not fully lightened in the region. The significant share of

[41] Department of Statistics; company "Energy – Pro Georgia", Company "SOCAR Georgia", Tbilisi city hall.

electricity for outdoor lighting is consumed by Batumi, where outdoor lighting includes streets, sidewalks, parks, building facades, planting strips or plant lights in all seasons. In addition, this system is not yet fully equipped with energy saving technologies, which significantly increases the sector's energy consumption.

The dynamics of electricity consumption for outdoor lighting system is given in Table 4.3.

Table 4.3. Electricity consumption for outdoor lighting[42]

Year	2005	2006	2007	2008	2009	2010	2011
Ajara	1 606.4	3 541.1	5 986.9	8 799.4	11 157.6	12 685.9	15 108.6
Batumi	1 434.3	3 000.9	4 751.5	6 821.3	8 452.7	9 327.9	10 715.4

Tourism Sector

Tourism is a priority for the development of region. Tourist facilities include hotels, restaurants, catering and other service facilities.

In recent years the demand for tourist services significantly increased in the region. The number of tourist accommodations increased by 87% in 2011 compared to 2006. In 2011, from 51.1 thousand accommodation places more than 80% were family type accommodation. In the same year the annual load factor of these facilities was 16.6%, but in August - around 52.35%. The interest of tourists in Ajara grows significantly in summer - July and August.

Table 4.4: Energy consumption in the tourism sector (2011)[43]

	Electricity (kwh)	Natural gas (cub. m)	Firewood (Tons)	Gasoline (Tons)	Diesel (Tons)	Kerosene (Tons)	Liquid Petroleum Gas LPG (Tons)
Total Tourism Sector:	**59 274 253.0**	**2 589 238.0**	**0.0**	**0.0**	**650.0**	**0.0**	**365.0**
including:							
Heating	13 195 623.0	466 062.8	0.0	0.0	0.0		0.0
Cooling	15 115 421.0	0.0	0.0	0.0	0.0		0.0
Water Heating	8 233 621.0	595 524.7	0.0	0.0	0.0		35.0
Cooking	12 456 535.0	1 087 480.0	0.0	0.0	0.0		330.0
Lighting	7 036 541.0	0.0	0.0	0.0	0.0		0.0
Other:	3 236 512.0	440 170.5	0.0	0.0	650.0		0.0

[42] Batumi City Hall, the municipalities of Ajara
[43] Batumi City Hall, the municipalities of Ajara

Transport Sector

This report deals only with road transport within the transport sector. Department of Roads and Melioration Systems of AAR has 2 958.79 km of road on its balance including: a concrete roads - 205 km; gravel surface roads – 1 025 km; earthen roads – 1 728.79 km; Also, there is a tunnel of 657 m length; there are 430 bridges on the roads.

Particular attention is paid to the development of road infrastructure in recent years. In addition to many other projects of road infrastructure improvement, the very important new project for country and particularly for Ajara has been initiated by the government and with financial support of Asian Development Bank (ADB), which covers the construction of bypass transit road on Poti - Batumi - Sarpi section.

The analysis of road passenger transportation structure shows that the passenger turnover is high on large suburban routes, which is natural. The region consists of 64 communities (temi), which unite nearly 340 villages. Accordingly, the passenger turnover is daily and intense. There are around 240 suburban routes with daily passenger turnover of 48 000. Table 4.5 shows the stock of constant-owned vehicles in 2011and transport activity data.

Table 4.5. Registered road transport stock by the type of transport, the transport activity and fuel consumption (2011)[44]

Motor vehicles	Passenger cars (excluding taxi and municipal vehicles)	Taxi	Passenger cars serving municipalities and other state agencies	Busses	Mini-busses	Light Commercial Vehicles (up to 2 Tons of load)	Heavy goods vehicles
By type of fuel:							
Gasoline	21 300.0	510.0	326.0	52.0	85.0	38.0	0.0
Diesel	4 500.0	560.0	63.0	350.0	1568.0	350.0	258.0
Electricity	9.0	0.0	0.0	0.0	0.0	0.0	0.0
CNG	178.0	8.0	0.0	0.0	3.0	0.0	0.0
Total	**26 165.0**	**1087.0**	**389.0**	**402.0**	**1656.0**	**388.0**	**258.0**
Annual mileage (km/ vehicle)	7 000.0	15 000.0	5 000.0	103 680.0	61 200.0	21 600.0	43 200.0
Passenger activity (passenger-km)	274 732 500.0	24 457 500.0	2 917 500.0	506 520 000.0	208 656 000.0	0.0	0.0
Load activity (Ton-km)	0.0	0.0	0.0	0.0	0.0	38 761 200.0	206 193 600.0
Gasoline motor average efficiency (Liter/100 km)	15.0	14.0	12.0	20.0	13.5	14.0	30.0
Diesel motor average efficiency (Liter/100 km)	12.0	9.0	10.0	25.0	13.5	14.0	35.0
Electric motor average efficiency (kWh/100 km)	30.0	0.0	0.0	0.0	0.0	0.0	0.0
CNG motor average efficiency (cub.m/100 km)	7.0	6.5.0	0.0	0.0	0.0	0.0	0.0
Total gasoline consumption (liter)	22 365 000.0	1 071 000.0	195 600.0	1 078 272.0	702 270.0	114 912.0	0.0
Total diesel consumption (liter)	3 780 000.0	756 000.0	31 500.0	9 072 000.0	12 954 816.0	1 058 400.0	3 900 960.0
Total electricity consumption (kWh)	18 900.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CNG consumption (cub.m)	87 220.0	7 650.0	0.0	0.0	24 786.0	0.0	0.0

[44] Ajara Police Department of the Ministry of Internal Affairs; Department of Statistics

The rest of the commercial sector and industry

Industry and other commercial (non-tourist) sites, as well as the energy consumption of the agricultural enterprises are united in a separate group, energy consumption of which is given in Table 4.6.

Table 4.6. Energy consumption in the commercial sector and industry (2011)

	Electricity (kWh)	Natural gas (cub. m)
Energy Consumption	**77 120 552.0**	**3 997 537.2**

4.3. Business As Usual (BAU) GHG emissions scenario (2011-2030)

Scenario assumptions

The discussed energy consumption structure represents a "snapshot" (initial status) of the region in 2011, but it is very important to take into account the expected changes in the energy consumption. Possible trends of development of the initial status in case there is no energy saving programs implemented show a reference scenario.

The reference scenario is usually considered to be a "business as usual" (BAU) scenario, because it shows how the initial status would change, in the case that there is no municipal energy saving programmes implemented. For Ajara the following drivers were established that influence the energy consumption:

Population growth. This factor directly affects the energy consumption by population, passenger and commercial goods transportation. The dynamics of population growth in Ajara and Batumi are given in Table 4.7.

Table 4.7. Population growth forecast in Ajara and Batumi (excluding tourists)[45]

Territorial Units	2012	2015	2020	2025	2030
	Permanent population	Permanent population	Permanent population	Permanent population	Permanent population
Ajara	**393 595**	**395 000**	**398 000**	**400 000**	**410 000**
Batumi	169 400	195 000	200 000	210 000	220 000

Gross Domestic Product (GDP) and GDP per capita growth. As various studies[46,47] show, GDP (and GDP per capita) growth directly affects the energy consumption and transport turnover. As income increases, people, businesses and commercial organizations consume more energy and at the same time begin to move more. GDP growth forecast for Batumi and Ajara are given in Table 4.8.

[45] Department of Statistics of Georgia; Ministry of Finance and Economy of Ajara ARR

[46] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Passenger_transport_statistics

[47] Ghanadana R, Koomey J.G, Using energy scenarios to explore alternative energy pathways in California. Energy Policy, 33 (2005), 1117–1142.

Table 4.8. Gross Domestic Product (at constant prices) growth forecast for Ajara and Batumi[48]

Year	2011	2012	2013	2014	2015	2020	2025	2030
Ajara Regional Product (at constant prices, million GEL)	1 014.00	1 089.04	1 179.43	1 256.09	1 318.89	1 761.33	2 398.84	3 149.37
Batumi GDP (at constant prices, million GEL)	790.92	849.45	919.95	979.75	989.17	1 197.70	1 487.28	1 795.14

Increase in tourist numbers. Forecast of the growth of the number of tourists was used to evaluate the energy consumption in the tourism sector. This forecast is shown in Figure 4.2.

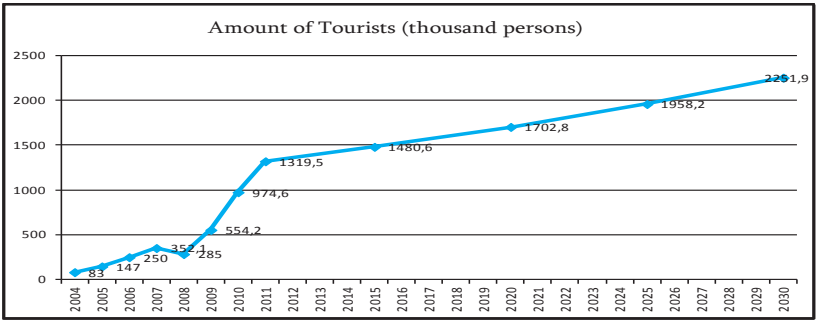


Figure 4.2. The dynamics of growth of tourist numbers in Ajara[49]

Additional assumptions include gasification, according to which 75% of the population of Batumi and 20% remaining population will be gasified by year 2030.

BAU scenario

Table 4.9 shows the main characteristics of BAU scenario.

Table 4.9: Main characteristics of BAU scenario For Ajara (2030) and Batumi (2020)

Parameter	Unit	Ajara			Batumi		
		2011	2030	Growth %	2011	2020	Growth %
Population	Thousand persons	390.6	410.0	5.0	171.0	200.0	17.0
GDP	Million GEL	1 014.0	3 149.0	211.0	791.0	1 198.0	51.0
Final Energy Consumption	GWh	1 968.0	4 250.0	116.0	1 110.0	1 719.0	55.0
GHG Emissions[2]	Thousand tons CO_2 eq.	276.0	693.0	151.0	201.0	339.0	69.0

[48] Department of Statistics of Georgia; Ministry of Finance and Economy of Ajara ARR
[49] Department of tourism and resort of Ajara ARR

The Table shows that population in Batumi grows faster than in the whole region of Ajara, this is partly due to migration of the population to Batumi, while the gross domestic product increases less rapidly compared to whole region's product, assuming that from 2020 agriculture development will promote the rural regions' share in the gross domestic product.

The energy consumption in Batumi increases more rapidly than in Ajara - this is caused by the migration of population from villages to Batumi and by the relatively better economic conditions. Increase in greenhouse gas emissions are approximately the same, which is partly due to the gasification of regions.

Figure 4.3 shows the trends in the various types of fuel consumption according to BAU scenario.

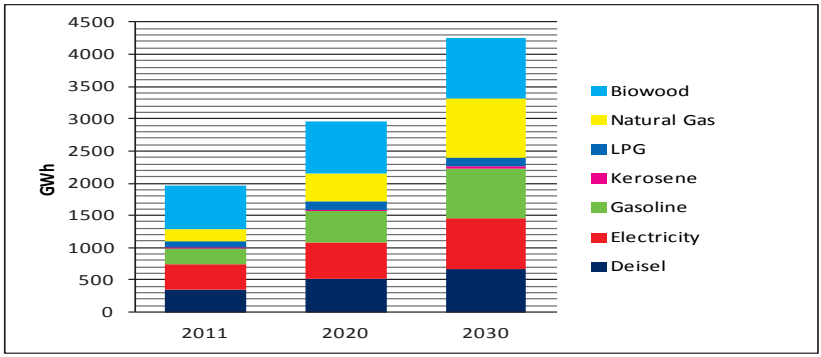


Fig. 4.3. The final energy consumption by energy carriers in BAU scenario

Fig. 4.3 shows that the most rapidly increasing fuel is natural gas (approximately 400% growth by the year 2030). This is partly due to the assumptions on gasification process, and partly due to the fact that with the growth of income already gasified customers are moving to a more intensive use of natural gas. The consumption of petrol (220%) and diesel (88%) increases rapidly as well, because of the increase in the number and activity of transport. Electricity consumption increases by 102%, while wood consumption - by only 39%.

As for the forecast of energy consumption of different sub-sectors, it is given in Figure 4.4.

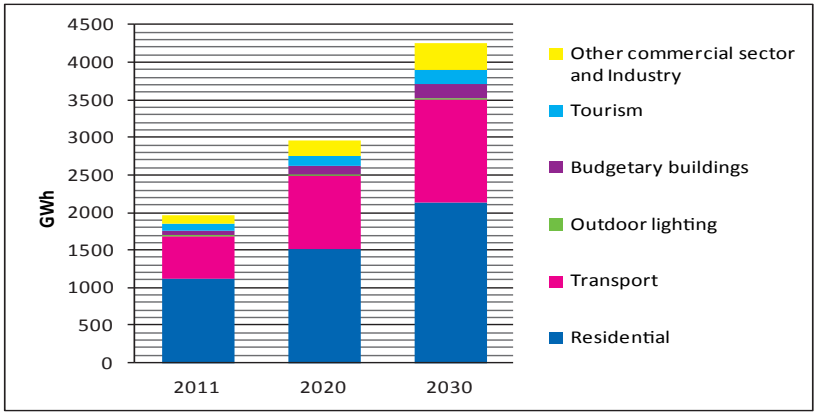


Fig. 4.4. The final energy consumption in different subsectors according to the BAU scenario

As shown in the diagram, the largest energy consumer is household sector, where consumption grows only by 92% for the year 2030. Second place is taken by the transport sector, where energy consumption increases by 143% by 2030.

Figure 4.5 shows the growth of all types of energy consumption in Batumi and the rest of the area.

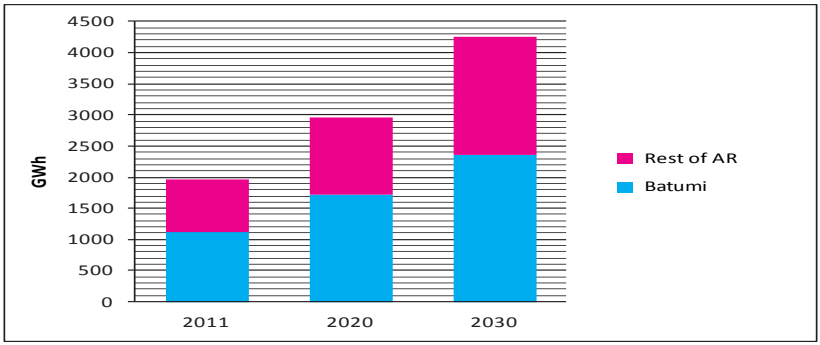


Figure 4.5. Final energy consumption in Batumi and the rest of Ajara according to BAU scenario

Considering the global warming potential, the largest share of greenhouse gas emissions in 2011 was emitted by diesel fuel (34%), and second largest was petrol (21%). By 2030, the share of petrol increases up to 27% - caused by the increase of private cars, and the share of natural gas increases up to 26%. The share of emissions from various fuels in Batumi and Ajara is shown in Figure 4.6.

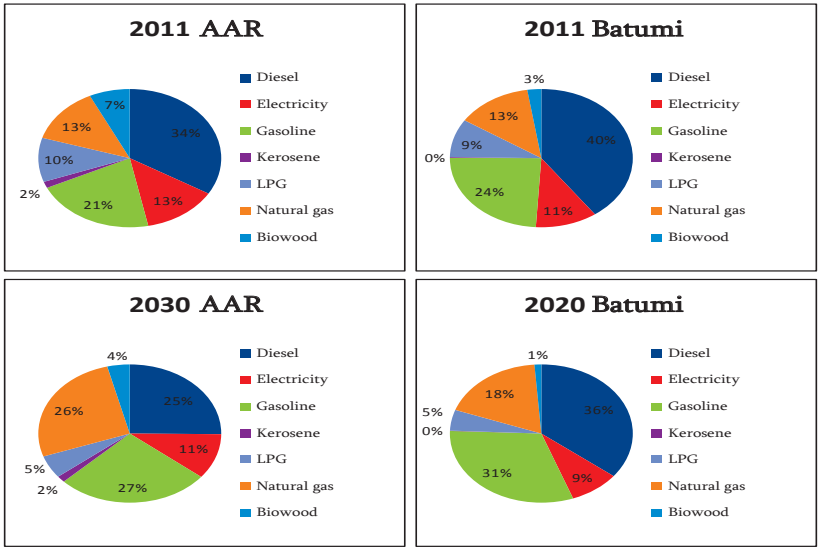


Figure 4.6. The distribution of greenhouse gas emissions in Batumi and whole territory ofAjara in2011, in 2020 (for Batumi) and 2030 (for Ajara) by fuel types

4.4. Evaluation of GHG mitigation potential by measures planned in GHG emission mitigation strategy

Transportation, building and lighting sectors

Table 4.10 presents main mitigation measures from greenhouse gas mitigation strategy (see Ajara Climate Change Strategy, Chapter 5) and the assumptions that have been made to evaluate mitigation potential of these measures[50]:

[50] Assumptions and estimations are based on calculations made in project proposals, on expert judgement and information from Tbilisi SEAP.

Table 4.10. Assumptions for assessment of mitigation potential of Greenhouse gas emissions mitigation measures from mitigation strategy

Measures	Assumption (basis for assumptions)
1. Restoration and development of transport infrastructure	The distance traveled by transport is reduced gradually, reduction reaches 1% by 2020, 2% - by 2030, (Tbilisi Sustainable Energy Action Plan - SEAP, expert estimates).
2. Improving public transport services and transition to more energy efficient technologies	By 2020, 70% of taxis are electric. This percentage ratio is maintained in the following years as well (project proposal). By 2020, 60% of buses and mini-buses in Batumi operate on Compressed Natural Gas (CNG). This percentage ratio is maintained in the following years as well (project proposal). The share of public transport increases by up to 5% in 2020 compared with the BAU scenario, by 7% - by 2030, (Tbilisi SEAP, expert estimates).
3. The promotion of low emission vehicles with a variety of incentives and restrictive measures for high emission vehicles	Private cars mobility is reduced by 7% by 2020, by 10% - by 2030 (Tbilisi SEAP, expert estimates). The share of cars operating on CNG increases by 5% in 2020 and by 10% by 2030 (expert estimates). Private car fuel consumption is reduced by 13% by 2020, by 15% - by 2030 (Tbilisi SEAP, expert estimates)
4. Increase of energy efficiency in Municipal building heating/cooling systems and promotion of renewable energy sources	As a result of insulation activities in municipal buildings,the heating/cooling efficiency improves by 30% by 2020 (expert estimates). 50% of Diesel-powered heating systems are replaced by heat pumps by 2020, 70% - by 2030, (expert estimates, project proposals on the use of heat pumps).
4. Increase of energy efficiency in touristic buildings (hotels, restaurants) heating/cooling systems and promotion of renewable energy sources	As a result of insulation activities in tourist buildings (mainly private guesthouses where energy efficiency is low)the heating/cooling efficiency improves by 40% by 2020 (expert estimates). 50% of Diesel-powered heating systems are replaced by heat pumps by 2020 (expert estimates).
6.Improvement of energy efficiency and promotion of renewable energy in residential sector	As a result of insulation activities in 30% of residential buildings, the heating/cooling efficiency in these buildings improves by 30% by 2020, and by 50% by 2030 (expert estimates based on Tbilisi SEAP). As a result of information campaign, population uses electricity more efficiently (by using efficient bulbs and other energy efficient technologies), resulting in decrease of electricity consumption for lighting and electric appliances in the family by 5% for the year 2030 (Second National Communication on Climate Change, expert estimates). By 2020, 50% of the population uses energy efficient wood stoves, by 2030 - 70% (Second National Communication on Climate Change, expert estimates).
7. Increase of energy efficiency in outdoor lighting	50% of inefficient lighting bulbs in outdoor lighting are replaced by efficient ones by 2020 and 90% are replaced by 2030. Additional 10% savings are obtained by optimal control system for outdoor lighting (Tbilisi SEAP estimations based on specific projects and technologies)

The assumptions where inputted into the model, and energy savings and reduced emissions were calculated in case of these measures. Table 4.11 shows the values of energy savings and mitigation potential of these measures for the years 2020 and 2030.

Table 4.11. Energy savings and mitigation potential of the GHG mitigation measures

Measure #	Energy savings compared to the BAU scenario, GWh		Emission reductions compared to BAU scenario, thousands of tons of CO_2 eq.	
	2020	**2030**	**2020**	**2030**
1	9.86	27.52	2.53	7.05
2	3.23	17.25	32.94	43.08
3	83.06	171.55	21.11	44.02
4	27.35	49.26	4.10	7.53
5	15.75	21.63	1.77	2.59
6	131.09	235.45	6.91	15.31
7	6.78	15.17	0.62	1.39
Total	**277.13**	**537.82**	**69.98**	**120.98**

Overall, these measures will reduce the emissions from Ajara's energy consumption sector by 15% in 2020 and by 17% in 2030.

Waste and Waste Water Sector

During different time intervals in 2000-2011 years, seven landfills were functioning in AAR with the total area of 30 hectares. In 2010 all small landfills were closed and waste now is transported to the large landfill near Batumi. By January 1, 2012 there were 3 landfill polygons in AAR, each of the open type and not controlled. The total area occupied by active landfills is 26.5 hectares. The exact amount of solid waste disposed at the landfills is known only for Batumi landfill, while for remaining landfills this value is unknown. Accordingly, for the purpose of calculating the methane emission, the amount of disposed waste was used for Batumi landfill, whereas for other landfills estimations were made according to the amount of population and average daily waste per capita (0.7 m^3). It should be emphasized that in the case of Batumi landfill, the real amount of waste is about three times larger than the amount estimated by population numbers and per capita values (tourists, hotels, restaurants generate additional waste). As a result, presumably, the real emissions from the solid waste in Ajara AR are about 20-30% higher than the calculated ones. The calculations of emissions based only on population, showed that annually about 1.65 Gg of methane is emitted, whereas the real amount of waste at Batumi landfill gives about 1.88 Gg of Methane emissions.

Today there are 137 large and small water treatment plants in Ajara AR, with design capacity of 92 849 m^3. One of them is biological, while the rest are of the mechanical type. Approximately 22 768 000 $m^3$of insufficiently treated water is collected annually in Ajara, including approximately 20 million m^3, which is completely cleaned by new

biological treatment plant. Methane Emissions from wastewater were approximately 0.15 Gg in 2011, N_2O – 0.027 Gg, giving the total of 11.60 Gg in CO_2 equivalent. Total emissions from waste and waste water sectors in 2011 were 46 160 tons of CO_2 equivalents.

The Ajara AR strategy for mitigating emissions from waste and waste water management sectors considers the following activities:

- Development of plan for reducing emission from existing wastewater treatment systems and landfills;
- Initiation of the pilot projects –establishment of methane extraction system and flaring or utilization of methane at old Batumi and new Kobuleti landfills. (Measure 8);
- Establishment of methane extraction system and flaring or using for energy purposes of methane at wastewater treatment plant (Measure 9).

According to the strategy, it is expected that implementation of the pilot projects (Measure 8) can reduce emissions from the waste sector in the years 2014-2020 and 2014-2030 correspondingly by 89 950 (24%) and 452 720 (51%) tons of CO_2 equivalent. The fact that in 2014 the old landfill is closed and new one is open is considered (see proposals 6.2.1 and 6.2.2). As for the annual reduction of emissions, the numbers equal to 26 100 (50%) in 2020, and 33.95 (65%) tons of CO_2 equivalent in 2030. These calculations and forecasts of future emissions do not consider the growth of number of population, tourists and the amount of waste produced per capita, which would result in higher amounts of methane emitted from the landfills and more energy resources available. Assessment of methane as an energy resource by this approach is conservative, but rather reduced in terms of estimating the emissions growth.

From the waste water sector (Measure 9), the greenhouse gas emissions will be reduced by an average of 1 993 tons of CO_2 equivalent per year, which by 2020 will reduce emissions by 13 950 tons of CO_2 equivalent and 33 881 tons of CO_2 equivalent by 2030.

Table 4.12. Methane emission reduction assessment results

#	Activity	Annual emission reductions compared with BAU scenario, thousands of tons CO_2 eq.		Cumulative emission reductions compared with BAU scenario from 2014 on, thousands of tons CO_2 eq.	
		2020	**2030**	**Till 2020**	**Till 2030**
8	Extraction of Methane from solid waste	26.10	33.95	89.95	452.72
9	Extraction of Methane from waste water	1.99	1.99	13.93	33.88
	Total	**28.09**	**35.94**	**103.88**	**486.6**

Agriculture Sector

According to the 2011 data the number of domestic animals and birds in Ajara AR was approximately 154 000, generating about 1 064 tons of excrements per year. From this it is possible to generate approximately 29 million m³ of biogas annually. From this amount 50% can be technically used.

At present, a total of 89 biogas digesters are installed in Ajara with annual capacity of 96.79 thousand m^3, but only 50% of them are operational. The GHG mitigation strategy of Ajara aims to disseminate the use of biogas, which includes the selection of pilot villages and introduction and popularization of different types of biogas digesters. In this process it is very important to promote the idea of joint use of the biogas plant, which will make this renewable resource significantly more attractive economically. Using biogas will reduce methane emissions from the agricultural sector, since methane will be no longer emitted from livestock excrements. During combustion of Methane (1 ton), carbon dioxide is emitted (2.7 tons), the global warming potential of which is 21 times less than methane potential. Theoretically, if the excrements of total livestock of 2011 in Ajara are converted to biogas, the emission reductions will reach 24 000 tons of CO_2 equivalents, but maximum of 50% of this can be estimated as realizable.

Due to the fact that specific project proposal hasn't been prepared for this sector, the conservative assumption has been made that in case of use of 50% of potential, 12 000 tons of CO_2 equivalent emissions will not be emitted annually to atmosphere, which will cumulatively reduce 84 000 tons of CO_2 equivalent by 2020 and 204 000 tons of CO_2 eq. by 2030 (Measure 10).

In addition to the above measures, it is also possible to obtain biogas from cooking fats and organic waste of enterprises, which will reduce emissions from waste and waste water sector, but these measures require additional research and technology assessment, therefore, are not discussed here.

As a result the implementation of AAR mitigation strategy in the period of 2014-2020 will cumulatively reduce 703 thousand tons of CO_2 eq. and in 2014-2030 – 2 272.5 thousand tons of CO_2 eq. (Table 4.13).

Table 4.13. The GHG mitigation potential of measures from AAR mitigation strategy

Measure #	Annual emission reductions compared with BAU scenario, thousands of tons CO_2 eq.		Cumulative emission reductions compared with BAU scenario from 2014 on, thousands of tons CO_2 eq.	
	2020	2030	2020	2030
1	2.53	7.05	13.40	58.84
2	32.94	43.08	76.71	239.63
3	21.11	44.02	107.43	413.40
4	4.10	7.53	21.52	75.98
5	1.77	2.59	10.01	30.18
6	6.91	15.31	31.05	135.08

7	0.62	1.39	3.44	12.95
8	26.10	33.95	89.95	452.72
9	1.90	1.90	13.93	33.88
10	12.00	12.00	84.00	204.00
Total	109.98	168.82	451.44	1 656.66

5. Climate change strategy of Ajara region

Introduction

This strategy has been elaborated within the preparation process of Georgia's Third National Communication. The strategy mainly deliberates activities for assessment and mitigation of negative impacts of climate change and undertakings to be carried out to reduce GHGs emissions. Except for the mentioned activities, the strategy also includes the activities recommended by the project implemented in Georgia in order to assess climate change impact and means of adaptation and mitigation measures needed to strengthen local potential, which, on its part, will support elaboration of new projects. The main part of the strategy dictates a list of those departments/units/bodies, increase and strengthening potential of which is necessary to combat risks triggered by climate change and to support economic infrastructure, as well as tourism and agricultural sustainable development.

Recommendations prepared for Ajara development strategy in 2010 with support of UNDP were envisaged to the maximum extent during the process of the preparation of this strategy.

Up to 15 project proposals are attached to the strategy, implementation of which will demonstrate successful practice in different sectors.

5.1 Revealed impact of climate change in Ajara region

Soils

Soils are the most important resource of Ajara region, though Autonomous Republic does not possess yet comprehensive state land cadaster, which should be responsible not only for quantitative registration of land, but it should also make accounting and monitoring of land quality, economic evaluation and state registration of land users. From all the above-mentioned items currently only land users' system is organized. As for the registration of land according to its quality indicators (marks) – the work on it has not even been started yet. The same can be said regarding the economic assessment of lands, which is important to define normative price of land, calculate land charges (tax), mortgage and other economic and financial transactions. There is no monitoring for rational usage of land resources.

Impact of climate change on soils in Ajara, like in other systems and ecosystems, is going against serious anthropogenic background, which reinforces the negative

impact of climate change. For the time being the coefficient of techno genic load in Ajara is between 0.7-0.9, though taking into consideration sensitiveness of its geological environment, it should not exceed 0.4-0.5. Agricultural lands, sea coastal zone, riverbanks and lands in general are simultaneously attacked due to extreme geological events (landslides, mudflows, avalanches, floods).

The impact of climate change on agricultural lands and soils covered by forests in Ajara is mainly by caused intensive and heavy precipitation and the increase of sea level. According to the map of Georgia, the most part of Ajara is covered with brown forest soils, on which agricultural lands are located on the areas free from forest cover, mainly on slopes. In excessively humid Ajara heavy rains cause wash off of cultivated agricultural lands (water erosion of lands). As a result – every year several tons of arable land is washed out from each land ha and soil degradation proceeds. The soil degradation indicator in Ajara varies between 30-35% which two times exceeds the limit of other regions of Georgia. It should also be noted that during the recent 10-20 years in Ajara, as well as in whole Georgia, the amount of one time intensive and heavy precipitation increased due to global warming impact. This, on its hand, hardens problems related to erosion (decrease of soil fertility, loss of lands, activation of landslides, increase intensity of mudflows, etc.).

Due to the dense population, the biggest threat for Ajara population is landslides and mudflow processes, the intensiveness of which has been significantly increased during the recent 20 years. Until 1970-es Ajara, according to the amount of landslide and mudflow damages and threats belonged to the medium risk category (with coefficient 0.3-0.5), but for 2000 this region due to the damages caused by extreme events was shifted to highly hazardous category (coefficient of risks 0.5-0.9). The situation is aggravated due to the fact that more than 80% of the lands affected by mud torrents are directly connected to landslides processes and their intensiveness and risk of threat is linked to the scales of landslides.

Anthropogenic impact and large-scale techno genic loading have negatively influenced the Black Sea coastal zone morpho-dynamic processes, which were reflected in washing out of shores and destruction of buildings. This negative impact has mostly affected the most active zone – beaches. Beaches are natural protective mechanism that preserves private and state property located on it, including natural, historical and cultural complexes. Beaches in Ajara represent the biggest recreation and economic resource. Further activation of erosion processes in the sea coastal zone in the current century is expected due to global warming, permanent increase of sea level by 2-3 mm per annum and heavy storms. All these threats increase above-mentioned risks and urgency of problems. Assessment of climate change and taking into consideration its impact is one of the utmost parts in this component.

Up to now, according to rough estimations, since 1967 about 24 000 ha of agricultural land is outworn, washed off and eroded, that comprises 33% of total agricultural land (8% of Ajara total territory). In addition 200 ha is washed out by the Black Sea.

Black Sea Coastal Zone

Assessment of climate change impact on the Black Sea has shown that it has several directions: increase of sea level, changes of storms according to seasons and intensiveness and upper temperature regime of sea.

In particular, since 1970-es, the amount of rough storms in Ajara has significantly increased: up to now number of days of 5-shaft storms has increased two times; 6-shaft storms – three times; case with 7-shaft storm was also fixed; the amount of 4-shaft storm was insignificantly decreased. With regards to global warming during the last 10 years the regime of storm seasonal distribution also changed: if in 1961-2000 storms were mainly revealed in late autumn and winter, during the recent 10 years strong storms take place even in summer.

According to the research made during 1961-2011 the average increment of the sea level has exceeded the mean value by 20 cm during the recent 20 years. Extreme indicator of level variation has equally increased and has reached up to 50 cm annual amplitude. The annual regime of the sea level variation has also changed: until 1989, the minimum was noticed in autumn-winter and maximum in spring-summer, that has changed to winter-spring maximum and spring-autumn minimum since 2006.

Global warming has also influenced the temperature regime of sea upper layer. Namely, during 2000-2009 a regular temperature with minimum ($+7^0$C) in February-March and maximum in July-August ($+28$, $+29^0$C) was established. Deviation from the norm was started in 2010, when the surface temperature reached 33^0C. The mentioned factors caused complete destruction of mussels and oysters in summer 2010 in Ajara. In 2011 the same index overpassed for a longer time 30^0C.

Assessment of Ajara sea coastal zone has shown that almost in all parts of sea coasts (except for Batumi Cape) intensive wash out of shores is going on. Necessary activities needed to stop the process causing damages are given in Annex I. In the current century permanent increase of sea level by 2-3 mm/yr and activation of further erosion processes are expected due to global warming and increase in the rough storms frequency, which makes the above mentioned problem even more crucial.

Forestry sector

Negative impact of climate change, namely, increase of temperature and precipitation in Ajara causes 3 main problems for Ajara forest sector: diseases of tree-plants (increase of old diseases spread and emergence of new diseases); disappearance of forests in the sub-alpine zone and lowering of upper levels of forests by 300-400 meters due to erosions caused by intensive rains (floods) and deep snow cover, as well as increased risks of fire.

The problem related to waste decay and spreading of wreck-diseases is enhanced by the global warming that has started in Ajara since 1990. It is a well-known fact that increase of temperature and precipitation in forests creates gainful conditions for spreading/expansion of wreck-diseases in ecosystems of the forests. A confirming example of the above is that areas of diseased chestnut forests increased up to 5 209 ha by 2010,

which comprises 28% of the total area. At the same time, in line with the increase of annual average temperature, the scope of diseases is moving forward up to high chestnuts forests areas (Shuakhevi, Khulo). Relatively new diseases like Cameraria ohridella Deschka (chestnut moth), Tischeria complanella Hb = Tischeria Ekebladellia Bjerkander (oak moth) and Cylindrokladium buxicola (box tree disease) was fixed in Ajara during 2006-2010 with different intensity levels. This might cause catastrophic damage to the main species against the climate change background. Namely, the box tree disease has covered 55-65% of Kintrishi Reserve landscape during the recent 2-3 years; Affected by the disease box tree population amounts to 60% at the Mtirala National Park.

Quite difficult situation is created at the coniferous forests in Ajara. Currently 5 870 ha (13% of the total area) is dried out, or fallen on the ground or stuck (421 000 m^3, i.e. 2.5% of the total storage). This in summer, especially in hot periods, together with spreading of wreck-diseases will increase the risks of fire in the forests.

As per problems caused by climate change in sub-alpine forests, as mentioned above, the forest border has come down by several hundred meters during the recent 50 years. This is mainly caused due to heavy rains, washing out of soils and progress of erosion processes. For the time being, 2 790 ha is registered at sub-alpine zone, where the forests still maintain natural self-renovation process. But pasture and other anthropogenic factors prevent this process.

Agriculture

The most significant impact on agriculture from the climatic parameters is made by air temperature, amount of precipitation and frosty days and their distribution according to seasons, duration of vegetation period. The most significant importance is given to the minimal temperatures due to their impact on subtropical cultures – distribution of their totals according to seasons/months during the vegetation period taking into consideration the essence of these parameters.

The following main problems are revealed in Agriculture sector in Ajara linked to climate change: erosion of arable lands and destruction/reduction of fertility/ productiveness; spreading of different types of diseases of plants (tomatoes, citrus). This negative impact of climate change is aggravated by anthropogenic influence. Namely, in the terms of small-scale farm economies provision of recommendations on sustainable land management to the population is complicated, accordingly good practice cannot be introduced.

The landscape of Ajara creates difficult conditions for Agriculture. 25.1% of land is occupied by agricultural lands, among which plains occupy only 5.0%. 1.18 ha of agricultural land comes per person, including 0.03 ha for arable land. Slopes and steep mountains occupy the main part of the region, enormous amount of precipitation is added to this (2 000-3 000 mm) that in total cause activation of erosion processes, flash floods, landslides, mudflows and avalanches. As a result the amount of agricultural land is decreased: if in 1980 it comprised 78 718 ha, for 2010 it lessened to 72 862 ha. All this is facilitated by incorrect land usage and cultivation of annual plants

without any preventive measures taken in advance. At the same time the areas under perennials is also decreased.

Statistics show that types and scales of wreck-diseases have been increased in Ajara during the recent years that are directly linked to climate change issue, polluted environment and accommodation of diseases with measures to combat them. This is why it is vitally important to take fundamental measures to struggle against the above problem via using biological and integrated methods. Ajara subtropical zone is not completely safe from frosts, since it represents the extreme northern part of subtropical zone of the world, due to what frequent freezing of citrus twigs and leaves occurs. As per fruit itself, for its ripping (maturing) sum of 4 000 -4 500 (^{0}C) active temperatures is necessary. According to Kobuleti and Khelvachauri meteorological stations, the necessary sum of active temperatures is accumulated by 15-24 November. Usually at this period frosts and solid precipitation (hail, heavy snow) is expected (at least once in 3-4 years). This negatively affects the fruit, decreasing its quality and competitiveness on the market.

Vulnerability of Healthcare

Diarrheas of infective origin are assessed as the most acute medical problem in Ajara. According to 2009-2010 results Ajara is a leader among other regions of Georgia and exceeds the average data of the country by 4-5 times. Increase of inflectional diarrheas is noted during the holiday season (June-September), when 60-65% of incidents fall. It was also defined that this disease is noted particularly in children under the age of 4. This factor stipulates to consider small age children one of the most vulnerable groups to climate change impacts (together with elderly persons and chronically diseased patients).

During the recent times, some diseases have emerged, not characteristic to Ajara (spreading of which was made via insects and animals) that are associated with climate change, mainly with global warming. In lines with climate warming, the area and activation of these diseases is being increased. Namely, during the recent years there were noted such pathological infections as Leptospirosis and Borelios in Ajara. Creation of suitable conditions for spreading of these diseases is connected with climate change impacts.

Leptospirosis or Hay fever (canicola fever) which is transmitted through water and food from warm-blooded animals to humans was fixed in Ajara during the recent 9 years. From the revealed 101 cases 43 cases were accounted during 2008-2010. 19 cases out of 31 were laboratory confirmed in 2011. It should be noted that 5 patients died from this disease that confirms the heaviness of the pathology. Despite the fact that hay fever is mainly connected to agricultural activities, its indicator is high during the tourist season (August-September) in resort areas – Kobuleti and Batumi. As a result of analysis based on the existing data, it was confirmed that cases of hay fever increase during the months when the rise of temperature is noted. The coefficient of correlation between the intensity of diseases and maximal temperature indicator has comprised 0.85. Cases of boreliosis (lime disease) were fixed in Ajara in 2009 for the first time. In 2011 the 15 laboratory confirmed cases were registered. All the above-

mentioned diseases and spread up might be linked to climate change –increase of temperature and humidity.

From the climate-related diseases in Ajara mental disorders should be noted. With indicator of adult incidents Ajara has exceeded the total indicator within the whole Georgia by 13%, in children – by 58%. This tendency is maintained for traumas as well. Mental disorders in children can be motivated by the factor that in Ajara, unlike to other regions of Georgia, natural extreme events are more frequent causing chronic stress and negative impact on the mental condition of a person.

Vulnerability of tourism

Warming of climate might cause the whole chain of results for tourist sector – both, negative and positive.

As a positive result we can consider prolongation of tourist season followed by extension of relevant service fields and infrastructure, consequent and appropriate increase of income for the local population and improvement of living conditions. In case of Ajara, as mentioned above, for the middle period of the current century, in the sea coast zone it might comprise even a month and tourist season can be prolonged even till November. Analogically, improvement of comfortable climate conditions would be expected in May for the mountainous regions; in high-mountainous zone – prolongation of tourist season in September.

Expected negative results:

Excess of extremely hot days in sea coastal zone (prolongation of heat waves) in July-August, which will cause definite inconveniences for the tourists;

As a result of increase of heavy storms frequency, worsening of tourist and recreation conditions is expected in the sea coastal zone, also increase of threats caused by rough seas, washing out of beaches and flooding of coastal zone.

Due to intensive heavy precipitation in summer the threat of flashfloods is increased. This factor creates significant hazard especially to tourist areas located in mountainous zones.

In Ajara conditions, increase of temperature during the tourist season might cause upturn of number of diarrhea related inflectional diseases and frequency of heat waves. This factor will stipulate creation of early warning system that will provide recommendations and notifications in advance. Health problems related to climate change, extreme events like injuries and mental disorders also are expected. In order to combat these problems it would be reasonable to include healthcare sector in disaster management system.

In case of temperature growth by 1^0C in winter in high-mountainous zones by 2050, it is expected that ski season will become shorter, though according to forecasts, volume of precipitation will increase by 7% that will to some extent compensate negative impact of global warming.

Significant increase of water temperature (≥30 ^{0}C) together with air temperature might lead to complete destruction of mussels and oysters in water. This will negatively affect specific field of tourism – diving.

5.2. Adaptation strategy

Research of climate change impacts in Ajara has confirmed that the most vulnerable to climate change are the following categories of land: populated areas (landslides, mudflows and flashfloods), forests and pastures (erosions), agricultural lands (erosion and decrease of fertility) and the Black Sea coastal zone (capturing of lands by the sea). This current process is especially dangerous for Ajara region, since the density of population - about 130 persons per 1 km^2 - is one of the highest in Georgia as well as the rate of increase of population, which had second rate in 2000-2009 following the growth rate in Tbilisi city[51]. Accordingly, the first priority in the process of adaptation to climate change in short, as well as long-term perspectives is preservation of lands or rehabilitation of lost lands where possible.

It is very important to note, that all the above-mentioned problems are not caused only by climate change impact, but also by anthropogenic influence as well. It is very difficult to distinguish between these two, nevertheless, the research results have shown that in most cases the primary is anthropogenic impact and climate change seems to be secondary accelerator of the process. In the end, by reducing the anthropogenic factor the climate change impact will also be decreased.

According to above mentioned, the short-term strategy (10 years) on climate change adaptation process is reduction of anthropogenic influence on soils taking into consideration sustainable development principles and maximal protection of lands to maintain them. Long-term strategy (after 10 years) envisages rehabilitation of lands along with reduction of anthropogenic impact.

As a result, vulnerable sectors in Ajara according to priorities have been classified as follows: soils (all types), coastal zone, extreme events, agriculture, forests, healthcare. Notwithstanding the fact that these priorities do not allot the vulnerability in tourism sector directly, all the above sectors play significant role in tourism development sector. That is why each considered adaptation proposal is vitally important for sustainable development of tourism sector in Ajara. Also it should be highlighted that all the adaptation activities related to soils and discussed within this strategy for demonstration of different adaptation approaches are discussed and agreed with geological service, which should ensure their sustainability in future. Accordingly, the first principle suggested by the strategy on land adaptation and sustainable management is the following:

All activities (agriculture, forestry, infrastructure development, etc.) should be in compliance with geological examination and should be planned in agreement with geological service.

Ajara strategy in the process of adaptation with regards to climate change impact on **soils** considers the following components:

[51] http://froph.com

1. Maximal **maintenance** of the most vulnerable lands via reduction of anthropogenic impacts:
   - 1.1 Rehabilitation of degraded (thin out) forests;
   - 1.2 Changing of agricultural farming practice and transfer to sustainable management practice;
   - 1.3 Planning and O&M of populated and infrastructural lands.

2. **Rehabilitation and preservation** of the most vulnerable lands:
   - 2.1 Planting of new energy and soil protective trees at the territory of disappeared forests and eroded areas;
   - 2.2 Restoration of fertility of the agricultural lands lost due to erosion;
   - 2.3 Rehabilitation of the most important areas captured by the Black Sea.

3. Rehabilitation of lost lands (captured by the sea or degraded due to avalanches, rivers and landslides):
   - 3.1 Rehabilitation of eroded areas where this is economically and socially gainful/profitable;
   - 3.2 Sustainable increase of coastal zone area for disposing new beaches and infrastructural elements.

4. Preparation of Action Plan.

Ajara strategy in the adaptation process of negative impact of climate change in regards to **Black Sea coastal zone** considers:

1. Construction and development of infrastructure, tourist and private facilities in the areas recommended by the coats protection service; carrying out risk reduction activities;
2. Taking out preventive/protective measures for infrastructural, tourist and private sectors (their co-participation is considered);
3. Carrying out activities on the protection of hazardous to population segments (these activities should be mainly implemented by the municipalities);
4. Development of new tourist areas (beaches) in compliance with the sustainable development principles;
5. Preparation of action plans taking into consideration the principles of sustainable development.

Ajara strategy on reduction of impacts from the **extreme geological events** provoked by climate change considers the following:

1. Establishment of monitoring system
   - 1.1 In the high risk areas for the population ;
   - 1.2 In the hazardous places for chief infrastructural objects;

2. Carrying out prevention activities with maximal involvement and participation of the population;
3. Installation of modern forecasting systems;

4. Preventive practice activities for infrastructural objects;
5. Preparation of Action Plan.

Ajara strategy on **agriculture** in the process of adaptation to climate change process considers the following:

1. Strengthening of farms through correct management of agricultural lands/ soils via reduction of load on agricultural lands/soils (by using different alternative ways, e.g. by resettlement of population into the plains; utilization of sustainable lands from the geological perspective into large economies where the usage of preventive and fertility increase measures are more effective; support to creation of farmers' unions, etc.);
2. Support in increasing of potential of agricultural service centers and particularly to reduction of negative impacts of climate change and to increase of soils' fertility;
3. Permanent observation on climate change impacts (currently active warming is going on) in order to correctly assess potential of shifting agro-climatic zones and to provide appropriate recommendations to the population and farmers in order to reduce risks in case if climate change impact is revealed;
4. Preparation of action plan on sustainable development of the agricultural sector to facilitate maximal usage of ecologically clean products in the tourism sector.

Ajara strategy in the process of adaptation to climate change process in the **forestry** sector considers the following:

1. Reinforcement of soil protection functions, rehabilitation of the degraded forests;
2. Monitoring on diseases (especially on climate change related diseases) and close liaison with the forestry departments of the neighboring regions and countries in order to prevent broad expansion of these diseases;
3. Increase of potential of forests as CO_2 sinks, that implies decrease of their age and improvement of quality (density) up to the high standards;
4. Study of alternatives on privatization of forests (community forests, tourist sector forests, etc.);
5. Preparation of Action Plan for sustainable development in forestry sector.

Ajara strategy in the process of adaptation to climate change process in the **protected areas** considers the following:

1. Deployment of protected areas to study/assess impacts of climate change within the frames of protected areas. This monitoring is very important for the preparation of adaptation projects, since in this case the anthropogenic factor is excluded and only climate change impact matters;
2. During the Action Plan, preparation for protected areas the role of this sector should be highlighted in the mitigation process.

Ajara strategy in the process of adaptation to climate change process in the **healthcare sector** considers the following:

1. Improvement of control and management of infectious diseases;
2. Raising awareness among medical personnel on climate-related diseases;
3. Monitoring and risk management of climate related diseases;
4. Improvement of medical service in tourism sector.

Ajara strategy in the process of adaptation to climate change process in the **tourism sector** considers the following:

1. Utilization of profitable conditions caused by positive impact of climate change for tourism development;
2. Complete provision of tourism sector with local food/agricultural products;
3. Improvement of tourist services from the healthcare perspective;
4. Ensuring that international standards are met at the small family-hotels taking into consideration the climate change impacts.

5.3. GHGs emissions from Ajara and future forecast

In 2011 the emissions from energy sector (including transport sector) in Ajara comprised 276 000 tons of CO_2 equivalent[52]. The biggest part (53%) comes on transport sector, followed by buildings sector (residential, state budgetary and tourist) with 41%. According to the basic scenario, by 2020 emissions from energy sector in Ajara will grow by 67%; to 2030 – by 151%. The transport sector will remain as the biggest emitter, the share of which by 2020 will comprise 55%, and by 2030 – 51%.

The analysis made according to the consumed fuel showed that the biggest consumption was made in firewood (35%), followed by the electric energy (20%) and diesel (18%)[53]. According to the basic scenario by 2030 the biggest consumption will still fall on firewood, though it will comprise only 22% of the total consumption. It will be followed by consumption of natural gas (21%) and electric energy (19%).

As per shares of fuels according to types in 2011 emissions, the highest share falls on diesel (34%), followed by gasoline (21%). By 2030 according to basic scenario the biggest share of the energy sector in total emissions will be calculated from petrol use (27%), followed by consumption of natural gas (25%), and by the consumption of diesel, the share of which will be decreased down to 25%.

[52] This value is higher than emission from energy sector in 2011 in table 1.1 because mitigation sector emissions include energy emissions from electricity with average emission factor 0.0915 tones CO_2/MWh

[53] The gasoline, kerosene, natural gas and LPG are also consumed in smaller quantities.

5.4. Mitigation Strategy for GHG emissions

The research made on energy sources and energy consumption in Ajara has confirmed, that the most important sector currently making biggest contribution to GHGs emission process and out of which the greatest increase in emission is expected in the future, is the transport sector. Actually, this sector is completely dependent on fossil fuel due to what emissions from this sector are very high. Taking into consideration that Ajara is tourist area and at the same time transit region, significant increase of traffic (transport load) is expected in this sector. According to the above, sustainable development of the transport sector and correct scheduling of reduction of GHGs emission plan/activities are top priorities in this strategy.

The important portion in reduction of GHGs emission process comes on construction sector (residential, tourist, state budgetary). The consumption of energy in Ajara by the different types of construction (multi-story buildings, private houses, tourist facilities, budgetary/state buildings, etc.) from the energy efficiency point of view has not been studied yet properly. Accordingly, it is very important to make inventory of all buildings and assess their energy efficiency potential while preparing the strategy on emission of GHGs in Ajara. It is also important to study the practices of different kinds of energy consumption based on which improvement activities in energy efficiency and utilization of renewable energy should be defined.

Besides the mentioned two sectors, energy sector also considers utilization of energy efficient bulbs for street lighting and activities in regards to improvement of street illumination system management. Also, generation of energy obtained from the methane recovered from waste waters and landfills which will be used for lighting of the highway on Batumi-Sarpi section.

From non-energy sector the significant role in reduction of GHGs emission process can be played by waste and wastewater treatment sector. In 2011 the domestic waste produced in Ajara comprised 11% of Georgia's total waste with 3 operational landfills out of which 34 000 tons of methane gas (CH_4) in CO_2 equivalent was emitted and from the waste waters – 5 200 t CO_2 eq. accordingly, the utilization of the methane gas or its flaring theoretically will decrease GHGs emissions in Ajara by 15%.

Out of the activities that can make Georgian electricity grid with low-emission, the potential of wind energy and hydro resources should be utilized in Ajara. Finally, rehabilitation of forests and soils and increase of sustainable development will not only increase the potential of sink and contribute to reduce GHGs emission, but it also represents significant adaptation plans at the same time. As an example, we can state that rehabilitation of degraded pastures and hay fields will decrease emissions by 32%.

Hence, the priorities of GHGs emission reduction activities in Ajara are established as follows:

Ajara strategy on GHG emissions reduction from the **transport sector** considers the following:

1. Rehabilitation and development of transport infrastructure, which includes restoration and improvement of road covers, development of detour transit routes, construction of tunnels and bridges to shorten distances between places of location (short-term strategy);
2. Improvement of public transport and transfer to better energy efficient technologies. The main focus should be made on the development of electric transport, since efficiency of electric engine is higher than that of internal combustion engine. It is also considered that emission coefficient caused by utilization of electric energy will be decreased in Georgia in the nearest future, since in accordance with the national policy of the Government significant increase is planned in cumulative volume of hydro plants' share (middle-term strategy);
3. Limitation of private cars traffic and encouragement of the use of vehicles with low emission. This activity will be carried out by the time when the transport infrastructure is so developed that it can satisfy all needs of population (long-term strategy).

Strategy on reduction of GHGs emission in **buildings sector** considers the following:

1. Inventory of different types of buildings (multi-story buildings, private houses, municipal buildings, hotels, commercial utilities, etc.) in Ajara and assessment of energy efficiency (from the heat insulation perspective), study of practice on energy utilization (for heating, cooling, for cooking, lighting, etc.);
2. In a short-term strategy – increase of heating-cooling systems' efficiency in municipal buildings (kindergartens, hospitals, polyclinics, etc.) and utilization of renewable energy sources in this sector (effective technologies on biomass, heat pumps, etc.);
3. In a middle-term strategy introduction of above-mentioned activities and renewable energy technologies in the buildings used by the **tourist sector** (hotels, restaurants, etc.);
4. In a long-term strategy, increase of energy efficiency and utilization of more renewable energy (biogas, solar heaters and others) in **residential sector**.

Strategy on reduction of GHGs emission in **street lighting sector** considers the following:

1. Substitution of non-efficient street lighting bulbs with efficient bulbs;
2. Arrangement of intellectual management system which will regulate lighting level;
3. Generation of energy from methane recovered from the wastewaters and landfills that will be used for lighting of Georgia-Turkey highway on Sarpi-Batumi section.

Strategy on **reduction of emissions from the waste and wastewater sector** will consider the following:

1. Preparation of emission reduction plan from the waste and wastewater handling systems existing in Ajara;
2. Initiation of pilot projects – at the old landfill in Batumi and new one in Kobuleti; arrangement of system for extraction of methane, its flaring or utilization;
3. Arrangement of a system – for the, extraction of methane from the wastewater handling facility and its flaring or utilization as energy resource.

Ajara strategy from the point of view of **reduction of emissions from the energy sector** discusses the following:

1. Further Increase of hydro-energy generation share. Hydro-energy represents a country priority for Georgia, Its potential is well examined, projects are prepared and are placed on the official website of the Ministry of Energy of Georgia. That is why it is not discussed in details in this part of the report. Though it is important to note that utilization of hydro-energy and increase of its share in final generation will result in the reduction of emissions in energy network; accordingly, this will support reduction of emissions from the whole Georgia, including Ajara. The Government of Ajara is exclusively interested in development (rehabilitation) of micro hydro power plants and by their local utilization. Schemes should be searched in this direction in order to make micro hydro plants attractive and profitable for the investors, local population and authorities;
2. Ajara possesses significant wind energy potential, which has already been assessed but has not been utilized yet. That is why preparation of project proposals on utilization of wind energy in energy generation to attract investors is one of the priorities (we can consider such projects in Clean Development Mechanism which can give additional income to the project). For this reason in order to successfully utilize wind energy, schemes should be searched and elaborated that will make this project profitable and attractive to the investors.

The strategy on reduction of GHGs emission also considers sink categories, like **forests** and **soils** in Ajara (these activities are in compliance with activities set forth by the adaptation strategy and that is why it is not included into the mitigation sub-sector of the climate change strategy).

1. One of activities to increase the GHG sinks is sustainable management of forests, so that forests used for firewood do not exceed the natural increment of forests. Increase of sink potential of forest implies rehabilitation of degraded forests, planting of new trees and refreshing of old ones. Sustainable management plan should be prepared which will increase the potential of GHG sink;
2. Increase GHG sink potential of soils (mainly pastures) implies rehabilitation of degraded pastures and their sustainable management. This will on its side require control of over-grazing and improvement of pasture quality. Preparation of sustainable management plan for pastures should be prepared, which will increase the potential of GHG sinks.

5.5. Climate change strategy for Ajara

Key objective of the strategy	Main target group	Action/activity	Potential leading organization/unit	Expected result	Potential donors
Short-term strategic objectives					
• Envisaging of climate change results/risks in the implementation plans and concepts • Elaboration and implementation of action plan for long-term sstrategy on land management	• Government of Adjara AR • Supreme • Council of Adjara AR	• Directorete for Environment and Natural Resources (DENR) of Adjara	Government of Adjara	• Loss, degradation of land, number of eco-migrants and victims are minimized • Other risks caused due to climate change are reduced • Land management action plan has been prepared and is in the process of implementation	• Government of Adjara • Batumi Municipality • Representatives of local municipalities • International donor organizations
Strengthening of local potential to reduce risks caused due to climate change					
1. Establishment/creation of local potential in each sector linked to climate change to assess risks expected in the respective sectors	• Adjara Ministry of Agriculture • Adjara Ministry of Health • Disease control center of Adjara • Tourism Department • Legal entity of public law "Forestry Department of Adjara" • Local coast protection service • Adjara DENRA • Adjara Ministry of Agriculture • Adjara Ministry of Finance and Economy	• Arrangement of different seminars and workshops on issues related to climate change • Involvement of other stakeholders, and institutions linked/related to climate change into the process of project preparation	DENRA Adjara	• Local potential is created in target bodies for raising awareness on the problem as minimum) • Problems related to climate change are permanently discussed • Responsible person/unit is allocated at each body	• Government of Adjara • USAID • UNEP • UNDP • Components of public awareness and creation of local potential under the aegis of projects related to climate change • GEF small grants program

2. Strengthening of DENRA potential on the climate change related issues. Creation of coordination unit responsible for assessment of climate change issues and monitoring	Adjara DENRA	• Implementation of public awareness projects • Trainings of local experts	DENRA of Adjara	• Responsible person unit for climate change issues is appointed at the Adjara DENRA • The DENRA is in active liaison with other bodies to have climate change included into the general development plans • The department carries out monitoring of the implementation of strategy and makes periodic updates • The responsible person works on awareness rising among population and local authorities on the municipality level	• Government of Adjara • USAID • UNEP • UNDP • Components of public awareness and creation of local potential under the aegis of projects related to climate change • GEF small grants program • National Communication on Climate Change
3. Creation of implementation unit responsible for monitoring of GHG emissions and energy efficiency, and strengthening of this potential in Batumi municipality (or outside Batumi)	Batumi municipality	• Creation of unit responsible for reduction of GHGs emission within the Covenant of Mayors • Creation of agency responsible for the implementation of Covenant of Mayors	• Batumi Municipality • Monitoring agency authorized by Batumi Municipality	• Monitoring and implementing agency on sustainable energy development plan is created by Batumi City Hall • The potential for sustainable energy development is created • Local experts are trained in energy efficiency and in action and technologies for reduction of emissions • Sustainable energy plan for Batumi is prepared • Implementation of sustainable energy development plan for Batumi has been launched and monitoring is in process	• European Union • Different programmes created under Covenant of Mayors (CoM) initiated by EU • Low Emission Development Strategy under USAID (LEDS) • Batumi Municipality • Government of Adjara • Government of Georgia (within the frames of the National Communications on Climate Change and other projects)

4. Provision of informing and public awareness on climate change possible risks and reduction of these risks in Adjara municipalities	• Population and local authorities of 6 municipalities of Adjara • DENRA	• Implementation of Programmes on public awareness • Involvement of local population and authorities into the process of pilot project preparation	DENRA of Adjara	• Population and local authorities are well-aware of the problems that might be caused due to climate change • Population is aware of the simple preventive activities needed to reduce risks caused by climate change impacts	• Government of Adjara • UNEP • UNDP • USAID (different projects on climate change), institutionalization of climate change adaptation and mitigation measures in the regions of Georgia (ICCAMGR) • Non-governmental sector (CENN, REC)
5. Arrangement of monitoring systems necessary for assessment of climate change risks and dissemination of monitoring results among different bodies	• DENRA • Local coast protection service • Ministry of Agriculture • Agricultural service centers • Local units for meteorological and hydrological observation	• Insurance of proper work of the hydro meteorological stations • Identifying the best practice of monitoring systems on the market for the following ecosystems: agricultural soils, sea coastal zone • Selection of best monitoring and forecasting systems for Adjara conditions • Preparation of local personnel for the management of monitoring and forecasting systems • Creation of combined monitoring system (meteorology, hydrology, coastal zone, soils, landslides, mudflows, avalanches). Determination of host unit and its capacity building.	• Adjara DENRA • Agricultural service centers • Local coast protection service • Local units for meteorological and hydrological observations	• Observation on climate and hydrological parameters has been improved • Monitoring systems are arranged/monitoring system action plan is prepared for the following events and ecosystems: landslides, mudflows, flashfloods, floods (rivers), storms (sea), soil erosion, forest, climate related diseases • The best monitoring systems most appropriate for Adjara conditions are identified • Local experts are prepared who can independently work with modern data base and forecast models • Monitoring on the listed above ecosystems is being carried out	• UNDP • FAO (AEZ -model) • WHO • Different double funds • Adaptation funds • Government of Adjara • Batumi Airport (Adlia) • Batumi Port

6. Introduction of climate change elements into the education system, on the starting stage as facultative	• Ministry of Education, Culture and Sport • Non-governmental sector	• Inclusion of elements related to climate change into the secondary education system within the relevant subjects (Chemistry, Geography, Physics, Biology) • Addition of facultative subject on climate change and sustainable development into the high education system. This addition should be made mainly to the subjects that are substantially linked to the problem: Oceanology, Hydrology, Geography, Chemistry, Physics, Agriculture, Transport, Energy, Tourism, Healthcare, Economics, Forestry, Biology, etc. • Additional trainings should be provided to the teachers on the issues related to climate change	• Ministry of Education, Culture and Sport • Non-governmental sector	• Programmes, manuals and "teacher's guideline" are prepared • Sufficient number of teachers are prepared who are aware of the problem and can assist students to carry out simple investigations and provide them with relevant information	• Ministry of Education, Culture and Sport • Non-governmental sector • UNFCCC • UNEP • EU • GEF small-scale grants programme
7. Financing on the competitive bases of the target programmes in the research institutions to study climate change impacts on different ecosystems and sectors of economy	• Scientific-research institutes and high educational institutions • Shota Rustaveli National Science Foundation • Agency for Protected Areas • Representatives of the sectors vulnerable to climate change: healthcare, tourism, agriculture, protected areas, energy, transport, etc. • Private sector vulnerable to climate change impact	• Issues important and necessary for assessment of risks related to climate change are to be outlined and prioritized within the national communications and other projects • Coordination of the necessities identified within different projects should be performed for which coordination unit should be created • Private sector should be maximally informed about the expected threats	• Shota Rustaveli National Science Foundation • Government of Adjara • Government of Georgia • Management of scientific-research institutes	• Those issues and fields that most of all lack climate change impacts assessment are outlined (special attention should be paid to the collaboration with the leading countries and that have similar climate and economic parameters • Private sector is at most involved into the process of research financing • The research of those issues is financed the utilization field and interested consumer of which are known in advance • Protection of intellectual property is ensured by the government	• State scientific grants • Foreign scientific grants • Private sector • GEF • National Communication on climate change and other projects (these projects will reveal necessity of research in different fields)

8. Creation of sustainable land resource management body, responsible for the provision of coordinated approach to the land management process	• Government of Adjara • Local authorities • Line ministries linked to sectors vulnerable to climate change (healthcare, agriculture, tourism, infrastructure and regional development, etc)	• Structure responsible for land use in the process of sustainable development should be defined (new or current) that will take care of the maintenance of the existing lands and rehabilitation of the damaged lands • The monitoring system responsible for land use and fertility should be arranged • Legislation should be performed to reinforce the prevention component • The potential of this body should be reinforced	DENRA Adjara	• Structure for sustainable land management is established/created • System for land fertility and quality monitoring is arranged • Priority is given to preventive measures to be taken in regards with legislation on land management • Potential of the mentioned structure is created (experts, technologies)	• Government of Adjara • UNDP • FAO • UNDP • Private sector interested in the reduction of risks • Insurance companies
9. Creation of combined commission of Adjara government working on the adaptation policy related to climate change impacts and its implementation	• Government of Adjara • Management of different non-governmental bodies • DENRA	• Commission with participation of the interested parties should be created • Secretariat for the commission responsible for the organizational issues should be selected •	• Government of Adjara • DENRA Adjara	• Commission has been created with participation of stakeholders • The functions of the commission secretariat are carried out by the department of the DENRA (one of the options)	Government of Adjara
Adaptation strategy to current and expected climate change impacts in Adjara					
Strategy on **soils** adaptation					
10. Preservation of lands most vulnerable to climate change via reduction of anthropogenic loading	• Ministry of Agriculture • DENRA of Adjara • Coast protection local service • Body responsible for the sustainable management of land resources[1]	• Rehabilitation of degraded (thin out) forests • Changing of agricultural practice and shifting to sustainable management practice • Sustainable planning and O&M of the local areas and infrastructural lands	• Body responsible for the sustainable management of land resources	• Threat due to increased degradation of forests is lessened • Incorrect agricultural practice is ceased • Dislocation of population into new places and construction of new infrastructural objects is planned at the safe territories	• GEF • UNDP • USAID • FAO • Bilateral programmes • Adaptation funds • Government of the Netherlands

[1] Recommended by the TNC to be established by the Government

11. Rehabilitation and maintenance of lands most vulnerable to climate change	• Ministry of Agriculture • DENRA of Adjara • Coast protection local service • Body responsible for the sustainable management of land resources	• Planting of new energy and soil protective forests on the vanished forests areas and eroded soils • Restoration of fertility of agricultural lands lost due to erosion • Restoration of the most important Sea for the sustainable economic development areas captured by the Black	• Body responsible for the sustainable management of land resources	• The lost forest cover is rehabilitated and the further erosion of soil has been stopped • The fertility/productiveness of soils has been increased • The segments, seizure of which creates serious problems to already constructed infrastructural facilities (airport runway, Georgia-Turkey connection highway, etc) are rehabilitated/reinforced	• GEF • UNDP • USAID • FAO • Bilateral programmes • Adaptation funds • Government of the Netherlands
12. Rehabilitation of the **lost/degraded and captured** lands (by the sea, landslides, rivers), which should be considered under the long-term perspective, though commencement of the pilot projects is recommended immediately)	• Ministry of Agriculture • DENRA of Adjara • Coast protection local service • Body responsible for the sustainable management of land resources	• Rehabilitation of lands eroded by the rivers in the places where this is economically and socially profitable • Sustainable growth of coastal zone for new beaches and infrastructural elements	• Body responsible for the sustainable management of land resources	• The lands captured and eroded by the rivers have been rehabilitated, aimed at the implementation of social programs and settlement of eco-migrants • At the places where it is economically profitable and ensures attractiveness to private investors, the sea coastal zone is expanded	• GEF • UNDP • USAID • FAO • Bilateral programmes • Adaptation funds • Government of the Netherlands
13. Preparation of plan on sustainable management of land	• Government of Adjara • Ministry of Agriculture • DENRA • Coast protection local service • Body responsible for the sustainable management of land resources	• The plan on sustainable management of land should be prepared via consultations with all stakeholders	• Government of Adjara • Body responsible for the sustainable management of land resources	• Action plan for sustainable land management has been prepared and approved by the Government of Adjara, concrete project proposals are attached to it. • The body responsible for the implementation of this action plan is appointed	• Government of Adjara • UNDP
Adaptation strategy on Adjara **Black Sea Coastal zone** to the negative impact of climate change					

14. Construction and development of new infrastructural, tourist and private sector facilities at the places recommended by the Coastal protection service; Carrying out of risk reduction activities	• Local coast protection activities • Private sector (tourism, construction business) • Batumi Municipality • Local authorities of Kobuleti and Khelvachauri municipalities	• Agreement of construction work with the local coast protection activities prior to starting up of works (with the body on sustainable management of land resources) • Potential of the coast protection activities should be increased introduction of (modern methods of assessment, monitoring system that will make their evaluations more reliable) • In the places where construction of new utilities is necessary due to their strategic definition, action plan for coast protection activities and defined sources of financing should be attached	• Local coast protection units • Body responsible for the sustainable management of land resources	• The risks in the areas close to coastal zone are reduced for the new-built constructions, since in the process of their designing the intensity of storms and sea level rise are taken into consideration • The local coast protection service has enough potential (technologies and experts) that can provide relevant accurate assessment of risks and issue recommendations on safety measures and necessary activities needed for the coast protection	• Government of Adjara • Local authorities • Private sector • Insurance companies
15. Conduction of activities needed for maintenance of existing infrastructural, tourist and private sector utilities and reduction of climate change related risks (co-participation of private sector and other infrastructural units is necessary)	• Local coast protection service • Private sector (tourism, construction business) • Batumi Municipality • Local authorities of Kobuleti and Khelvachauri municipalities	• All the already constructed objects vulnerable to sea should be subjected to inventory • Action plan on protection of existing facilities (reduction of risks) should be prepared via participation of all stakeholder • Implementation of the action plan should be started	• Local coast protection service • Body responsible for the sustainable management of land resources	• All the objects threatened sea are registered • Proposals on reduction of risks and action plan for the registered objects have been prepared; potential inventors are identified • Implementation of risk reduction action plan is launched	• Government of Adjara • Local authorities • Private sector • Insurance companies
16. Carrying out of protection measures in vulnerable to population segments, raising of public awareness on preventive measures (this mainly concerns the municipalities)	• Local coast protection service • Batumi Municipality • Local authorities of Kobuleti and Khelvachauri municipalities	• Risk assessment for the local population • As a result of inventory the objects should be clearly divided into those for which risk reduction measures should be implemented by the state, and those for which measures may be taken by the population itself • Active cooperation with the population in order to carry out the preventive measures	• Local coast protection unit • Local authorities of Kobuleti and Khelvachauri municipalities	• Risk containing segments for the population are registered • The action plan to reduce risks for the strategic utilities that should be implemented by the Government is prepared • Intensive trainings regarding the preventive measures are being carried out	• Government of Adjara • Local authorities • Insurance companies • UNDP • USAID • Adaptation funds created under the UNFCCC

17. Development of new tourist areas (creation of beaches) based on the sustainable development principles. In this regard the sources of beech nourishment and their quantity should be assessed, the utilization of which will not damage other areas or other sectors (this action is mainly considered for the long-term perspective, though it is not excluded that in case of the investor's interest the process can start earlier)	• Government of Adjara • Private sector • Coast protection service • Body responsible for the sustainable management of land resources	• Under the initiative of Adjara Government or private sector new places are selected for the profitable economic activities. In such places artificial creation of new territories or development of old ones might be needed • Geological conditions and access to inert material needs to be studied in details in order to develop new territories. This should be made without causing damages to other areas, population or infrastructural objects.	Coast protection service	• For Adjara economy and tourism development the areas are selected where beaches/new areas should be developed • Possibilities for the creation of new areas are studied in details in the long-term perspective run from the availability of material and sustainability point of view • The basis regulating business activities is created for these areas (what and how can be built or prohibited to build)	• Government of Ajara • Private sector
18. Establishment of a system for permanent monitoring of the current changes using the modern technologies	• Government of Adjara • DENRA • Local coast protection unit • Body responsible for sustainable management of land resources	• Definition of the body responsible for the monitoring • Creation of legal basis for the continuous monitoring • Determination and importing of technologies needed for the monitoring • Training of local experts on the process of data system management	• Government of Adjara • Local coast protection service, body responsible for the sustainable management of land resources	• The body responsible for the monitoring has been appointed • The legal basis for the monitoring exists • The technological basis for the monitoring is created • The potential has been created and local experts are trained in the condition of monitoring	• GEF • UNDP • Batumi Airport of (Adlia) • Batumi Port • Construction sector • Tourism Department • Government of Adjara
19. Preparation of action plan for sustainable development of Adjara coastal zone taking into consideration the climate change impact	• Government of Adjara • DENRA of Adjara • Local coast protection service • Body responsible for sustainable management of land resources	• Sustainable management plan for the coastal zone, envisaging all possible risks should be prepared via consultations with all interested parties	• Local coast protection service • Body responsible for the sustainable management of land resources	• Plan of sustainable management on Adjara coastal zone is prepared and agreed with all stakeholders. Concrete project proposals are attached • Action plan is supported by the local Government, experts and private sector	• Government of Adjara • UNDP • Adaptation funds
Adjara strategy to reduce **extreme geological events** impact at the climate change background.					

20. Creation of extreme geological events (landslides, mudflows, avalanches, flashfloods) monitoring and forecasting system. In the high risk areas for the population In the hazardous places occupied by significant infrastructural facilities	• Government of Adjara • DENRA • Body responsible for the sustainable management of land resources	• Consideration of the body responsible for the monitoring of extreme geological events (landslides, mudflows, flash floods, etc.). • Creation of legal basis needed for permanent monitoring of extreme geological events • Definition and importing of technologies needed for monitoring and risk assessment • Training of local experts in the database management system	• Government of Adjara • DENRA of Adjara • Body responsible for the sustainable management of land resources	• The unit responsible for the monitoring of extreme geological events has been appointed • Legal basis needed for the monitoring exists • Technological basis needed for the monitoring and forecasting of risks has been created • Local experts have been trained to monitor and forecast extreme geological event and processes; Local potential is created	• GEF • UNDP • Construction sector • Tourism Department • Government of Adjara
21. Carrying out preventive activities with complete participation and involvement of population	• DENRA of Adjara • Body responsible for the sustainable management of land resources • Local authorities	• Based on the monitoring results, all those objects that are in risk zone (vulnerable zones) will be registered • Guidelines and manuals for the population to carry out preventive activities are being prepared • Public awareness on preventive measures to stop the processes further development is being raised • Continues monitoring on results of preventive measures is being carried out	• DENRA (Geological service) • Body responsible for the sustainable management of land resources • Local authorities • Non-governmental sector	• Every family living in the risk zone of extreme geological events (landslides, mudflows, avalanches, flashfloods) is registered • Guideline handbook has been prepared for the families where effectiveness of preventive activities is confirmed by the geological service • Continuous and active work is being conducted with population on preventive measures implementation • Regulatory basis for utilization and populating of areas vulnerable to geological threats exists • Permanent monitoring (using modern technologies) on effectiveness of preventive measures is being carried out	• Government of Adjara • Local authorities • Non-governmental sector • Adaptation funds created by the convention

22. Introduction into practice of preventive measures for the infrastructural and tourist facilities	• Government of Adjara • DENRA of Adjara (Geological service) • Body responsible for the sustainable management of land resources • Private sector	• Based on the monitoring result, all the vulnerable infrastructure objects will be registered • Action plan for preventive measures is being prepared (project proposals are attached to the Action plan) • Preventive measures should be carried by the Government together with the private sector systematically (where it concerns private sector) • Permanent monitoring is being carried out on the results of the preventive measures	• DENRA of Adjara • Body responsible for the sustainable management of land resources • Private sector	• All the infrastructural and private sector objects located in the extreme geological events risk zones are registered • Action plan, with participation of all stakeholders for the areas where necessity of preventive measures is confirmed by the Geological service has been prepared • Systematic preventive activities are carried out by the government together with the private sector (where it is being concerned) • The basis regulating the deployment of infrastructure utilities under extreme geological threats exists • The continuous monitoring (using modern technologies) is carried out (risk assessment)	• Government of Adjara • Private sector • Adaptation funds created by the convention
23. Preparation of action plan for the mitigation of extreme geological events results	• Government of Adjara • DENRA of Adjara • body responsible for the sustainable management of land resources	• Sustainable management plan of risks caused by extreme geological events envisaging all possible threats relevant to climate change should be prepared in collaboration with all the interested parties	• Department of environment protection and natural resources of Adjara (Geological service) • Body responsible for the sustainable management of land resources	• Sustainable management plan of risks initiated by extreme geological events envisaging all the possible threats relevant to climate change has been prepared together with all stakeholders supplied with concrete project proposals • The action plan is supported by the local government, experts and private sector	• GEF • UNDP • Construction sector • Tourism Department • Government of Adjara
Adjara strategy on adaptation of **Agriculture** to climate change impact					

24. Facilitating enlargement of household farms in order to reduce negative impact on soils caused by agricultural activities and aimed at correct land management (via using different kinds of alternatives, i.e. settlement of population into the plain areas; Use of geologically sustainable lands in large economies, where prevention and fertility raising activities are more effective)	• Adjara Government • Ministry of Agriculture of Adjara • Body responsible for sustainable management of land resources • Local authorities • Agricultural service centers • Tourism sector • Farmers • Population involved in agriculture	• The action plan to facilitate establishment of big farms instead of small households should be elaborated by the Ministry of agriculture of Adjara, Sustainable land management body and local authorities via close consultations with all the interested parties • The legal basis for the establishment and supporting of farmers' unions should be created • In order to maintain sustainable land management process continuous consultations with large farmers and farmers' unions should be carried out	• Local authorities • Non-governmental sector	• The Action plan on facilitation the establishment of big farms instead of small households has been elaborated and is approved by the all stakeholders. The plan is supported by the Government of Adjara. • Legislative basis supporting activities of enlarged farms is created and is in action • Intensive consultations with large farmers and farmers' unions to maintain the process of sustainable management of lands are in progress	• Government of Adjara • Local self-governments • Non-governmental sector
25. Facilitating capacity building for the service centers aimed at the reduction of risks caused by climate change impacts and land fertility rise	• Body responsible for the sustainable management of land resources • Agricultural service centers • Ministry of agriculture of Ajara • Different agricultural institutions working on agricultural issues • Local authorities	• The inventory of agricultural lands should be undertaken and database describing the condition of lands should be created that will be updated periodically • The technologies to reduce erosion of agricultural lands with steep slopes should be identified (international practice). The most appropriate and acceptable technologies and means of management of agricultural lands should be selected for Ajara • Local experts to assess climate change risks on agriculture (productivity, quality, storing qualities, compliance with international standards) should be prepared	Agricultural service centers	• The inventory of the agricultural lands has been conducted made and the cadaster of lands is being created that is periodically updated • The technologies adopted in international practice to reduce erosion of agricultural lands with steep slopes have been studied. The most appropriate and acceptable means for the management of agricultural lands have been selected for Ajara conditions • Local experts and guideline documents to reduce climate change impacts are prepared and ready to be provided to the farmers' unions	• FAO • UNDP • GiZ • GEF • Adaptation funds created by the convention

26. Conduction of permanent observations at agro-meteorological stations on climate change impact under the global warming to assess shifting of agro-climatic zones and prepare relevant recommendations to reduce corresponding risks	• Agricultural service centers • Research institutions working on agricultural issues • Hydro-meteorological service	• Agricultural service centers should carry out permanent monitoring on current change in the climate and its positive and negative impacts should be assessed • Recommendations to the farmers' unions should be prepared. The private sector (farmers, tourism service, etc) and all stakeholders should be actively involved into the process	• Agricultural service centers	• Permanent monitoring on current changes of climate change and assessment of agro-climatic zones is being carried out, positive and negative impacts of climate change are being assessed • Recommendations, oriented to reduce risks in agro-climatic zones have been prepared. The private sector and all stakeholders (farmers, tourism service sectors, etc) are actively involved	• FAO • UNDP • GiZ • UNEP •
27. Preparation of action plan on sustainable development of agriculture for tourism sector taking into consideration its maximal provision with locally supplied ecologically clean products	• Government of Ajara • Ministry of Agriculture of Ajara • Private tourist sector	• Sustainable management plan considering positive and negative impacts of climate change should be prepared through consultations with all stakeholders	• Government of Adjara • Ministry of Agriculture of Adjara	• The action plan on the management of positive impacts of climate change in agricultural sector has been prepared • The action plan on mitigation of the negative impacts of climate change in agricultural sector has been prepared	• FAO • UNDP • GiZ • Government of Adjara
Adaptation strategy on Ajara **forests** to the climate change impacts					
28. Reinforcement of soil protection functions, rehabilitation of degraded forests and increase of sink sources, rejuvenescence of forests	• DENRA of Ajara (Forestry agency) • Local authorities	• Registration of degraded areas is conducted permanently • Action plan on rehabilitation of degraded (thin out or very aged) forest areas should be prepared which will enclose particular project proposals	• DENRA of Ajara (forestry agency)	• Degraded forest areas in Ajara are registered • Action plan on rehabilitation of degraded areas in Ajara supplied with concrete project proposals have been prepared	• CDM • GEF • Adaptation funds created by the UNFCCC • GiZ
29. Monitoring on trees diseases, especially on climate-related ones. In order to prevent spread out of tree diseases monitoring should be carried out in close cooperation with the Turkish side, Artvin forest department	• DENRA of Ajara (Forestry department) • Artvin forestry department from the Turkish side • Forestry department of Georgia (adjoining sections)	• Monitoring system for management of tree diseases implying detection of diseases and working out recommendations for joint combat against them should be established together with the Turkish side • Local potential (on Georgian, as well as on Turkish side) is created (machinery/equipment, experts, information and expertise to combat climate change related diseases	DENRA of Ajara (Forestry department)	• The monitoring system on tree diseases has been arranged in collaboration with the Turkish side, which implies detection of diseases and working out recommendations to combat their spread • Local experts are prepared and modern equipment is purchased to combat climate change related diseases	• CDM • GEF • Adaptation funds created by the UNFCCC • GiZ • FAO

30. Study of alternatives for privatization of forests (community forests, tourist area forests, etc)	• Government of Ajara • DENRA of Ajara (Forestry agency) • Local municipalities • Local population • Private sector (including tourism service segment)	• Privatization forms acceptable for Adjara should be studied and relevant legislation basis should be prepared • Local potential to monitor privatized areas should be prepared to prevent reduction of forest soil protection ability	• Government of Ajara • DENRA of Ajara (Forestry agency)	• Privatization forms acceptable for Adjara and relevant legislation basis have been prepared • Local capacity is built to carry out monitoring of privatized forests in order to prevent reduction of forest soil protection potential	• Government of Adjara • UNDP
31. Preparation of action plan for sustainable development of forestry sector taking into consideration all negative and positive impacts of climate change	• Government of Ajara • Department of Environment Protection and Natural Resources of Ajara (Forestry agency)	• Sustainable management action plan for forests should be prepared through active consultations with all stakeholders taking into consideration climate change risks (rehabilitation of degraded forests, refreshment, identification of appropriate forms of privatization of forests effective use of surplus biomass)	Department of Environment Protection and Natural Resources (forestry agency)	• Action plan for sustainable management of Adjara forests taking into consideration risks related to climate change is prepared (rehabilitation of degraded and lost forests, refreshment of old tress, privatization issues, etc)	• Government of Adjara • Department of Environment Protection and Natural Resources (forestry department) • GEF • GiZ • UNDP
Adaptation strategy on Ajara **Protected Areas** in regards to climate change					
32. Deployment of protected areas for the assessment of climate change impacts on biodiversity and other eco-systems located within the protected areas. This monitoring is very important for the preparation of new adaptation projets, since in this case anthropogenic factor is virtually removed and only impacts initiated by climate change remain	• Agency for protected areas • DENRA of Ajara • Scientific-research institutions • Ministry of Environment Protection of Georgia	• Within the National Communications and other related projects ecosystems and elements of biodiversity vulnerable to climate change should be selected at the protected areas; continuous monitoring on them should be carried out in order to reveal their current changes • Local potential in Ajara protected areas should be reinforced in order o monitor ecosystems and carry out appropriate research	Ajara branch of the Department of Protected Areas	• Ecosystems and elements of biodiversity vulnerable to climate change have been selected at the protected territories and permanent monitoring is being carried out to reveal current changes • Local potential for Adjara protected areas has been created (local experts, modern means of monitoring) for monitoring and carrying out of research activities • Specific adaptation project proposals have been prepared to protect biodiversity	• Government of Adjara • GEF • UNDP • GiZ • National Communication on Climate Change • Tourism Department

33. In the process of preparation of action plan for the protected areas the role of the sector (as well as in forestry sector) in the mitigation process should be highlighted	• Agency for protected areas • DENRA of Ajara • Scientific-research institute • Ministry of Environment Protection of Georgia	• Preparation of action plan for the development and improvement of protected areas status	Ajara branch of the Department of Protected Areas	• Contribution of protected areas in the process of climate change mitigation process is increased • Action plan on the rehabilitation of degraded forests and pastures at the protected areas has been prepared	• Government of Adjara • GEF • UNDP • GiZ • National communication on climate change • Tourism Department
Ajara strategy on **Healthcare sector** adaptation to climate change					
34. Reinforcement of local potential to reduce risks of climate-related diseases in population and tourism sector	• Ministry of Health and Social Affairs of Adjara • Center of Disease control and pulic health of Adjara • Tourism service sector (hotels, public catering units) • Ministry of labor, health and social affairs of Georgia	• Monitoring of climate-related diseases and provision of risk management • Raising awareness of the medical personnel on climate-related diseases • Improvement of infectious diseases management control • Improvement of medical service in tourism sector	• Ministry of Health and Social Affairs of Adjara • Center for disease control and public health of Adjara	• The monitoring system on climate-related diseases is established and risk management action plan has been prepared • The medical personnel is informed on climate related diseases • The manual handbook containing information on climate related diseases has been prepared • The standards of control and monitoring of infectious diseases corresponds to the international standards • Medical service in the tourism sector (especially in case of climate-related diseases) corresponds to the international standards	• WHO (World Health Organization) • USAID • UNDP • Adaptation funds created by the UNFCCC
35. Creation of post-traumatic rehabilitation centers for the local population (due to the high indicators of mental disorders, that are most probably caused by frequent extreme geological events especially in high mountainous Ajara regions). That is why it is important to establish such centers in Ajara	Ministry of Healthcare and Social Affairs of Adjara	• Post-traumatic rehabilitation centers serving mental disorders and traumas should be established	• Ministry of Healthcare and Social Affairs of Adjara	• Post-traumatic rehabilitation for centers have been established • The manual on the treatment of post-traumatic mental disorders has been prepared for medical personnel • Special trainings are held for the medical personnel to combat post-traumatic diseases	• WHO • USAID • UNICEF • Government of Adjara •

36. Preparation of action plan for Adjara healthcare sector taking into consideration all risks related to climate change	• Government of Adjara • Ministry of Healthcare and Social Affairs of Adjara • Center for disease control (Adjara) • Tourism service sector (hotels, public catering objects)	• The action plan for climate related disease control in Adjara should be prepared via consultations with all the interested parties	Government of Adjara	• The action plan for management of risks caused due to climate related disease in Adjara has been prepared via intensive consultations of all the interested parties • Concrete project proposals to fulfill action plan have been prepared	• WHO • USAID • UNDP •
Ajara **tourism** sector adaptation strategy to climate change					
37. Utilization of favorable conditions created due to climate change for the development of tourism sector	• Department of tourism and resorts of Adjara • Ministry of Environment Protection of Georgia (national communication on climate change) • Government of Adjara	• Study of climate change impact on tourism sector (seasonal) should be made • In case of creation of appropriate trends (increase of season, etc) the potential should be utilized at most	Department of tourism and resorts of Adjara	• Climate change impact on tourism sector has been studied/assessed	• National Communication on climate change • Government of Adjara
38. Complete provision of tourism sector by local agricultural products	• Agricultural service centers • Ministry of Agriculture of Adjara • Department of Tourism and resorts of Ajara • Farmers' unions	• In the production of agricultural goods positive and negative impacts of climate change should be envisaged including the demand of the tourist sector on the products • Tourism sector should be maximally provided with the local production	Farmers' unions	• In the production of agricultural products positive and negative impacts of climate change is envisaged including the request of the tourist sector on the products • Tourist sector is at most provided with local and (produced in Georgia) products	• Farmer economies • Agricultural service centers • Private sector serving tourism industry • GEF • UNDP • FAO
39. Improvement of healthcare services of tourists	• Ministry of Healthcare and Social Affairs of Adjara • Center for Disease Control and Public Health of Adjara • Tourism service sector (hotels, public catering objects)	• Study of international practice of climate change related diseases treatment in tourism sector • Preparation of guidelines and medical personnel in order to reduce risks of climate-related diseases • Adaptation of the best medical insurance practice for Adjara • Establishment of comfortable dispensaries for the tourists	Ministry of Healthcare and Social Affairs of Adjara	• Medical personnel and relevant guidelines to reduce risks related to climate change in tourism sector are prepared • The best practice for the medical insurance has been studied and is adopted for Adjara conditions • Comfortable dispensaries have been established for tourists in Batumi and Kobuleti	• WHO • USAID • UNDP • Ministry of Healthcare and Social Affairs of Adjara • Department of Tourism and Resorts of Ajara •

40. Ensuring of international standards envisaging climate change impacts in small family hotel services	• Government of Adjara • Department of tourism of Georgia • Department of tourism and resorts of Adjara • Center of disease control and public health of Adjara • Tourism service sector (hotels, public catering objects)	• Against the climate change impacts international standards of services for small hotels (fridges, sewage, requirement for cold and hot water, conditioning system, etc) are changed. New standards should be studied and adopted for Adjara conditions • Small family hotels should be provided with recommendations on modern international standards and meanwhile trainings should be conducted on the improvement of service quality • In order to be able to provide high standrads of services the local small hotels should be offered long-term preferential loans	Department of tourism and resorts of Adjara	• News standards (on sanitary norms) are elaborated against the climate change impacts and are adopted for Adjara conditions • Small family hotels are provided with trainings and instructions to ensure high standards of services • The system providing long-term preferential credits (loans) for the small family hotels exists	WHO
Strategy on reduction of GHG emissions					
GHG inventory in Ajara					
41. Inventory of GHG emissions from Batumi territory	• Batumi Municipality • Representatives of transport sector	• The unit responsible for implementation of Batumi Sustainable Energy Action Plan (SEAP) development and monitoring should be created • Continuous update of Batumi energy development action plan • Preparation of report and monitoring on Batumi energy development action plan for the Covenant of Mayors	Batumi Municipality	• Batumi energy development action plan has been prepared and is periodically updated • The unit responsible for Batumi energy development action plan has been created • Intensive works with the population to explain/motivate the priorities of the energy efficient activities are being carried out • The monitoring on the implementation of Batumi SEAP is being carried out and biannual reports are prepared for the Covenant of Mayors	• Batumi City Hall • Private Sector • Cooperation programs of public and private sectors • EBRD • European Energy Efficiency facility • IEE (Intelligent Energy Europe) • ELENA (European Local Energy Assistance) • ELENA-KfW • JESSICA (Joint European Support for Sustainable Investment in City Areas)

42. GHG inventory at the Ajara territory	• Unit responsible for the inventory (to be defined in future, tentatively DENRA of Ajara)	• Body responsible for the inventory (tentatively DENRA of Ajara) should be defined for the future • Local experts for the key sectors (energy-transport, agriculture, wastes and forests) should be prepared • System for data collection and archiving necessary for GHG inventory and monitoring should be created	Responsible body for inventory	• The unit (body) responsible for the GHG inventory has been defined • Local experts for key sectors have been prepared (energy-transport, agriculture, waste, forestry sectors) • The data gathering and archiving system needed for inventory and monitoring has been created	• GEF • Government of Adjara • Government of Georgia • Batumi City Hall
Mitigation strategy on emissions of GHGs from the **transport sector** in Adjara					
43. Rehabilitation and development of transport infrastructure	• Ministry of Finance and Economy of Ajara • Ministry of Regional Development and Infrastructure of Georgia • Batumi Municipality • Local municipalities	• Rehabilitation and improvement of road cover • Planning and development of circuit transit roads • Construction of tunnels and bridges to shorten distances between locations	Ministry of Regional Development and Infrastructure of Georgia	• The emission of GHG will be reduced by 2% to 2020 and by 3% to 2030 compared to the basic scenarios • The road cover has been improved • Traffic distances are optimized in Ajara • The traffic is maximally discharged (unloaded) in Batumi and on central highways	• Government of Georgia • Government of Adjara • Local self-governments • WB (World Bank) • MCG (Millennium Challenge Georgia)
44. Improvement of public transport services and transfer to more energy efficient technologies	• Batumi Municipality (Transport Department) • Local municipalities • Private transport and tourist companies	• Development of electric transport (electric taxis) • Development/support of public transport fueled by Compressed Natural Gas (CNG) • Improvement of public transport services (more comfortable public transport, electronic boards, regular technical inspection, improved ticketing system, planning of routes, etc) • Public transport popularization campaign (information campaign, marketing and branding, exchange of info on routes, etc.)	Batumi Municipality	• To 2020 GHG emissions from the transport sector will be reduced by 23% and by 17% to 2030 compared to the basic scenario • By 2020 70% of taxis in Batumi will be electric taxis, 60% of buses and minibuses will work on CNG • Public transport is available for the local population and tourists, it is accessible, affordable, ecologically cleaner, quick, safe and reliable	• Batumi City Hall • EBRD • European Energy Efficiency facility • IEE (Intelligent Energy Europe) • ELENA (European Local Energy Assistance) • ELENA-KfW • JESSICA (Joint European Support for Sustainable Investment in City Areas)

45. Limitation of high-emission private vehicles use and stimulation of low-emission vehicles deployment by different measures	• Batumi Municipality (Transport Department) • Population of Batumi • Private and state transport companies	• Limitation of traffic in separate central districts of the city (environment islands) • Development of bicycle routes • Support/encouragement of low - emission vehicles use by reducing of parking costs and similar measures	Batumi Municipality	• GHG emissions will be reduced by 14% from the transport sector to 2020 and by 17% to 2030 compared to the basic scenario • Sa-called "green zones" are created in Batumi where movement of traffic is limited • Energy-efficiency of private vehicles is improved	• Batumi City Hall • ELENA (European Local Energy Assistance) • ELENA-KfW
GHG emissions mitigation strategy from the **buildings sector** in Ajara					
46. Inventory of different types of buildings in Ajara, audit of their heat insulation and study of energy consumption practice by the inhabitants	• Government of Adjara • Ministry of finance and economy of Adjara • Batumi municipality • Local authorities • Tourism Department • Private sector • Non-governmental sector • population	• Inventory of the state budgetary and municipal buildings and energy efficiency audit, study of energy consumption practice • Inventory of the tourist and other commercial buildings, their energy efficiency audit and study of energy consumption practice • Inventory of the residential buildings and energy efficiency audit, study of energy consumption practice by residents • Assessment of possibilities of energy consumption optimization and preparation of recommendations • Preparation of action plan for the reduction of emissions from buildings sector	• Batumi Municipality • Non-governmental sector	• Inventory of the different types of buildings is undertaken, their energy efficiency and energy consumption are studied • Possibilities of energy consumption optimization in different buildings are assessed • Action plan for the reduction of emissions from the buildings sector has been prepared	• Batumi City Hall • USAID • EBRD • GRF/UNDP • European Energy Efficiency facility • IEE (Intelligent Energy Europe) •

47. Efficiency increase of heating/cooling systems in the state budgetary and municipal buildings and facilitation of renewable energy use	• Government of Adjara • Batumi City Hall • Local municipalities	• Implementation of insulation measures in the municipal/budgetary buildings • Introduction of renewable energy technologies (heat pumps, solar – heaters, energy efficient biomass and stoves) instead of firewood and diesel based heating systems currently practiced in different municipal buildings	• Government of Adjara • Batumi City Hall • Local authorities	• GHG emissions will be reduced by 44% from the municipal and budgetary buildings by 2020 and by 48% to 2030 compared to the basic scenario • Heat insulation of roves and external walls of the municipal buildings has been improved • Renewable energy technologies have been introduced in the municipal buildings currently heated by wood and diesel based heating systems	• Government of Adjara • Batumi municipality • USAID • EBRD • GRF/UNDP • European Energy Efficiency facility • IEE (Intelligent Energy Europe)
48. Increase of energy efficiency and utilization of renewable energy sources in heating/cooling systems of tourist buildings (hotels, restaurants) in	• Tourism Department • Tourist agencies • Owners of the hotels	• Offering of optimized ways of energy consumption to the owners of tourist buildings (hotels, restaurants, etc) • Offering of reduction of loss, increase of energy efficiency and technologies operating on renewable energy to the owners of the tourist buildings (hotels, restaurants, etc) • Selection of pilot buildings to carry out the heat insulation activities and in order to popularize them	Owners of the tourism service buildings (hotels, restaurants, etc)	• GHG emissions will be reduced by 13% to 2020 from the tourist buildings sector and by 12% to 2030 compared to the basic scenario • Information regarding activities on effective technologies saving energy has been provided to the tourist companies • Pilot/demonstration projects have been prepared and commenced	• Private sector (tourist companies) • EBRD • GRF/UNDP • European Energy Efficiency facility • IEE (Intelligent Energy Europe)

49. Increase of energy efficiency in the residential sector and wider utilization of renewable energy	• Population of Ajara • Batumi City Hall • Local authorities • Government of Ajara • Non-governmental sector	• Popularization of measures on the reduction of heat losses and utilization of effective renewable technologies among the population • Selection of pilot buildings and carrying out of heat insulation activities in order to popularize them • Preparation of plan on biogas deployment practice dissemination and selection of villages to instill and demonstrate different types of bio-digesters • Offering/popularization of energy efficient firewood stoves • Taking by the government of encouragement measures to facilitate residents of energy efficient buildings	• Government of Adjara • Non-governmental sector	• Emissions from the residential buildings sector will be reduced by 8% to 2020 and by 11% to 2030 compared to the basic scenario • Emissions from the agricultural sector will be reduced 204,000 tons in 2014-2030 • The population is informed on possibilities of saving energy and relevant technologies are available • The pilot projects have been prepared and commenced • Plan on dissemination of biogas deployment has been prepared and biogas digesters are installed in the pilot villages • The number of encouraging activities have been suggested by the government to raise energy efficiency	• USAID • GEF/UNDP • EBRD • European Energy Efficiency facility • IEE (Intelligent Energy Europe) • Energy-efficiency center Georgia • Different donor countries
Strategy on GHG emissions mitigation from the **street lightening** in Ajara					
50. Increase of energy efficiency and renewable energy use in outside lightening sector	Local municipalities	• Substitution of non-efficient bulbs with energy efficient ones in the street lightening • Creation of intellectual management system in big cities to manage the level of lightening • Generation of energy from the methane gas gained from the landfills that will be used for lightening of Georgia-Turkey main road Batumi-Sarpi section	Local municipalities	• GHG emission will be reduced by 35% from street lightening sector by 2020 and by 63% to 2030 compared to the basic scenario • Utilization of renewable energy (methane from waste, solar energy) has been increased in outside lightening sector • Outside lightening is optimally managed in large cities	• Municipalities • Batumi Municipality • EBRD • ELENA (European Local Energy Assistance) • ELENA-KfW • CDM (Clean Development Mechanism)
Ajara strategy on mitigation of GHG emissions from **waste and wastewater treatment** sector					

51. Preparation of plan on the reduction of GHG emissions to the atmosphere from the waste and wastewater treatment systems in Ajara	• Batumi Municipality • DENRA of Ajara • Local municipalities	• Registration/accounting of waste dumped at the landfills along with other parameters needed for the assessment of emissions • Monitoring and assessment of emission of waste water and chemical composition	• Batumi City Hall • Local authorities	• In the waste and waster water treatment sector all the parameters needed for calculation of methane emission has been studied and assessed • Action plan to reduce emissions to the atmosphere from the waste and waste water treatment sector in Adjara has been prepared • Emissions from this sector has been accounted	• National Communication on climate change (GEF) • 2 year program for national inventory (GEF) • EBRD • SIDA • KfW
52. Initiation and implementation of pilot projects on extraction of methane and its flaring or utilization for energy needs and implementation at the Batumi operation/old and Kobuleti new landfills	• Batumi Municipality • Kobuleti Municipality • Department of tourism • LTD Hygiene -2009 • European Bank for Reconstruction and Development (EBRD) • Private construction sector • Tourism Department • LTD "Sandasuptaveba"	• Study of parameters of the landfills, measurement of recovered biogas and preparation of the business plan • Arrangement of gas extraction system • Study/assessment of possibilities for the utilization of methane gas as energy resource and installation of relevant infrastructure or biogas laring system	• Batumi municipality	• In the period 2014-2030 emissions from the waste sector are reduced by 453,000 t CO2eq. (51%) • The donors have been identified and pilot projects are initiated	• Batumi City Hall • EBRD • ELENA (European Local Energy Assistance) • ELENA-KfW • CDM
53. Initiation and implementation of pilot projects on the extraction and flaring at the site or utilization for energy production of methane gas at the Batumi wastewater treatment plant	• Batumi municipality • LTD "Batumistskali"	• Arrangement of methane extraction system • Assessment of potential for utilization of recovered methane as energy resource or installation of methane flaring system	• LTD "Batumistskali"	• In the period 2014-2030 emission from the wastewater treatment utility reduced minimum by 33,881t CO2eq. (51%) • The donors have been identified and pilot project has been initiated	• Batumi City Hall • EBRD • ELENA (European Local Energy Assistance) • ELENA-KfW • CDM (clean development mechanism)
Ajara strategy on mitigation of GHG emissions from the **energy generation sector**					

54. Facilitating the construction of small and micro hydro power plants at the territory of Ajara	• Government of Georgia • Government of Adjara • Ministry of Energy and Natural Resources of Georgia • Management of the Georgia's electricity grid • Private sector • Local authorities	• Creation of profitable environment for the investors • Elaboration of the development plan for micro power plants including study of different options for their link up to the grid • Search for investors	Private sector working in the micro hydro plants sector should be established	• In case of realization of the total hydro potential additional 240 MW is installed (1.577 million MWh per annum) and about 145,000 t CO_2 per annum is reduced • The schemes supporting the construction of micro-hydro PP have been studied • Enabling environment for the construction of micro hydro plants is created • Projects have been prepared	• Private investor • Government of Norway • CDM • Energy efficiency center Georgia • Municipal development fund /fund for renewable energy • USAID
55. Promoting the construction of wind power plant in Ajara	• Government of Georgia • Government of Adjara • Ministry of Energy and Natural Resources of Georgia • Management of the Georgia's electricity grid • Private sector	• Creation of profitable environment for the investors • Elaboration of wind energy development • Attraction/search of investors	• Private sector (e.g. Batumi Airport) or any other interested party (e.g. Batumi Municipality) interested in the consumption of this energy should be identified	• In case of complete utilization of total wind potential additional 60 MW capacity is installed (132 thousand kWh per annum) and 12,078 tCO_2 is reduced annually • The schemes supporting construction of wind power plants have been studied • Favorable environment for the construction of wind power plants has been created in Adjara • The projects have been prepared (for Batumi and Goderdzi Pass)	• Private investor • CDM • USAID • JICA • EBRD • Batumi Airport
Supporting of climate change adaptation and mitigation technologies development and dissemination					

56. In order to implement adaptation action plan for climate change revealed in Ajara it is necessary to assess technologies and to prepare action plan for the introduction of advanced technologies	• DENRA of Ajara • University of advanced technologies • Ministry of Agriculture • Agricultural Service centers • Ministry of Healthcare and Social Affairs • Coast-protection service • Ministry of Regional Development and Infrastructure of Georgia • Private sector • Agency of protected areas/local authorities	• Identification and study of adaptation to climate change technologies and preparation of recommendations for the following sectors and ecosystems: protection of soils, protection of coastal zone and river banks, landslides, mudflows, avalanches, productivity of agricultural soils, healthcare, tourism, biodiversity, forests. • Assessment of barriers in the process of development, transfer and introduction of technologies and elaboration of action plan for each sector and technology • Raising of public awareness on modern technologies and training of local experts • Creation of supportive legal basis	• Department of Environment Protection and Natural Resources of Adjara • University of technologies	• Information on the best accessible technologies for adaptation has been searched and required technology basis is created for Adjara • The barriers existing to the introduction of new technologies are studied and ways to overcome them are recommended • Action plan to introduce new technologies has been prepared with participation of all stakeholders • Local experts for the maintenance and operation of modern technologies have been trained • Legal basis supports the development and introduction of adaptation technologies	• GEF • UNEP (regional centers for Technologies • USAID • Bilateral programs • Adaptation funds defined by the UNFCCC • Grants for non-governmental organizations

57. Assessment of technologies required for the implementation of GHG emissions reduction action plan in Ajara and preparation of action plan to develop of the indigenous technologies or to import new technologies	• DENRA of Adjara • Universities of advanced technologies • Batumi Municipality • Ministry of Finance and Economics of Adjara • Private sector responsible for the increase of emissions (e.g. hotel business, etc)	• Identification, study and recommending of technologies needed to reduce GHG emissions from the following sectors: transport, landfills, wastewater, buildings, heat and electricity generation, energy efficiency, eroded soils (pastures), degraded forests. • Assessment of barriers in the process of development, introduction and implementation of technologies and elaboration of action plan for each sector and technology • Arrangement of the legal basis • Raising of awareness on modern technologies and training of local experts • Support the creation of joint enterprises • Involvement of private sector into the process	• University of advanced technologies • Batumi City Hall • Local self-government bodies	• Information on the best accessible emission reduction technologies has been searched and required for Ajara technology database is created • The barriers existing to the introduction of new technologies are studied and ways to overcome them are recommended • Action plan to introduce new technologies has been prepared with participation of all stakeholders • Local experts are trained for the maintenance and operation of new technologies to ne instilled are ready and prepared • Private sector is maximally involved into the process of technology introduction • Legislative basis supports the development and deployment of new technologies (energy efficient, renewable, etc)	• GEF • CDM (Clean Development Mechanism) • Green Climate Fund • UNEP (regional centers for technologies) • USAID • Bilateral programs • Private sector • Non-governmental sector
Long-term strategy targets (after 2025) • Transfer of Adjara to the sustainable development principles	• Government of Adjara • Supreme Board of Adjara	• Minimizing of risks related to climate change • Utilization of positive impacts of climate change • Development and introduction of modern, climate friendly technologies	DENRA of Ajara		Government of Adjara International donors Batumi City Hall Heads of local municipalities Non-governmental sector Private sector

6. Project proposals

6.1. Climate change adaptation proposals

6.1.1. Project proposal for rehabilitation of areas damaged from land erosion in Kobuleti Municipality

6.1.1.1. Description of the problem

The project area covers 10 ha in the basin of R. Chakvistskali. It is located in the neighbourhood of Chakvi, where the average annual precipitation comprises 2 788 mm. As everywhere else, the climate change impact became significant for the last 30 years. The average annual precipitation in 1986-2010 compared to 1961-1985 increased by 5% and the most of the increase (16%) is observed in autumn. As for the future (2021-2050), even more serious, approximately 30% increase is expected. The rise in precipitation is forecased at all seasons, though it will probably increase (by about 30%) in autumn. In future the amount of days with torrential precipitation (more than 50 mm and 90 mm) will also significantly increase. The negative impact of climate change mostly affects those agricultural plots, where the coefficient of erosion is high. Changes in the temperature regime is also very important since it causes intensive melting of snow in spring at the upper reaches of rivers, resulting in flooding which supports the process of breaking and destruction of riperian areas.

These processess have especially activated since 1990, in particular, at the "Messon District" (X0729523, Y4621184), where the population lived from olden times and agricultural infrustructure was developed during the Soviet period. Starting from 1990-es the River Chakvistskali carries out lateral erosion of agricultural lands, as a result of which the former pavillion building is completely destroyed; currently functioning boarding-school and Batumi water supply pipe are under risk, since during the floods the river washes out supporting abutments.

Photo 6.1.1.1 The village of Chaisubani, Messon district

Also in the settlement of "Kvis Khidi" (X 0730705, Y 4621009), the river Chakvistkali carries on active lateral erosion, due to which the personal plots of several families (2 families of Makharadzes, 2 families of Davitadzes, Guram Tsetskhladze, Tamaz Shamilishvili, Alexander Churkeidze, and Levan, Osman, Jambul and Shadin Kobaladzes) were wiped out.

The Ajara Department of roads and melioration systems conducted necessary coast-protection works in 2009-2010, resulting in the construction of a 300 m gabion. This positively affected the local populated areas, namely, it protects private plots and houses from washing out, but on the rest of 1 700-1 800 meters section the active lateral erosion is still ongoing. Virtually, the above mentioned two sections are continuation of each other, meaning that they both are one district in total. The difference between them is that Kvis Khidi is populated by the residents, who traditionally inhabited there, while Messon section was occupied by public infrastructure and crops. Notwithstanding the fact, that in accordance with Georgian "Law on water", the river Chakvistkali belongs to the small rivers' group and its sanitarian zone comprises 10 meters, during the last period it stands out for violent flash floods, as a result of which the lateral abrasion of banks has reached 100 meters.

Since 1991 the River Chakvistkali has wiped out approximately 12 ha of agricultural land and, in case if the preventive measures are not taken, it might put another 30 ha of agricultural land under risk, including state and private premises and lands occupied by the local population.

Photo 6.1.1.2. The village of Chaisubani and Kvis Khidi settlement

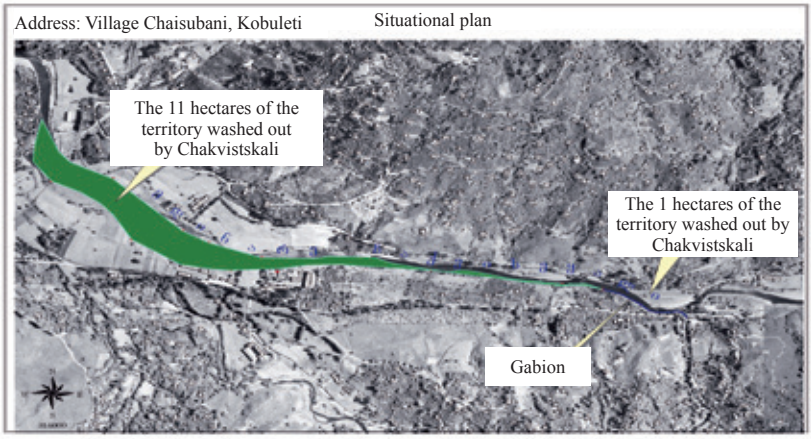


Photo 6.1.1.3. The pilot project area and the ongoing processes

6.1.1.2 Objective of the project

Considering the fact, that Ajara is a very densely populated area and faces very serious problem of land erosion, the main objective of this pilot project is to demonstrate the possibility of rehabilitation of eroded lands that can be spread over other similar areas. This will be one of the most important actions in land maintenance strategy. Within the pilot project, 10 ha out of 12 ha of degradated and washed-out land will be rehabilitated and 1800 m gabion will be arranged. For the construction of gabion locally available inert materials will be used (cobble-stones) in first place.

After consultations with the geologists, it was defined, that this artificially rehabilitated soil will be solid and can be used for agricultural (in case of adding of humus layer) and non-agricultural purposes. Filling up of washed out land will be carried out by the Chinese construction company (CINOHYDRO), which is mainly constructing Kobuleti section of Sarphi-Choloki highway. The ptoject on its side, should take responsibility to arrange gabions along with 1 800 meters and will prevent soil from further wiping out. After the project development process is finished, the following premises will be saved: boarding-school, that has been under risk for years; personal agricultural lands for 3 families; the washing away process of the neighbouring areas will be ceased (where the Polish investors plan to develop a turkey farm). In case if the above mentioned washing off processess are not prevented, the implementation of these social projects might be threatened. Part of the rehabilitated areas will be used to arrange sport boarding-school and also for the construction of settlement for population damaged by floods and mudflows.

In case if the amount of barren rock mined out during the tunnel construction is not sufficient, there is an additional extra resource. Namely, 4-5 km away from the project territory, there is 8 ha of abandoned agricultural land (former tea plantation), on which, without taking away the humus layer, thousands of cubic meters of dead rock excavated as a result of already functioning tunnel construction is piled on

According to the evaluation of the geologists, the rehabilitation of the above 10 ha should be carried out on the height of 2 meters. In case if we plan to use this land for agricultural purposes in future, we should raise it up to 1.65-1.75 meters using excavated rock, after that – humus layer should be put. In case if the land is not defined for agricultural purposes, it can be fully covered by the dead rock.

Photo 6.1.1.4. The agricultural land (8 ha) damaged with barren rock

These photos show thousands of cubic meters of barren rock that can also be used for the rehabilitation of soil.

6.1.1.3 Project implementation

Methodology

The main method/technology used in this project proposal is the river bank protection carried out with the help of gabion arrangement. Existing gabions at the neighbouring areas have shown that they can perfectly carry the function of bank protection in case of rivers. In addition to gabions, phyto-melioration activities should also be carried out that will ensure further strengtening of soils.

Activities

The project implemenattion will take approximately one year during which the following works should be carried out:

- Bringing in dead rock and earth excavated from the tunnel construction to rehabilitate 2 meters of soil;
- Arrangement of gabions for bank protection;
- Carrying out phyto-melioration works (planting and cultivation of trees that can be used for bank protection) to strengthen the soil and prevent it from further washing out;
- Raisingawareness on measures to be carried out annually for the prevention of further washing off among population and representatives of infrustructure, which is located on these areas.

Note: the commencement and implementation of projects directly depends on the beginning of the tunnel construction works.

6.1.1.4 Partners and beneficiaries

Project parners are:

- Georgian branch Chinese corporation CINOHYDRO that is constructing the highway and bears responsibility to replenish the washed out area with inert material;
- Company "Aisi Kobuleti Ltd "established with Polish inestmentt that already had started arrangement of the turkey farm on this area, but had to cease activities due to the emergency situation;
- The Municipality of Batumi, the water supply system of which may also be threatened in the nearest future;
- The Government of Ajara, which is interested in preventing land erosion processes.

Project beneficiaries are:

- Local residents living in the neighbouring areas, whose personal plots are annually washed away by the river Chakvistkali. They are ready to make their own contribution to the implementation of the project by performing physical works;
- Operating boarding-school that is currently threatened by the bank erosion;
- The Government of Ajara and namely Kobuleti Municipality that will get additional 10 ha of land to arrange sporting complex and dwelling settlement for eco-migrants;
- The "Aisi Kobuleti Ltd" whose social project is currently under the risk of ceasing.

6.1.1.5 Factors supporting project implementation

Project implementation promoting factors are:

- Interest of the Government of Ajara and Kobuleti Municipality to return and rehabilitate the washed away lands. The Kobuleti Municipality is one of the most densively populated areas, with the majority of population (2 115 households) who have private lands of less than 0.6 ha. This municipality is one of the most vulnerable towards climate change processes due to density of population and land erosion;
- A number of social projects is planned to be implemented on the rehabilitated area. Several foreign investors are interested in the implementation of mentioned projects;
- The construction of a tunnel is going on near the rehabilitation area. During the construction works, additional lands will be excavated and its piling will become necessary. Besides, 4-5 kms away from the rehabilitation area, in Chakvi, there is 8 ha of former agricultural land, which was covered by the thousands cubic meters of barren rock excavated during the already operating tunnel construction.

6.1.1.6 Barriers to the project implementation

The following barriers should be taken into consideration during the implementation of this project proposal:

- The cost of the project is quite high and it will be extremely difficult to implement it without co-financing that is envisaged from the building of tunnel and construction activities. The project is partially linked to other projects and is timely dependent on tunnel construction project development. However, from the technical perspective, as mentioned above, there is an alternative option that increases the cost of the project, though in exchange, creates additional 8 ha of agricultural land;
- The public awareness on climate change issues and its impact is very limited in population. This knowledge is essential to carry out systematic maintenance of areas from the population and government side. They should acknowledge the scale of expected damages and risks of losing lands;
- Lack of knowledge on technologies/activities that population itself can and should carry out in order to maintain personal land plots. These are for example phyto-melioration activities, which are quite effective among river bank protection technologies;
- Despite the fact, that formally there is currently in force "Law on soil conservation and rehabilitation", currently Ajara A/R does not even possess complete state land cadaster which should include accounting of land by qualities, economic assessment of soil and state registration of land users. Land degradation caused by the incorrect use of land resources, still remains the main problem in Ajara. In some places these problems are aggravated by climate change;
- During this transitional period the main attention from the Government is paid to the most vulnerable strategic highway and objects. Other utilities should be taken care of by the population and local government. This is not usual for them, accordingly, they do not possess relevant knowledge and experience.

6.1.1.7 Implementation activities and budget

Activities	Implementing agency	Terms of implementation (in months) and budget (USD)	Anticipated result
1. Carrying in 200 000m^3 of dead rock and earth obtained from tunnel construction to rehabilitate 2m high soil earth	Georgian branch of Chinese corporation CINOHYDRO that constructs the highway	12 500 000	Land is brought in on the eroded territory
2. Step by step leveling of carried in material	Department of roads and melioration systems of Ajara A/R administration of the village	12 10 000	The carried in land is leveled
3. Treatment of cobble-stone ground in the river bed with caterpillar excavator, feeding of bulldozer with excavated ground and its piling out	Department of roads and melioration systems of Ajara A/R, the administration of the village	12 51 000	The river bed is cleaned and material to arrange the gabion is taken out
4. Arrangement of 1800 m long and 3m high protection gabion	Department of roads and melioration systems of Ajara A/R, the administration of the village	12 55 000	Protection gabion is arranged
5. Carrying out of additional phyto-melioration works (cultivation of land protection plants)	Environmental protection department of Ajara A/R Local government Population of pilot project territory and private sector	12 50 000	Phyto-melioration protection zone is created
6. Training of local population and representatives of the neighboring infrastructure in operating and maintenance of gabions and linked areas	Project management Environmental protection department of Ajara A/R	3 50 000	Insurance of sustainability of project results
Total		**1 211 000**	

From the total amount of project cost, 500 000 USD works will be carried out by the Chinese company CINOHYDRO. P

6.1.2. Creation of stationary network for landslides regime observation and early warning system at the territory of Ajara

6.1.2.1. Description of the problem

Ajara is one of the most vulnerable regions to geological extreme events region in Georgia. At the territory of Ajara, due to the high density of population, these events often transform into natural disasters. Significant activation of natural geological hazards usually takes place in spring due to snowmelt. In Ajara Mountains underground and surface waters are fed both by rainfall and melting of snow cover, which causes the abundant wetting of surface strata and provokes natural hazards. This could be illustrated by the case of extreme events which took place in the spring of 1998 around the village of Vashlovani, causing the loss of 6 people. Actually, the process began in 1997, when the number of snowy days in Khulo district reached 124 against the climatic norm of 106. Moreover, the total height of snow cover that winter grew up to 428 cm, while the average value of this parameter for the last 25 years made only 69 cm.

The maximum amount of daily precipitation in Ajara in the warm period of the year reaches 80-100 mm with the duration of 2-4 hours. From April to October the average number of such days in the coastal zone equals to 23, and in Ajara Mountains - to 10-12. The occurrence of mudflows coincides just with this period. During the preparation of Georgia's Third National Communication to the UNFCCC, it was defined that the extreme geological events at most are activated when the amount of annual precipitation exceeds climatic annual values by 200-400 mm. One of the most vulnerable to geological hazards areas in Ajara is the Khulo municipality.

Despite the revealed direct links between climate parameters (mainly precipitation) and geological extreme events, the implementation of preventive measures requires more sophisticated study of these connections applying modern technological achievements, taking into account both the anthropogenic impact on extreme geological events and the influence of climate change.

From the climate features, most important for these processes are abundant precipitation and its intensity, while from anthropogenic factors, major impact is related to the growth of areas under perennials, the construction of new industrial and recreational facilities, building of motor-roads, and mining of minerals. All these activities create the misbalance in natural equilibrium and activation of destructive geological processes, leading to the alteration of geological environment in local and regional scale. Hence, the study of geological processes and projection of their development trends is very important for Ajara region, where mountains and soils are prone to landslide and mudflow formation. On the bases of these studies, the risks reduction strategy should be elaborated to substitute the Soviet era practice, when the only way to combat extreme geological processes used to be (as it is up to now) the resettlement of population to safe areas. At the same time, the abandoned territories are not looked after, that is quite important for Ajara with its shortage of arable land.

The long practice has shown that high efficiency of measures against the geological

hazards is achieved only in case, when they are carried out in a complex way and according to scientifically grounded foundation, elaboration of which is possible based upon the reliable engineering and geological monitoring and survey results.

In the Soviet period relatively simple geological process monitoring system was functioning, which has completely disintegrated after the end of this period.

In 1976-1982 Georgian Geological Administration created the permanent stationary observation (monitoring) network that was widened with the newly studied sites. Representative plots were marked with concrete bench-marks, the disposition (coordinates) of which periodically (once or twice a month) was instrumentally measured by topographer to determine their displacement (now this can be made with the GPS system). In 1995-2004 these activities were performed by Ajara Autonomous Republic Geological and Mining Department, and since 2006 they are carried out by Ajara Environment Protection and Natural Resources Administration's Geological Service. Up to now about 5 thousand applications are studied, during which schematic maps of 1:2000-1:5000 scale are made at the site, the hazard is assessed visually and conclusions are drown up. The practice has demonstrated that carrying out of preventive measures at the examined and potentially hazardous territories is far more effective and advantageous than the liquidation of consequences of already happened processes, the stabilization of which costs ten or hundred times higher compared with the preventive measures. Up to now the stationary observation (bench-mark) system is obliterated. The visual examination and assessment of representative plots is going on.

6.1.2.2. Objective of the project

The objective of the offered project proposal is to study best contemporary practice for the monitoring and management of geological processes and to pilot the system/ method that is most suitable for Ajara. The piloting introduction of widely recognized modern system for monitoring geological processes, and in particular the landslides, is planned in the Khulo municipality, which is, in geological respect, one of the most vulnerable districts of mountainous Ajara, where at present the tourist infrastructure is intensively developing.

It ought to be mentioned here that the seashore Khelvachauri and Kobuleti municipalities are marked with the abundant precipitation (2 500-3 000 mm/yr), while in Khulo municipality this value is smaller (1 300-1 500 mm/yr). Moreover, the unstable geological structure of the coastal zone promotes the origination of perilous geological events (landslides, mudstreams). High density of population also causes higher number of applications here compared with the Khulo mountain zone. Nevertheless, despite the predominant activity of landslides in Khelvachauri and Kobuleti municipalities, Khulo district has been chosen by expert geologists as a pilot area taking into account its particular importance for the development of tourist infrastructure.

The monitoring system should be combined with the early warning system. In case this pilot project is successfully implemented, the same method or another approach

more suitable for Ajara can be adopted in other vulnerable municipalities of Ajara, or elsewhere in Georgian mountainous regions (e.g. Dusheti) that experience serious losses from landslides.

6.1.2.3 Project implementation

Methodology

Methodology applied in the project includes the study of world-wide adopted systems for monitoring and management of geological processes (in particular the landslides) as well as for carrying out early warning services and their introduction in Georgia (Ajara) for the prevention of related risks/anticipated hazards. The possibility of effective reconstruction of previously functioning monitoring system will be examined as well. Modern systems of landslide monitoring, which could be deployed in mountainous Ajara, for the moment are not known. The selection of such system and its adaptation to Georgia's conditions is a part of this methodology as well.

Activities

Activities to be implemented in the project framework will be conducted in the following directions:

- Study of modern practice of landslide monitoring and management, and working out recommendations on the introduction of systems suitable for Ajara.

Formerly (in the Soviet period) geological studies were conducted using the bench-mark system, but now only applications from the local population are being responded. On the basis of these applications the 1:50000 scale geological maps are drown up and specialized engineering-geological investigations are undertaken. In the offered project the recommendation is to be worked out on the expediency of reconstructing the bench-mark system, or if it is possible, on the introduction of contemporary monitoring system and planning of preventive measures. Usually, geological maps are designed for separate damaged plots scaled at 1:2000-1:5000 and hence, the general picture is fragmentary. It is necessary to amalgamate them in a single system and draw up a 1:50 000 scale map for the entire territory of Ajara. This map should feature the engineering and geological conditions and include geomorphological and engineering-geological division of territory by regions. The map will reflect the geological structure of the territory, the spread of disastrous geological processes and their development conditions. Current geological processes should be classified according to their activity degree. Each damaged plot should have its number and will be registered in the relevant cadastre.

The geomorphological map describes the origin of the examined territory's relief and the history of its development. Geomorphological regions, sub-regions and plots are marked at this map, indicating both basic relief-creating processes and contemporary, now acting developments. The map is a summary document, in which sub-regions

are classified according to the inclination of relief and the plots-according to their dynamic state, genesis and the development degree. According to the stability and dynamic state, plots are divided into 5 categories: **Stable** (geological processes are not indicated); **Relatively stable** (dynamic equilibrium is indicated along with slight display of geological processes and weak erosion of soil); **Limited stable** (alternation of stable and unstable plots, stabilized landslides are indicated, land erosion is medium); **Slopes under stabilization process** (geological processes are suspended naturally or under the preclusive measures); **Unstable** (hazardous geological processes are manifested intensively, whole area or its significant part is damaged). The climate mostly affects unstable plots.

- Working recommendations on preventive measures.

For each plot indicated at the engineering-geological map of regions, the kind and volume of preventive measures is to be recommended, after taking these measures plots will be stabilized and conditions for the development of disastrous geological processes will be eliminated.

- Allocation of territories that are convenient for the development.

The final stage of engineering-geological division is the allocation at the map of territories which are convenient for the development of specific branches of economy. In this respect 5 groups of territories could be identified: **Convenient** (soil cover is stable, erosion is not developed and the territory is more stable than in the following category); **Suitable** (active geological processes are not indicated); **Limited suitable** (outlets of basic rocks are indicated, geological processes are not displayed, but can commence in case of inappropriate development of the territory); **Suitable after** taking preventive measures; **Unsuitable** without taking special capital preventive measures.

The engineering-geological maps represent reliable basis for the conduction of preventive measures at the potentially hazardous slopes to secure the rational use of land, to protect the environment and improve the landscape.

- Carrying out of systematic observations (monitoring) on disastrous geological processes and elaboration of recommendations for their management.

Monitoring of measures taken to prevent disastrous geological processes and analysis of the results. One of the preventive measures is believed to be the creation of permanent observations stationary network, the sites of which will be selected considering both geological and social acuteness. Observations will be conducted on the state of examined territory and the degree of extreme geological processes. As a result the reliable, comprehensive and efficient information on the dynamics of these processes could be obtained, upon which a forecast will be made, creating a basis for scientifically grounded adoption of preventive measures and risk reduction.

- Arrangement of early warning system.

6.1.2.4 Partners and beneficiaries

From the **beneficiaries** of the project, following should be mentioned in the first place:

- Local population, which in the Soviet period was cared for by the state in an organized and centralized way. At present some of the problems should be solved by the population themselves, though they have no adequate knowledge and information. In the framework of the project, they will undergo a training on the best practices of carrying out simple preventive measures;
- Ajara Ministry of Agriculture, which at the end of the project will possess firm basis for the sustainable development of the sector and assimilation of new arable land;
- Local Municipality, which will obtain prepared in advance and coordinated action plan to reduce anticipated risks;
- Farmers/private sector, which,after the end of the project, will get firm foundation for the sustainable development of economy and assimilation of new arable plots, as well as necessary information to reduce risks to their property;
- Department of Tourism will obtain information necessary for planning and development of less risky options of tourist routs and tourist infrastructure;
- Insurance companies, which will get reliable information required for insuring both agricultural lands and property of local residents.

Partners of the project

- Ajara Environment Protection and Natural Resources Administration which will manage the monitoring structure;
- LEPL "Saknapirdatsva Ltd.", which possesses experts to be included in the implementation of this project, who have accrued necessary experience in sea-shore survey and coast protection since 1981. This company is specialized in combating hazardous events, owns relevant machinery and has highly skilled personnel;
- Project could be of interest to LEPL "Ajaravtogza", which is laying motor-roads and is interested in the geological information;
- Department of Tourism, which could get important information for the development of tourism;
- Insurance companies, which could significantly reduce their risks.

6.1.2.5 Factors supporting project implementation

- Major supporting factor to the implementation of the project is the interest of and promotion by the local and central authorities. Ajara is a very densely populated region which is constantly experiencing loss of land due to washing off by the sea, land erosion, landslides, mud streams and floods. Therefore local authority is highly interested in the preservation of land;
- The Ajara Regional Development Strategy considers the necessity of state

control on the soil erosion protection measures and of the elaboration of Soil Protection Program. In this Program, current state of soil degradation and its trends will be described using the GIS data. The implementation of this Program will demonstrate natural and anthropogenic processes facilitating land degradation and will formulate the degradation protection measures and feasibility of investments in this sector regarding current economic and financial situation in the country;

- Tourism development is one of the highest priorities in the country, especially both seashore and mountain tourism development in Ajara. Thus, it is important for the region to preserve territories and develop safe infrastructure;
- The offered project proposal has particularly many partners and beneficiaries, among which are to be mentioned population, Tourism Department and insurance companies;
- Successful implementation of the project would be based upon the former experience. There are numerous experts in Ajara, who have extensive experience in working on similar undertakings. In the territorial geological funds the data are preserved on the previous engineering-geological surveys carried out during many years,, these data can be looked for and used.

6.1.2.6 Barriers to project implementation

- Lack of local personnel to be used for the perfect adoption of modern sophisticated systems. It would be necessary to carry out very intensive trainings to overpass this barrier;
- Limited information on contemporary technologies. To remove this barrier the inclusion of foreign expert into the project will be necessary;
- The system is sufficiently expensive in terms of both initial investment and annual maintenance. Stability scheme of the project's results should be elaborated;
- Vast amount of necessary data and problems related to the information exchange between different authorities;
- Inadequate performance of meteorological service. This barrier is common for all vulnerability and adaptation to climate change projects and the solution of this problem is especially important for Ajara.

6.1.2.7 Implementation activities and budget

Project implementation is estimated for 3 years.

Activities	Implementing agency	Terms of implementation (months) and budget (USD)	Anticipated result
1. Study of the modern practice of landslide monitoring and management and selection of systems suitable for Ajara's conditions.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources [4]	12 50 000	The decision is made on the type of monitoring system to be introduced in Ajara
2. Drawing up of 1: 50 000 scale maps for specialized engineering-geological studies.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	12 30 000	Maps are designed to carry out geological studies.
3. Preparation of recommendations for the implementation of protective measure.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	12 50 000	Recommendations are prepared to be presented to population during the training course.
4. Conduction of systematic observations (monitoring) on hazardous geological processes.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	18 10 000	Results of monitoring system operation.
5. Working out recommendations on the management of hazardous geological processes.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	6 30 000	Geological processes management strategy to minimize the risks is elaborated.
6. Monitoring of the efficiency of disastrous geological processes preventive measures and analysis of obtained results.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	Permanently 5 000	Effectiveness of preventive measures is assessed creating a basis for planning further activity.
7. Elaboration of strategy for the implementation of preventive measures.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	12 70 000	Strategy for the introduction of preventive measures and effective management of geological processes is worked out.
8. Arrangement of early warning system.	Directorate of Environment and Natural Resources of Ajara A.R; Body responsible for the sustainable management of land resources	12 100 000	Early warning system is put into operation.
	Total	345 000	

6.1.3 Retaining coastal stability in Ajara seashore area

6.1.3.1 Description of the problem

At the background of global warming, the impact of climate change is most apparently evident in the sea coastal zone; this is caused by sea level rise and the growth of gale activity. In future these events will provoke the acceleration of complex morpho-dynamic processes going on in Ajara sea coastal zone, pulling in stable sections as well, as a result of which, in case of inactivity, the major part of Ajara seashore zone will transform into the ecological disaster area. Therefore, while carrying out the coast protection activities, it is necessary to foresee the increase in the amount of inert material brought in at the beaches, and in cases when coast is reinforced with hydro technical constructions, new parameters of waves should be considered in calculations.

Despite the fact that coast protection measures are carried out at local sections of Ajara sea coastal zone, there still remain the emergency sections, requiring the implementation of the same kind of activities. The review of some of them is given below.

- **Kobuleti coastline** (from the month of R. Achkva up to Pichvnari)

While coast protection measures at the Kobuleti section of seashore zone is carried out, it is necessary to take into consideration its recreational importance. The reconstruction of coastal areas should be performed by the artificial nourishment and enlargement of beaches.

In the seashore zone of the central part of Kobuleti, in front of wave-repelling stepped walls (they were constructed in 1970-es and reconstructed in 2012 with prolongation of these walls by 1 km to the north), creation of 50 m wide beach at the first stage requires to bring in at once 1.5-2.0 million m^3 of coarse-grained inert material, and afterwards – 50 thousand m^3 of small-grained sandy material annually to preserve the obtained beach. The initial pilings will replenish the beach, while later heaping will increase its recreational attractiveness.

This section of coastline is especially interesting for the tourism sector as the Kobuleti seashore is unique in Georgia from the recreational and balneological standpoint. The air in the Kobuleti coastal zone is enriched with iodine from the sea, which, coupled with the scent of pine-trees planted at this area, gains recreational features and is good for people with cardio illness. At the same section, in case of inactivity, the beach will be shifted by the sea to the north; the obsolete wall will collapse and greatly damage the Kobuleti Boulevard.

- **Tsikhisdziri Cape**

Along the Tsikhisdziri Cape, where the railway passes at the edge of cape's peripheral part, sufficiently high wave-repelling wall is built. In front of Tsikhisdziri Cape there are both old wave-repulsive walls (constructed in 1950-es) and new ones (built in 1970-es).

Despite the firm foundation of the wall, based upon the abruption of rocks, it is nevertheless depreciated, creating hazardous situation at each gale process. To relieve this state, along the Tsikhisdziri Cape coastline the reinforced concrete waste, obtained after the demolition of different constructions, is being dumped chaotically, without any planning, the same happens with the slag from Zestaphoni ferroalloys enterprise. None the less, it became obvious that these measures cannot provide the safety of this sector of seashore. It is desirable to reinforce this sector with the broken stone berma, which has proven its effectiveness at the Georgian (e.g. in the northern part of Mtsvane Kontskhi) as well as Turkish territories.

Protection of this section especially concerns the Railway Department because a great deal of oil transportation to Batumi is performed through the railway.

❖ **Central part of Chakvi**

The central part of Chakvi, where in mid 1970-es a massive vertical wall was erected from the mouth of R. Achkva to Buknari, turned out to be in a critical state. The wall did not provide the coast stability and heavy blocks (100 tons and more) of reinforced concrete were laid in front of the wall for holding up of abrasive impact. However, even this measure proved ineffective to protect the coast and as a result the funnel-like forms evolved at the coast. In case of inactivity, after the winter storm season, both the creaked wall and buildings will appear in the sea as the water-front is already reaching the wall.

For the preservation of status quo and restoration of recreation zone, it is necessary to create wide beaches by artificial nourishment of shore line at this section. For this task it would be necessary to bring in at once 150-200 thousand m^3 of inert material followed by further piling of 40 thousand m^3 annually.

Photo 6.1.3.1. The funnel-form cavity washed out by the wave behind the wall

❖ **Kalendere Cape**

The Kalendere Cape is a 2 km long rocky coast between Sarpi and Kvariati, mainly consisting of volcanogenic rocks. Since 1977 the main highway connecting Georgia with Turkey functions along the water-front of this cape. The highway is constructed over the piles of blasted rocks, most part which is washed off and transported by the sea to Kvariati. Major section of the highway (about 1.2 km long) is in an abrasive state, is being washed out and requires reinforcement. It is advisable to carry out coast protection measures here by arranging the broken stone berma. In this case this technology is recommended for the same reason as above.

6.1.3.2. Objective of the project

The objective of this project is to prepare the Black Sea Ajara coastal zone adaptation to climate change strategy and to demonstrate some elements of this strategy in the process of implementing specific adaptation measures. The project proposal considers most vulnerable for the current moment the segment of the Black Sea coastal zone from the outfall of R. Chorokhi to the Batumi Cape. The mentioned section is the most complicated part of Ajara Black Sea coastal zone both in terms of technogenic and anthropogenic loading and of the impact of active abrasive processes. This section is the seashore portion of Kakhaberi Plane, which is occupied by the city of Batumi, the seaboard boulevard from Batumi Cape to the Airport (in future up to Kvariati), the Batumi Airport runway, first in Georgia wastewater handling facility and other utilities.

The major part of this section from the Zhilinski canal up to Batumi Cape, due to the presence of more than 100 m wide beach, is in a stable condition. As to the section between R. Mejinistskali mouth and the Airport, its steadiness is preserved by the beach's artificial nourishment. For the third year, coast protection measures are carried on under the financial support of Ajara government. About 100 thousand m^3 of inert material is brought in annually, as a result of which the seashore beach has been widened by 40-50 m. Such kind of coast protection measures should be continued without fail. Otherwise the territory of the new boulevard will be washed off. As to the measures which will provide coastal stability for a longer period of time, at the present stage they are not known to the project authors and if the recreation zone is to remain here, this measure is to be considered as the most appropriate one.

Rather complex situation is from the Airport runway to the south up to the mouth of R.Chorokhi, where the wastewater handling constructions and reservoirs are disposed. Here, in the active abrasive zone, the designed road and boulevard construction works have been started. According to inactivity scenario, in case coast protection measures are not carried out, the abrasive processes will be sharply activated, resulting from the decrease of R. Chorokhi sediment supply and the rise in frequency of heavy storm processes. Consequently, after the first stormy season all mentioned-above facilities could be washed out by the sea.

There are a lot of project proposals aimed at the preservation of coastal stability from

the mouth of R. Chorokhi to the Batumi Cape. One of the latest options, designed by Dutch experts, is sufficiently expensive (75 million euro) and has heavy technologenic loading. It implies the arrangement of broken stone spurs in each 200 meters from the wastewater facility up to Batumi Cape, the construction of deeply cut into the sea concrete underwater wave-breakers and sand-keepers along the old boulevard, as well as the artificial filling of space between the spurs with sandy material. Short extract from the report submitted by the Dutch company "Arcadis Nederland BV" is cited in Annex VI.

In case mentioned project is implemented, the natural beauty of Batumi beach will be altered, technogenic constructions will be amortized and become polluted with the construction waste, and the recreation zone will lose its attractiveness and function. The application of such type of constructions by Dutch experts[54] in the project design is due to the government request on the creation of sandy shore line (Annex VI). It ought to be mentioned that in the preparation of this project, the possible impact of climate change was not studied and envisaged.

In the present project proposal, the alternative project option is presented which is rather cheaper and, more importantly, provides the preservation of natural appearance of the seashore and its recreation and balneological functions.

As it was underlined above, the coastal area between the outfall of R. Chorokhi and the Batumi Cape has significant strategic importance for the region in terms of urban loading and is featured by complicated morpho-dynamical processes. It includes an erosive part from the mouth of R.Chorokhi to the Zhilinsky canal (5.0 km), accumulative stable section from this canal up to Batumi Cape (3.0 km), as well as the recreation zone from the Batumi Airport runway to Batumi Cape (6.5 km) and the non-recreational zone from the Airport runway to the outfall of R.Chorokhi (1.5 km).

To preserve the recreation zone for several years, it is necessary to take the following measures: to bring in annually 150 thousand m^3 of inert material in autumn, before the beginning of stormy season at the territory adjacent to the Airport runway. The mining of this material for decades ahead is possible in the bed of R. Chorokhi. (According to experts' assessment, the stockpile here is sufficient for 20-25 years, if the mining for other purposes, i.e. construction, will be stopped). Since 2009 at the Airport adjoining territory 100 thousand m^3 of inert material is heaped annually, as a result of which the beach has widened by 40-50 m. However, at the background of global warming the sea level rise and the increase of storm activity have intensified the natural flow of sediment along the beach from 100 to 150 thousand m^3 annually and hence, to compensate the erosion processes, it is necessary to pile annually 150 thousand m^3 of inert material.

In the non-recreational zone, where presently active abrasive processes are going on (with washing off rate of 5-7 m annually), such important facilities are situated as the Airport runway, wastewater treatment central units, the Batumi-Gonio highway under construction, and prolongation of Batumi boulevard. The coast protection measures at this section are to be taken in a more urgent way. Namely, it is necessary to arrange a 1.5 km long massive broken-stone berma with small sediment-keeping spurs, which

[54] ARCADIS NEDERLAND BV

would require minor repairs after each storm season. Up to now such works are being conducted only alongside the water handling facility (300 m) and this can produce a negative impact. In particular, to the south of berma, these works can generate the "boon" effect, the signs of which are already apparent. This effect provokes the formation of a small beach in front of the berma and activation of washing off process in its northern part, thus creating jeopardy to the Airport runway.

6.1.3.3 Project Implementation

Methodology

The project methodology implies the study of the most vulnerable sections of Ajara Black Sea coastal zone and elaboration of their risks management strategy considering state-of-the-art coast protection technologies, as well as the implementation of one pilot project.

Activities

- The analysis of measures already conducted at this and other sections, assessment of their positive results and shortcomings. Estimation of climate impact for each section;
- The analysis of the world's best practices of coast protection and assessment of the possibility of their adaptation to Georgia accounting for the current and anticipated in future climate change;
- Perfection of adaptation to climate change strategy for the Black Sea Ajara coast;
- Conduction of coast protection measures at the selected section of recreation zone in the framework of the pilot project. In particular, accomplishment of artificial nourishment of beach by heaping 150 thousand m^3 of inert material once every year.

The inert material mining site rocky sand-pits in the bed of R. Chorokhi. In case of inert material mining directly from the river-bed, the cost of single heaping is 1.22 million USD. The price of $1m^3$ of inert material including transportation expenses is 8 laris, hence 150 thousand m^3 will cost 1.2 million laris. Research of a coastal zone before and after the heaping costs 10-12 thousand laris and the monitoring of piling process 8 000 laris. The mining of inert material from the rocky sand-pit is 3 times more expensive. In this case the transportation of $1m^3$ of inert material will cost 25 laris and the price of 150 thousand m^3 will grow up to 3.75 million laris. Considering this, one of the recommendations will include the possibility of temporary mining of inert material from the bed of R. Chorokhi unit using more ecologically sound measures. According to coast protection experts' viewpoint, the mining by construction companies must be prohibited and the rest of sand and shingle should be used only for coast protection measures. The Ajara Environment Protection Administration and Georgia's National Environmental Agency have prepared jointly a bill, according to

which in all sea coastal rivers within the distance of 20-30 km from the mouth of the Sea Rivers, all mining activities will be prohibited.

- The heaping of inert material at the second vulnerable section, considered in the project proposal – the territory adjacent to the Airport runway. The piled material will be redistributed by sea waves along the coast. The period of heaping – autumn. This choice is based upon the following reasons: 1) To this moment the tourist season is over; 2) Before the winter gale season the berma created by the piled mass is an effective barrier to sea waves, the dynamic energy of which mainly be spent on removing of piled mass;
- The protection of 1.5 -1.8 km long non-recreational zone with the broken-stone berma.

The construction of berma will take 1.5 year. The mining of stones will be performed at the Dologani, Simoneti and Akhalsheni quarries. The transportation of $1m^3$ of broken stone from the Dologani quarry and its laying costs on the average 50-52 laris. To construct a berma with spurs at the mentioned section 120 thousand m^3 of stones is required, which costs 6.24 million laris. Construction design will cost about 25 thousand laris, and the examination of coastal zone and conduction of monitoring – 10 thousand laris. The berma is to be constructed as a single effort. In case of its depreciation, the damaged areas can be easily reconstructed by laying stones anew.

6.1.3.4 Partners and beneficiaries

Partners:

- Government of Georgia, as central highways, important for the country, pass through the coastal zone from the mouth of R.Chorokhi to Batumi Cape;
- Batumi Municipality, which is interested in the construction of multi-storey hotels and apartment houses at the territory adjoining the beach, arrangement of coastal boulevard and maintaining its stability, as well as in preservation and development of tourist, leisure activities and other infrastructural elements;
- The managerial team of Batumi Airport, which is interested in the protection of coastal segment bordering the runway;
- Owners of those hydropower plants, the construction of which will complicate the coast nourishment problem. This concerns small HPPs, planned to be built on R. Chorokhi (2 HPP) and R. Ajaristskali (3 HPP);
- The Ajara Coast Protection Service, which must conduct the relevant measures.

Beneficiaries:

- Residents of nearby territories;
- Batumi Municipality, which is responsible for the development of infrastructure, important elements of which (water treatment facility, landfill, boulevard) will be primarily damaged by the intrusion of the sea;
- Private sector engaged in tourism, interested in obtaining utilities with stable and comfortable infrastructure to ensure more effective development of its activity;
- Department of Tourism, as the ecologically clean and stable seashore is attractive for tourists;
- The Batumi wastewater handling facility, which is disposed at relatively small distance from the hazardous coastal zone considered in the project proposals.

6.1.3.5 Factors supporting project implementation

- Georgia is intensifying its efforts to develop the tourism industry. In this respect Ajara is one of the regions with highest potential that requires its coastal zone and infrastructure to be adequately well-groomed and protected. Therefore the Government is trying to preserve and develop tourist zones, though there are several barriers, discussed in the following section;
- One of priority directions in Ajara Development Strategy is the continuation of coast protection activities to preserve from erosion both basic and linear constructions. To reach this objective it is recommended: (a) to carry in the inert materials from the quarries to reinforce the coastal zone; (b) to mine inert material from the riverbed;
- The country possesses sufficient experience and expertise in the coast protection sector. However, it often deals with outdated information and technologies, which require renovation and reevaluation.

6.1.3.6 Barriers to the project implementation

- One of the major barriers to the project, as well as to the implementation of coast protection measures in general, is its high cost both in terms of initial investment and of annual maintenance, especially concerning the heaping. Consequently, the recommendation on heaping is given in extreme case, when it is related to the sections, where tourism is developing;
- Awareness in technologies. In the Soviet period coast protection activities were carried out in a centralized way and most technologies were transferred from Russia. Some of them have been justified, and some were not. In some segments one measure is more effective, and in another segments – the different one. In recent years the modern technologies are brought in slower and often local experts are not adequately engaged in their introduction;
- As it was mentioned above, the coast protection especially in recreation

zones, requires artificial nourishment by the inert material, transported from outside. Hence, the questions arise, where this material can be brought from so that other ecosystems are not endangered; what is their reserve and how long the nourishment can be provided by this way under the current climate change conditions. Lack of information on these questions is one of the essential barriers;

- Taking into account the climate change in the process of coast protection is one of those obstacles which must be surmounted without fail. To reach this objective the country should obtain contemporary models, on the basis of which, more or less reliably, it would be possible to assess these processes and to consider their development in the scientifically grounded way;
- Due to the lack of necessary funding, the Coast Protection Service (CPS) at the National Environmental Agency is unable to conduct permanent monitoring in the Ajara sea coastal zone. The operational survey is carried out in a fragmentary way along the damaged sections, where coast-protection measures are to be taken immediately. The survey is jointly conducted by the staff of Batumi and Tbilisi departments of Coast Protection Service. (In Batumi department, staff consists of 3 persons. It is advisable to train local young personnel, who will take part and manage these activities).

6.1.3.7 Implementation activities and budget

The implementation of the project requires at least 2 years.

Activities	Implementing agency/group	Terms of implementation (months) and budget (USD)	Anticipated result
1. Analysis of measures already taken at different sections of the Black Sea Ajara coastal zone and the assessment of their achievement and shortcomings.	Coast Protection Service (CPS) at the National environmental Agency.	6 25 000	Report on the critical analysis of coast protection activities carried out in Georgia at the Black Sea Ajara coastal area (prepared jointly with foreign consultants).
2. Analysis of practical implementation of state-of-the-art coast protection measures and assessment of their adaptability to Georgia accounting for current and anticipated climate change.	CPS in collaboration with foreign expert	6 30 000	Recommendations on technologies providing the most economically efficient ways of protection of Ajara zone under the climate change conditions.
3. Perfection of the strategy for adaptation to climate change of the Black Sea Ajara coastal zone.	Project management team, CPS at the National Environmental Agency and foreign expert.	6 20 000	Renovation of the Black Sea Ajara coastal zone coast protection strategy considering the policy of adaptation to climate change.

4. Conduction of coast protection measures in the recreation zone at the section selected in the framework of the pilot project.	CPS at the National Environmental Agency.	2 2 800 000	Coast protection measures are carried out in the recreation zone.
5. Heaping of inert material at the second vulnerable section considered in the pilot project – the Airport runway bordering territory.	The same.	2 (annual piling of 150 000 m^3) 1 200 000	Inert material is piled at the Airport adjoining territory.
6. Protection of non-recreational zone with broken-stone berma.	The same.	18 3 900 000	Mentioned section of coastline is protected in the long-run perspective.
7. Survey of inert material feasible sources taking into account the sustainable development principles.	Geological and Coast Protection service.	24 70 000	One of the most significant barriers to coast nourishment process (source of inert material) is identified and assessed.
	Total	8 045 000	

6.1.4. Establishment of monitoring system aiming at prevention of climate change impact on spreading wreck-diseases in Ajara forests

6.1.4.1 Description of the problem

The administrative area of Ajara Autonomous Republic comprises 290 000 ha (2900 km^2), out of which forests cover 192 488 ha that equals to 66% of the whole territory. Endemic and relict sorts of trees are the only means to satisfy population with wood for heating and represent the key resource for the population in this regard. Besides, Ajara forests have special capacity of soil protection and water management.

Unfortunately, due to inappropriate management, the density of the most of the forests is currently reduced. For the time being, forests are thinned out on 2 789 ha (01-04) that comprises 1.5% of the whole forests.

The species of Ajara forests are diverse and comprise up to 400 sorts of trees and bushes, among which the most area is engaged by beech, chestnut, spruce and abies. The data on the average age of the trees that occupy more than 1 000 ha, also the assessment of phytomass is given in Table 6.1.4.1.

Table 6.1.4.1. Areas of main species, average age and phytomass in Ajara forests

#	Species	Total area, ha	Average age, years	Total reserve of phyto mass (underground and overground) thousand m^3
1	Abies	19 213.0	120.0	13 734.5
2	Spruce	24 223.0	84.0	14 086.1
3	Pine tree	1 587.0	53.0	541.9
4	Beech tree	80 255.0	130.0	42 484.0

5	Oak	6 807.0	70.0	1 204.5
6	Hornbeam	6 656.0	70.0	2 090.5
7	Chestnut	26 324.0	71.0	10 126.8
8	Alder tree	11 818.0	52.0	2 844.7
9	Rhododendron ponticum	8 683.0	29 .0	402.5
10	Cherry-laurel	1 988.0	41.0	56.3
	Total	187 554.0		87 601.8

As we can see from Table 6.1.4.1, Ajarian forests are quite aged that supports spreading of different kinds of diseases among them. The total area of massively diseased forest in the region reaches 11 788 ha, which comprises 6.1% of the forest fund. Relatively low zones of the region, mainly in the chestnut forests of Kobuleti, Khelvachauri and Keda, the most widespread disease is endotic cancer (Chriphonectria parasitica), in upper regions – in spruce and abies forests of Kobuleti, Shuakhevi and Khulo entomologic wrecks are spread. Namely, dominant diseases in the forests are: Dendroctonuc micans, Ips tipographus L and Ips acuminatus Eichh. Due to their negative influence, the forests lose their stability, the wood loses material property. The wood is often occupied by fungus causing rotting - Phellinius pinivar, Abietis da Armillaria mellea. These diseases cause massive drying of trees. The results of monitoring for 2010 are given in Table 6.1.4.2.

Table 6.1.4.2. Results of stocktaking of thinned out forests, eroded and diseased areas in Ajara forestry administrations

Area	Total area, ha	Among them diseased area, ha	Eroded./degraded areas, ha	Thinned out area, ha	Composition	Evaluation of assessed trees		
						Number of trees	Average diameter (cm)	Average stock (m^3)
Kobuleti	23 790.8	3 800	32	245	Ch., Sp., Ab.	954 825	-	574 915
Khelvachauri	23 470.8	1 800	-	132	Ch	79 489	-	56 550
Keda	37 679.5	1 117	4	145	Ch	125 592	-	71 420
Shuakhevi	39 980.3	3 754	-	662	Sp., Ab.	720 540	-	880 664
Khulo	37 182.2	1 317	-	1 605	Sp., Ab.	143 364		108 066
Total	162 103.6	11 788	36	2 789		2 014 810		1 691 615

The diseases are significantly spreading in the chestnut forests of Ajara.

Research carried out in Kobuleti, Khelvachauri and Keda regions showed that drying out of trees, both separate and grouped, are of scattered character. 28% - 5 209 ha of the total chestnut forest area (18 897 ha) is dried out, to this 1 900 m^3 of broken and deteriorated chestnut trees are added that also makes the basis for spread out of wreck-diseases and increases risk of fires in the forests. According to the rules of the

mentioned forest, it is necessary to make special timber extraction from the forests. This will require building of special roads up to 72 km long that, on their part, will also decrease soil protective function of the forest. It is most important to follow sustainable principles in solving any problem related to forests.

It should be highlighted that diseased, dried out or broken chestnut trees do not give any increment of biomass, on the contrary, they support spreading of diseases and worsen forests' condition. Chestnut trees are in an extremely difficult conditions. One of the activities to prevent chestnut cancer is to make sanitary cuts of the diseased trees. If these measures are not taken on time, it is expected that drying out of trees will take more intensive character. The mentioned disease is spread out to other species as well (oak, hornbeam).

It should also be noticed that in dried out chestnut forests evergreen undergrowth, rhododendron, cherry-laurel have been activated, that prevents growth and development of new plants. In such sections it is necessary to cut under-forest and plant chestnuts of 1.2-5.0 meters height.

According to above given discussion, it is recommended to clean the mentioned chestnuts step by step in the frames of legislation. In places where rehabilitation of chestnuts is not applicable or creates risks, natural or artificial planting should be used.

Rotting of waste and subsequent spread of wreck-diseases is aggravated due to the increase of temperature caused by global warming in Ajara, which started in 1990-es. It is well-known fact that increase of temperature and precipitation facilitates spread out of wreck-diseases, the example of which is a research made in Ajara chestnut forests on endotic cancer. According to the results of this research, out of the total area of 18 897 ha, on the area of 2 268 ha (12%) chestnut forests in Khelvachauri, Kobuleti and Keda were dried out. By 2010 the diseased area increased up to 5 209 ha, which makes 28% of the total area. At the same time, in line with the increase of temperature, the disease is progressing to high mountainous chestnut forests (Shuakhevi, Khulo).

Photo 6.1.4.1. Diseased forest stands

According to the research, comparatively new diseases – chestnut moth, oak moth and box-tree disease (Cylindrokladium buxicola) were found with different intensiveness in Ajara forests during the period of 2006-2010. Against the climate change impact, this can cause extreme damages to the relict and endemic host species. Namely, the above mentioned box-tree disease has covered 55-65% of Kintrishi Reserve landscape during the recent 2-3 years (where temperature increase comprised 0.5^0 C, precipitation - 4% and humidity 0%). In Mtirala National Park box-tree disease has spread out on 60% of the total area (here the increase of temperature comprised 0^0 C, precipitation 5% and humidity 1%). Comparatively weak intensiveness is observed in the rivers Chorokhi, Machakhela and Acharistskali basins.

The conditions are also very tough in the coniferous forests of Ajara, namely, in Shuakhevi, Khulo and Kobuleti municipalities (Gomi mountain section). Currently 5 870 ha (13% of the total area) in the coniferous forests are either drying or cut and

fallen on the ground (421 000 m^3, i.e. 2.5% of the total storage). According to the data provided by Khulo meteorological station, the increase in temperature during the recent period has comprised 0.1^0C, of precipitation - 11% and of humidity - 0%, which in hot summer periods, together with spreading out of wreck-diseases, creates threat of fire.

The consequent effect is also methane that is spread in the air due to the decomposition of waste in the forests.

According to the results gained from Georgia's Third National Communication to UNFCCC, by the end of the current century increase of annual average temperature by 3.5^0C is expected in West Georgia due to the global warming process. This will support spread out of diseases in all Ajara regions. At the same time, during the current process of global warming in different regions of Georgia, as well as in Ajara, increase of extreme events (such as intensive precipitation, landslides, mudflows, etc) is noted. It is well known that one of the most effective means to combat these processes and reduce damage is phyto amelioration, which implies extension of forest cover and maintenance of the existing one. This will increase effectiveness of activities aimed at combating wreck-diseases in Ajara forests.

Among different wreck-diseases spread in Ajara forests, the following are the most distinguished due to their negative impacts:

- Ips typographus;
- Dendroctonus micans;
- Cryphonectria parasitica;
- (Cameraria ohridella Deschka);
- (Tischeria complanella Hb= Tischeria Ekebladellia Bjerkander);
- Cylindrokladium buxicola;
- Huantria cunea.

From the 7 above mentioned diseases 4 were first fixed in Ajara after 1995, namely in 1995-2008. Besides, new wreck-diseases pop-up on healthy woods; this needs to be timely identified, assessed and appropriate preventive measures should be taken.

6.1.4.2 Objective of the project

The objective of the project is to create monitoring system for prevention of intensive wreck-diseases increased due to climate change impacts in Ajara forests. The most part of Ajara forests, due to significant inclination of slopes, is equipped with soil protection and water regulation functions. Due to climate change impacts, supportive conditions are created for increased spreading of wreck-diseases in the forests. During recent 20 years, diseased areas significantly increased, preventive measures are needed to combat the process, namely, in short-term perspective, diseased and deteriorated trees should be liquidated and withdrawn from the forests, and in long-term perspective – establishment of monitoring system in required, which implies: preparation of experts to carry out research works on diseases vulnerable to climate

change impacts, provision of monitoring system with necessary equipment and also supply of special vehicles of high off-road capability.

Within the project implementation process, barriers to achieving project's targets will be identified and means to overcome those barriers will be determined. The main outcome of the project will be the demonstration of forestry management practice based on modern technologies and methods, support to reduction of GHGs emissions and elaboration of recommendations for the strategy on sustainable development of Ajara forestry sector.

6.1.4.3 Project implementation

Methodology

Methodology envisaged in the project implies introduction of several modern principles in Ajara forestry management. The methodology discusses the following stages: monitoring of diseases of plant-trees (including neighboring states and regions) via modern methods, study of international practice of disease treatment and adaptation it to Ajara conditions, demonstration of sustainable development principles of forestry sector, piloting of measures to reduce already revealed and expected impacts of climate change.

Activities

Within the project, establishment of monitoring system should be carried out via which research and assessment of risks of diseases' spread out will be possible. Effective mechanisms to combat wreck-diseases spread out in Ajara forests should be studied and established. This will ensure sustainability of forestry management in the future and will increase environment protection, and accordingly - economic function of forests. Preventive measures will be more effectively utilized in the future by means of using the recommendations on mechanisms and activities gained from the project implementation.

Specific actions to be taken within the project implementation:

1. Study of the best practices in the world for monitoring diseases vulnerable to climate change in forests and selection of the best option for Ajara forests;
2. Elaboration of strategy on rehabilitation of diseased areas in Ajara forests taking into consideration climate change impact;
3. Training/preparation of qualified foresters who are well-aware of diseases vulnerable to climate change and are able to prepare recommendations to reduce risks in this field;
4. Preparation of guidebook document on effective methodology on protection of forests from wreck-diseases based on the world's best practices;
5. Equip monitoring system with necessary stock and equipment as well as special high off-road ability vehicles;

6. In case the above-mentioned activity partially limits utilization of forests, the public awareness on using these forest areas should be raised. Namely, the population should be provided with the following information:

   - Importance and significance of curing diseased kinds in forests;
   - Advantage of the areas covered by forests in comparison to thinned out areas;
   - The role of forests in maintaining of soil and water protection functions;
   - Economic effectiveness of healthy forests in terms of tourism development process; by rehabilitation of forest areas the oxygen release sources will be increased; this will attract more visitors, who will be served by the local population; natural domestic products will be sold locally; this will improve economic conditions of the population;
   - Development of bee-keeping (apiculture) will be promoted;
   - Significance of indirect utilization of forests (effective usage of mushrooms, trees and plants, yield, curing plants).

7. Preparation of specific pilot projects taking into consideration conclusions of experienced scientists-entimologists and phyto-patologists.

6.1.4.4 Partners and beneficiaries

The partners of the project are:

- Legal entity of public law Ajara Forestry Agency (AFA) which will be the main implementor of the project, where monitoring system will be created and that will take responsibility to provide monitoring service with space, salaries and cover other costs needed for further functioning of the system;
- Forestry Institute which will provide the project with qualified personnel;
- Authorities of Ajara Government and local Municipalities, who have confirmed priority of soil protection functions of Ajara forests and importance of their maintenance among strategic priorities. The government is ready to support the project, as from the revision of legislation point of view (in case of need), as well as in other activities, namely, elaboration of strategy;
- Republic of Turkey, namely Artvin province and Artvin Forestry Department Georgian-Turkish forests border each other for more than 100 kilimeters, due to what both side are ready to jointly carry out monitoring activities and take preventive measures to combat wreck-diseases in the forests, also to share experience. Since 2005 Turkish side is implementing our pilot projects to combat diseases like American white butterfly, chestnuts cancer and other;

- Memorandum between Georgia and Turkey on cooperation in forestry economy and environment protection issues was signed on 5 December 2009.

The beneficiaries of the project are:

- Legal entity of public lawAFA, since the strategy and methodology to combat diseases vulnerable to climate change will be transferred to it;
- Forestry Institute that will get additional prospects/opportunities for additional research activities;
- Local population, since in terms of proper management and cleaning of forests, more lands will be protected against erosions and landslides;
- Local government authorities, since less problems will be created from forest fires and hazardous geological extreme events;
- Population of Ajara Autonomous Republic, since via reduction of wreck-diseases in the forests and improvement of healthy conditions in Ajara forests, continuous utilization of lands will be maintained.

6.1.4.5 Factors supporting project implementation

- Despite the fact that wreck-diseases are significantly increased and spread in Ajara, it is still possible to save healthy plants through natural self-renovation process;
- Huge soil protection importance and function of forestry in Ajara increases the potential of the project. Namely, the strategy of regional development of Ajara states that "investment to abolish wreck-diseases in Ajara forests should be attracted and stability of self-renovation process of forestry resources should be preserved in order to maintain biodiversity of forest ecosystems". Besides, the necessity of training of personnel is also suggested in the strategy for which "competence development/training of workforces employed in forestry sector is needed";
- Close cooperation with Republic of Turkey, namely with Artvin Disease Laboratory in order to reduce the risk of spreading of the diseases from one territory to another;
- Maximum involvement of local authorities and population into the activities related to forestry rehabilitation process.

6.1.4.6 Barriers to the project implementation

- In Georgia, especially in Ajara, forests are located on slopes that in most cases prevents withdrawal of unnecessary biomass from forests or makes such activities very expensive;
- Due to climate change new diseases emerged, combat of which was not always possible and available. That is why it is very important to use and

share foreign experience and make joint research (relationship with Turkey and other countries);

- Side effects of using chemical methods are not always known in advance, that might cause or lead to other damages to healthy kinds of trees (risk is especially large for endemic sorts);
- Insufficient local staff/personnel, which will have potential and wish to work and assimilate modern methodologies and technologies.

6.1.4.7 Factors supporting project implementation

The implementation of the project will require 2 years

Activities	Implementing agency	Terms of implementation in (months) and budget (USD)	Anticipated results
1. Study the best world practice for monitoring diseases vulnerable to climate change in forests and select the best option for Ajara forests	AFA, non-governmental sector (NGO), Forestry Agency of Georgia, foreign experts	6 40 000	Information is prepared on diseases vulnerable to climate change in order to prevent spread out of these diseases and combat climate change impacts in Ajara forests
2. Elaboration of strategy on rehabilitation of diseased areas in Ajara forests taking into consideration climate change impact	AFA, invited scientists (phyto-patologist, entomologist), NGOs.	8 50 000	The strategy on rehabilitation of diseased forests and protection is prepared
3. Training/preparation of qualified foresters who are well-aware of diseases vulnerable to climate change diseases and are able to prepare recommendations to reduce risks in this field	AFA, NGOs, research institutions working on the forestry issues/ sector, foreign experts	3 20 000	The barriers caused due to lack of qualified staff/personnel in forestry management are removed
4. Preparation of guidebook on effective methodology on protection of forests from wreck-diseases based on the world's best practices	Ajara Forestry Agency; Institute of Forestry	12 20 000	Guideline document on protection of forests from diseases vulnerable to climate change is prepared
5. Provide monitoring system with necessary stock and equipment and special off-road vehicles	Project management together with AFA	24 50 000	The equipment necessary for monitoring system is purchased

6.	In case the above-mentioned activity partially limits utilization of forests, the public awareness on using these forest areas should be raised, especially needed in case of limitation	AFA, non-governmental sector	24 10 000	The population is actively involved in the process of forestry protection and its effective utilization
7.	Preparation of specific pilot projects taking into consideration conclusions of experienced scientists-entimologists and phyto-patologies	AFA; institute of forestry, non-governmental sector	24 30 000	Minimum 5-7 pilot projects are prepared and submitted to different donors
8.	Total		220 000	

Thus, according to the project, creation of monitoring and adaptation service (group/ team), training of personnel, provision with special stock and transportation will cost 220 000 USD.

6.1.5 Ways of rehabilitation of degraded sub-alpine forests and increase of CO_2 removals

6.1.5.1 Description of the problem

The high mountainous sub-alpine forests in Ajara represent upper catchment of the river Ajaristskali and river Mtkvari (tributary to R. Kvabliani). Namely, river Ajaristkali takes source from Arsiani Range western slope and R. Kvabliani - at its eastern slope (Beshumi forest area). 133 444 ha, i.e. more than 70% out of 188 645 ha represent forests that have high environmental importance: 124 982 ha have soil protection and water regulating function, 2 003 ha belong to portable water basin zone and 6 459 ha are sub-alpine forests.

More than a half of the areas covered by forests – 55.9% - are located on the slopes that have inclination of 31 degrees or more. This implies that Ajara forests wood is only allowed to be used, when it is necessary to satisfy needs of local population.

Unfortunately, starting from 50-ies until 90-ies of the last century, in Ajara forests, as if for necessary governmental needs, wood material production and supply was planned. Supply was provided to Georgian regions and also to the former Soviet republics (for example, Keda forestry used to produce different details from beech tree and send them to Russia). At the same time, in order to simplify fulfillment of state plans, forests were cut at one and the same, easily reachable places. So-called collective forests were allocated to the local population and they could use those forests for satisfying their own needs on woods. From 1990 to 2004 with support of Ajara government, anyone could produce, import or sell timber from any place.

In reality, during the 50-ies of the last century, the population made timber the only

source for survival. Groups that produced timber were created and in order to compete with each other, they made abundant amount of timber and stock left unsold would decay in the forest. No attention was paid to the slopes of forests, abolishment of forest density, composition, etc. As a result, in most part of the forests, mainly where motor-road was built, beechen and fur groves were completely destroyed at the forest margins. Due to the fact that law enforcement bodies ignored breaches of the law on forest and in some cases supported illegal cuts, the syndrome of non-punishment was established in the population.

Due to the above described negative reasons and actions, the quality of the forests in low, as well as in sub-alpine zones, deteriorated, the forest was degraded. In sub-alpine zones there are sections, where the whole forests are cut and turned into alpine pastures; example of such case is section Katriani, located near Beshumi that is the neighboring area of the village of Tkhilvani in Khulo municipality, etc. For the last 50 years, the upper level of the sub-alpine forest that mainly consisted of spruce, beech and fir trees has lowered by 300-400 meters and the process still continues. Cut and thinned out forests have lost their main functions. Due to heavy rains and intensive melting of snow, landslides have been activated. As a result, the village of Tkhilvana in Khulo municipality is in the first line of dislocation zone (there were 142 families in Tkhilvana by 2000, afterwards 60 families have been evicted, though 135 families still inhabit on the mentioned area. Actually, the eviction was mainly carried out according to the households). Due to the above, most probably, the village will cease existing in the nearest 3-5 years.

Also due to the non-systematic and exceeded utilization of forests, landslides are activated in the neighboring areas of sub-alpine forests of Khulo municipality:

- In 1989 25 people died in the village of Tsablnari (with more than 250 households);
- In 1989 the villages of Skvana (with up to 100 households), Kalota (35 households) and Mtisubani (52 households) were attacked by landslides.

According to 2010 data, in Kobuleti, Keda, Shuakhevi and Khulo administrations (Gomi mountain, Goma, Chirukhi, Naplati, Mtsvane Tba, Goderzi Pass, Lodiziri, Sakambecho, Zankebi and others), density of sub-alpine forests on 2 790 ha from the total of 6 459 ha, decreased to 0.4-0.2 (0.1-0.2 is thinned out, 0.2-0.4 implies low density, 0.5-0.6 - average density, 0.7-0.9 - high density, 1.0 normal density). When density falls below 0.4, forest loses its protective and self-restoring functions. The normal average level is 04. The main reason of thin out of the forests is the exceeded utilization of forest during the past years through means like: using lands for pastures, cutting of trees (legal and illegal), utilization for heating and construction reasons or for agricultural reasons for annual plants (like potatoes, cabbage and greens). Due to this, the new shoots-growing trees do not exist anymore and there are only left old and ripe trees, which, according to the local legislation, as sub-alpine zone trees, belong to the special protection area and it is prohibited to cut them. But the forest experiences process of getting old and is losing its vitality. It is expected that, most probably, it will be lowered by hundreds of meters.

Photo 6.1.5.1. Subalpine forests

Permanent population of 84 villages that belong to 24 communities of Ajara (more than 6 000 households) utilize the sub-alpine forests and neighboring areas – each year they bring cattle to pastures for 3-4 months. These villages are:

- 3 villages of Machakhela community in Khelvachauri municipality;
- 13 villages of Merisi, October, Tsoniarisi and Tskhomorisi communities in Keda Municipality;
- 26 villages of Shuakhevi municipality's 7 communities;12 communities of Khulo municipality (Vashlovani, Dekanashvilebi, Dioiknisi, Riketi,

Didachara, Satsikhuri, Agara, Ghorjomi, Tkhilvana, Khikhaziri, Pushrukauli, Skhalta) – 42 villages;

- more than 45 000 tourist and locals visit Beshumi, Chirukhi and Goma mountains, namely: nomadic local people - 16 000 persons, and 29 000 tourists;
- The construction of touristic infrastructure has already been started and is in process in Khulo municipality, namely on Goderzi Pass to establish winter skiing resort. On Goma section under Shuakhevi municipality the thorough repair was made to the main road and construction of winter resort spot is planned.

Current data on average air temperature and precipitation on Goderzi Pass and the neighbouring area show that, in comparison to 1961-1985 during the period of 1986-2006:

- The average annual air temperature increased by 0.2^0 C and increase by more than 1.6^0 C for 2050;
- Current decrease in annual precipitation will be replaced by increase in precipitation and significant changes are not expected. The amount of precipitation increased by 14% for autumn season. The amount of precipitation will increase by 17% in spring season by the years 2021-2050;
- The amount of hot days (Tmax >25°C) increased by 11 days, but we do not have any serious increase in either temperature or occurance of hot days in winter; no changes are forecasted in this regard in the future as well;
- Daily maximum sum of precipitation increased by 15 mm and rainy days will continue to increase in the future as well;
- Annual sum of abundant precipitation days (≥90 mm) increased by 1 day and more increase is expected;
- During the discussed period significant increase is noted in severe and extreme hydrological draughts, that seriously damages soils.

As a result, negative impacts of climate change, such as long-lasting draughts, simultaneous intensive precipitation, floods and torrent flows cause erosion of soils and promote the activation of landslides. Degradation of forests takes place and this creates serious risk to the removals of CO_2.

In consequent years, if prevention measures are not taken, the expected results will even more activate soil erosions in the thinned out sub-alpine forests; landslides will become more frequent; degraded areas will increase and the forest cover will be lowered.

The mentioned areas have self-restoration function, but during the summer period pastures are intensively grazed by the cattle, this completely destroys new-born plants, and impedes natural maintenance of forest growth; walking paths for cattle are being made and as a result, due to heavy rains and melting of snow, the process of soil wash-down is simplified.

6.1.5.2 Objective of the project

In order to stop the above mentioned processes of degradation and abolishment of the sub-alpine forest, without limiting the local population in their traditional nomadic life and economy activities, and at the same time, support development of tourism, there are two options. Mainly:

1. In the places, where there are signs of natural regeneration of sub-alpine forests, pasturizing process should be temporarily limited, for this purpose the thinned out areas should be fenced, temporary water regulating canals should be arranged for excessive water control during heavy rains and other activities related to natural renovation of forest should be carried out;
2. Planting of artificial forest on the areas of the abolished forests. For these reason, it is important to fence thinned out areas and start cultivation of forest plants. It is possible and even better to make these trees the source of energy and provide local population with these trees in an organized way so that the forest is maintained and risks for land erosion are decreased.

Accordingly, the project will have two sub-components: support to natural regeneration of the degraded forest area (111 ha) and cultivation of artificial forest on the old abolished forest area (20 ha). Both components have numerous common barriers and the project will be focused on eliminating the barriers.

The objective of the project is to define through practical testing if it is possible to regenerate thinned out forests and to cultivate artifical forests on those sub-alpine areas, where forests existed in past. Where are the barriers and how these barriers should be prevented. The final outcome of the project will be demonstration of management practice with modern methods, support in increase of GHGs' absorbtion and provision of recommendations for strategy of forest sector'ssustainable development in Ajara.

In the framework of the project, recommendations should be issued for the proper management of those forests (based on the sustainable development principles) that are widely used by the Ajara mountainous region. The project has to demonstrate how population should be involved in this rehabilitation process, in a way that they do not lose their existing source and on the contrary, economic situation is improved as a result of temporary limitations. Within the project, establishment of the best forestry management practices should be introduced. For these purposes, the barriers preventing implementation process should be assessed and the ways to remove these barriers should be found and piloted. According to the results of the project, the strategy of development of forest sector in Ajara will be prepared.

The reforestation activity embraces 20 ha of sub-alpine zone (second option), where, in place of former beech tree forest, a new artificial forest should be planted. Most probably, beech tree will be considered a priority, since these species had already existed on that area, though during this process not only origin of species should be considered, but also its resistance to soil protection and resilience to climate change impacts. This component requests more costs since activities should be carried out,

namely: in addition to fencing, arrangement of planting areas will be needed. Newborn plant, before implanting to soil, might be easily damaged due to snow cover and it will be necessary to make supportive fixing for the plants. The percentage of plants that take root in winter and summer will be significantly low due to external changes in temperature. Due to this, it will be necessary to refill the territory with new plants.

As for the first option (natural regeneration of 111 ha of thinned out forest), the forest offered for the rehabilitation pilot project still has the ability of self-renovation, accordingly, rehabilitation of such forests will be much easier, cheaper and more reliable.

Photo 6.1.5.2. Natural baby plants in beech forest damaged by the cattle

The project implies that the part of population, who uses the forest will be actively involved in the process of rehabilitation of degraded sub-alpine forests via self-restoration. Rehabilitation process includes fencing and periodic cultivation of the forest. It will be important to raise the awareness of the population as well.

111 ha of forest located in Khulo municipality, in the environs of Goderzi Pass, Green Lake and Beshumi spa was selected as first sub-component of the pilot project. This place is actively used by the population and visitors/tourists. The construction of skiing complex is in process. It represents thinned out degraded beech tree forest located on 111 ha, on different 8 micro-sectors. At the adjacent territories 1 846 ha is covered by the forest and 3 500 ha contains alpine pastures.

The selected 111 ha comprises 2% of 346 ha of forests and pastures and the sections, where tree felling has not been used since 2004 as it is prohibited by the law. So this will not prevent the local population and visitors. Rehabilitation of this forest will support construction process of skiing complex and development of tourism sector in the area.

As it was mentioned above, the second sub-component of the project implies artificial reforestation via planting of forest trees at the 20 ha area that was formerly covered by natural pine-tree forest. This area belongs to the Khulo Forestry Administration's Zegani plot occupying the vicinities of Beshumi Resort. Only some trees remain now at this territory. 50 years ago a grove consisting of spruce, fir and pine trees was standing in beauty here.

6.1.5.3 Project implementation

Methodology

The project methodology implies introduction of several modern principles into the forestry management. The methodology considers the following stages: study of the modern international practice on forestry management and adaptation to Georgian reality, demonstration of sustainable development principles of forestry sector on pilot areas (implementation of specific pilot projects), maximum of involvement of the stakeholders into the process of forestry management.

Also good examples of the past experience would be considered, for instance, in the 70-ies of the last century, in the neighboring area of the pilot project, natural rehabilitation of forest was carried out on the 25 ha of area (it was fenced from pasturing for 10-15 years), where new baby-born plants reached 2-3 meters of height. As a result we got mixture of beech, fir and pine trees forest and the natural renovation of the forest is ongoing (please see the photo), though during the implementation of this activity, the fencing of reforested territory did not oppose the interest of local population.

Photo 6.1.5.3. Beech forest naturally regenerated as a result of fencing

Activities

Demonstration of rehabilitation activities for the thinned out and cut forests should be made via project, when all the interested parties make contributions and get benefits from the project. Effective mechanisms for maintenance and renovation of forests in Ajara should be carried out within the project. These mechanisms will ensure sustainability of processes in the future and will increase environmental functions of the forests. By using these mechanisms and recommendations, further rehabilitation activities will be carried out more effectively and in a better way.

As a result of complete implementation of the project (rehabilitation of 2 790 ha thinned out forest), additional absorption of more than 21 000 tons of CO_2 and release of up to 45 000 tons of oxygen will be carried out. This will definitely contribute to the mitigation of global warming and will support improvement of local climatic conditions.

In particular the following activities should be taken:

1. Study of the best forest management practices, selection of the most appropriate one for Ajara forests through consultations with the interested parties;
2. Search for alternative fuel and suggest it to the population; preparation of the similar alternations for rehabilitation of other damaged forest areas;
3. Preparation of qualified staff in forest sector for proper management in terms of climate change;
4. Regulation of issues related to the utilization of forests;
5. Elaboration of strategy for the rehabilitation of degraded areas of Ajara forests taking into consideration the impacts of climate change;
6. Preparation of recommendations on methodologies on effective rehabilitation of forests. Finding a solution to the question: self-renovation is better in terms of current climate change conditions, or planting out a new forest with adapted species;
7. Prior to the implementation of the above activities, it is reasonable to rise awareness among the population that is utilizing this forest area, namely:

    - Advantage of areas covered by forest against areas, not covered by trees/forests;
    - The role of forests in maintenance of soil and water protection functions;
    - Economic efficiency of maintenance of healthy forests for the development of tourism; due to rehabilitated areas, the oxygen release source will be increased; it will attract more visitors, who will be served by the local population. Local products will be sold, this will, on the other hand, improve material conditions of the local population;
    - Importance of usage of forest indirectly – meaning utilization of soil upper cover (mushrooms, fruit, etc.).

8. Implementation of the pilot project. Fencing of forests in order to protect it from grazing, since it prevents the rehabilitation process of the forest. Fencing of the mentioned areas for at least 10 years will support growth of natural plants for up to 2.0-2.5 meters; fencing will prevent cattle from damaging the forest by grazing;
9. Planting of new forest on 20 ha area, where it used to be forest, but is currently completely destroyed;
10. Rehabilitation of eroded lands through consultations with geologists (if needed) on the pilot project area.

6.1.5.4 Partners and beneficiaries

Partners and beneficiaries of this project are:

- Population of Khulo municipality – by gradual rehabilitation of forests, non-stop utilization of forest areas will be maintained, after certain years renovated forest will be returned to the population for utilization;
- During the implementation process, local population will be intensively involved in fencing, soil preparation and maintenance works. 50 working places will be created during the first year, during the following 10 years 16 working places will be created seasonally per annum;
- The population and visitors will have more direct and indirect profits – gathering of mushrooms and wild fruits, medical plants, gathering of seeds, etc.;
- Through the project implementation the public awareness will be raised in regards to utilizing of forests by multiple functions;
- Visitors – the source of oxygen release will be increased, the tourism sector will be developed;
- Skiing fans – the skiing base is being constructed on Goderzi Pass. The rehabilitated forests along the ski routes will prevent soils from erosions, decrease landslides and will attract more visitors;
- The government will maintain those areas, that might become unusable in the future;
- The risks will significantly be decreased for private sectors involved into the tourism business;
- Rehabilitation of sub-alpine forests has significant impact in the research-educational sector.

6.1.5.5 Factors supporting project implementation

Supportive factors for the implementation of adaptation measures are:

- Existing low-density groves of ripe trees producing seeds, through which natural planting will be made;

- The selected areas represent upper boundary of the sub-alpine forests and in accordance with the local law, cutting of forests and pasturing are prohibited up to 300 meters from the border;
- Involvement of local authorities and population into the process of rehabilitation of sub-alpine zones;
- It is necessary to suggest population alternatives in exchange of any kind of restrictions; for instance, in exchange of limitation in utilization of fenced part of the forest, the population will be offered nearby forest areas for wood use, such as Zegni forest section #16-23, also neighboring areas of Adigeni forests. One of the alternatives is withdrawal of abandoned biomass from forests through private sector or Legal Entity of Public Law (LEPL) "Ajara Forestry Agency" (AFA) and to provide it to the population.

6.1.5.6 Barriers to the project implementation

The barriers preventing adaptation*:*

- Neighboring population of the selected area might express complaints on reduction of pastures due to fencing, though, as mentioned above, 111 ha of selected area is 2% of the total area of 5 346 ha (111/5 346=0.02, 2%);
- For the time being, the issue of alternative fuel and pastures has not been studied yet. It should be settled within the project implementation process;
- The areas allocated for the tourists and visitors will be limited, though it should be clearly explained that these areas will be temporarily protected and after years they will be returned to population in a better, rehabilitated condition;
- The local mountain population have seasonal houses in the sub-alpine areas (precise number is not known yet, tentatively, that is about 100 houses not included into the selected 111 ha), but they have kitchen gardens for different kind of annual plants; Accordingly, if these areas will be covered by the pilot project, so they will have to give up these lands. The problem should be solved through suggesting alternative plots to the population;
- It is also very important to note, that qualified staff in the forest sector has decreased during the last years, who possess relevant knowledge and experience in this regard;
- Also, very important problem is issues related to the historical ownership of lands between the communities and villages;
- In some places rehabilitation of landslided areas might become necessary before the forest rehabilitation works are carried out. Consultations with geologists are necessary on this subject.

Lack of attention to the gradual degradation of sub-alpine forests during the multiple years has led the forest to the condition that the upper layers of the sub-alpine forest are under high pressure from the population side. The AFA has no financial ability to carry out rehabilitation works independently. Even though this problem is included into the development strategy, this issue is still outstanding. The main problem still

remains related to the physical protection of forests and provision of local population with fire wood. At present, due to the lack of financial means, the construction of forest roads is financed by the Ajara Government.

The more time passes the more areas of sub-alpine forest is lost. In the coming years, if adaptation measures are not taken, the situation will aggravate even more – the soils will be completely degraded and their rehabilitation will become more difficult.

6.1.5.7 Implementation activities and budget

The removal of above-mentioned barriers should be demonstrated via implementation of two small-scale pilot projects: First – rehabilitation of 111 ha of thin out forest and the second – cultivation of new forest on 20 ha. The duration of the project is two years in total, out of which 1 year is envisaged for implementation of pilot projects.

Activities	Implementing agency	Terms of implementation (in months)* and budget (USD)	Anticipated results
Preparation of strategy for the rehabilitation of Ajara forests and introduction of modern management system			
1. Study of the best practices for forest management, selection of the most appropriate option for Ajara through consultations with each interested party	AFA, non-governmental sector, Forestry Department of Georgia	3 25 000	Specific ground is prepared for Ajara forestry development strategy
2. Finding alternative fuel (or forest areas) and suggesting it to the population. Preparation of the alternative plan for rehabilitation processes of other forests	Legal entity of public law jara forestry agency, NGOs, Khulo municipality	4 5 000 (this amount refers to research works to study the issue, but the actual cost will be defined during the process)	The barrier is removed for the population utilizing the forests
3. Preparation of qualified local staff in forestry sector for proper forest management in terms of climate change;	AFA, research institutions working on the forestry issues, foreign experts	3 30 000	The barrier caused due to insufficient personnel in modern forestry management is removed

4. Regulation of issues related to utilization of forest	AFA, Ajara's Supreme Board	5 50 000	The barriers preventing proper effective forest management will be removed, so that protective functions of the forests are maintained
5. Elaboration of strategy for the restoration of degraded forest areas in Ajara taking into consideration climate change impacts/issues	AFA, project management	24 70 000	The strategy will promote to attract new investments and projects
6. Preparation of recommendations on the methodologies for effective rehabilitation of forests: is self-renovation better to do in terms of climate change or via cultivation of new forests by selecting the adapted brands.	AFA	24 3 000	These recommendations will be issued based on the results of implemented project proposals
7.Rehabilitation of eroded soils through consultations with geologists on the pilot areas within pilot/ demonstration project (upon request)	Geological Unit of Ajara, Directorate for Environment and Natural Resources, Soil ProtectionService	The expenses for this component are not currently included into the project costs	Risk of failure of pilot projects will be decreased
8.Raise of public awareness on utilizing pilot project forests	AFA, non-governmental agency	24 30 000	The population is actively involved in issues related to protection of forests and their effective economic utilization
9.Implementation of 2 pilot proposals (please see details below)	AFA, Khulo municipality, population utilizing forest areas	12 months (main works) 111 ha rehabilitated area (133 400) 12 months (main works) 20ha planting/ cultivation of new forest (223 500)	- forest cover will protect baby plants from frost; - sub-alpine forest areas will be maintained; - absorption of CO_2 will be significantly increased; - erosion and landslide processes will be ceased ; - negative impacts of climate change will be mitigated; - recreation areas will be increased

Pilot project for rehabilitation of 111 ha of degraded forest			
10. Purchase of barbed wire fence and fencing	AFA, Khulo municipality, population utilizing forest areas	4 61 400	Protection of area from the cattle
11.Purchase of fixing poles and fixing	AFA, Khulo municipality, population utilizing forest areas	4 50 000	Protection of plants from snow and high winds
12.Preparation of soil	AFA, Khulo municipality, population utilizing forest areas	5 13 000	Increase of striking root of plants and prevention of project from failing
13.Transportation costs	AFA, Khulo municipality, population utilizing forest areas	12 9 000	
14.Spring rehabilitation works (during the next 10 years)	AFA, Khulo municipality, population utilizing forest areas	4 44 000	The plants are brought to the condition when no additional protection is needed
Pilot project for foresting of 20 ha area			
15.Purchase of barbed wire fence and fencing	AFA, Khulo municipality, population utilizing forest areas	4 10 500	Protection of area from the cattle
16.Purchase of fixing poles and fixing	AFA, Khulo municipality, population utilizing forest areas	4 10 000	Protection of plants from snow and strong winds
17.Cultivation of plants (or purchase) and planting Pine-trees (100 000), maples (55 000), birch (55 000)	AFA, Khulo municipality, population utilizing forest areas	12 130 000	Saplings are planted on the selected area
18.Making of holes (0.5 m-0.5 m per 1 ha) 10 000 holes	AFA, Khulo municipality, population utilizing forest areas	2 40 000	Holes are prepared to plant saplings
19.Transportation costs	AFA, Khulo municipality, population utilizing forest areas	12 2 000	
20.Spring rehabilitation works (during the next 10 years)	AFA, Khulo municipality, population utilizing forest areas	10 years 31 000	Saplings are brought to the condition when no additional protection is needed

According to the project, rehabilitation of 111 ha will cost in total 133 400 USD, on the average 1 200 USD per ha (soil rehabilitation cost is not included). After fencing, 32.93% of the total maintenance expenses will be covered by the Ajara Forestry Agency (AFA) (44 000 USD); Cultivation of 20 ha of pine trees (fencing, cultivation of plants, planting, maintenance and protection during10 years) will cost 223 500 USD, on the average 11 200 USD per ha.

After fencing, the 47% of total maintenance costs (14%-31 000 USD renovation of fencing and maintenance during 10 years, 50% i.e. 75 000 USD (33% of the total cost) will be covered by the AFA.

6.1.6. Reduction of negative impacts of climate change on stream trout population within the protected areas of Ajara and its neighborhood

6.1.6.1 Description of the problem

Stream trout (Salmo labrax fario *Linnaeus, 1758, please see photo #6.1.10) represents Black sea inhabitant form of the Black sea salmon (Salmo labrax Pallas, 1811, photo # 6.1.11).* It is included into the red list of Georgia, with protective status: subject for inclusion into the red list of VU (vulnerable) is caused due to significant decrease of its form during the recent years. According to the experts, the population of trout has been decreased by 3 times during the last 20 years. The decrease is especially shown on those parts of the rivers with altitude of 600 meters from the sea level.

Historically, stream trout (together with its black sea salmon form) represented the most important and expensive forms of fish in the rivers of Kintrishi, Chakvistskali, Korolistskali, Machakhlitskali. Condition for reproduction and multiplication, also for getting weight was caused due to ideal hydrological, hydro chemical and hydro physical distinguishers. The stream trout played important role in the bio productivity of the rivers, keeping balances of substance and stream energy affecting and resulting in sustainability of the eco-system.

The significant decrease of the above-mentioned charismatic forms is noted during the last years. The reasons are different: illegal fishing (catching), regulation of rivers and climate change impacts.

Most of sections of trout in the rivers Machakhlistskali, Kintrishi, Chakvistskali and Korolistskali are within the protected areas (Mtirala and Machakhela National Parks, Kintrishhi protected areas).

According to existing data, it has become clear that the average air temperature and precipitation during multiple years in the mentioned river basins during 1986-2006 compared to 1961-1985 have been changed in the following way (on the example of Keda, which is the closest to the localities from the climate change point of view):

- The average annual air temperature has increased by 0.5^0C and will tentatively increase by 1.7^oC by 2050;

- Annual precipitation has increased by 16% and will tentatively increase by additional 2%;
- The total amount of hot days (Tmax>25°C) has increased by 473 days compared to the first analogical period;
- Severe and extreme hydrological draughts have significantly increased;

The stream trout form belongs to the cold water fish, maximal margin of water temperature should be 12-14°C, and optimal should vary between 8-16^{0}C. For the new-born trout this indicator is even lower than it should be. The oxygen level in water equals to 9.5-12.5 mg/liter. The area of the mentioned localities with such thermal and oxygenic regime taking into consideration current climate change impacts, especially in hot months (July-September), is quite limited and, considering the current tendencies, will most probably increase in the future as well. During July-September the total mass of the stream trout is gathered in the upper parts and streams of the mentioned rivers, where the existing space and food basis is quite limited. In the hottest years (for example in 2012) they move even upper, to the beginnings of the rivers. In such cases space and food is even more limited and results in damaging of new-born trout. This causes the main factor for reduction of multiplication of stream trout.

Photo 6.1.6.1. Stream trout

Photo 6.1.6.2. Black Sea Salmon

6.1.6.2 Objective of the project

The objective of the project is to support natural reproduction of stream trout within the protected areas of Ajara and its neighbourhood via reduction of negative impacts caused by climate change.

To achieve the above goal, following problems should be settled:

- Creation of center for artificial reproduction of stream trout;
- Formation of demystified herd from the local genetic fund;
- Periodic restocking of stream trout (in the rivers of Machakhlitskali, Kitrishi, Chakvistskali and Korolistskali).

6.1.6.3 Implementation of the project

Methodology

The stream trout of the lower Ajara Rivers reproduces mostly in the months of November-December, sometimes even in January (different upper Ajara Rivers, where reproduction starts approximately one month earlier. Incubation period of spain lasts approximately 45 days, incubated larva is passively fed by spain park for up to 25 days, i.e. baby fish are born in January. In the middle of the water temperature peak (middle of August) baby stream trout reach about 4 grams, with length up to 6 centimeters. Baby fish of this size is easily reachable for big fish, as only trout reaching up to 10 centimeters are not vulnerable to the attacks of the big fish.

In case of artificial conditions, maturing of stream trout is done in September by thermal and gonadrotropical stimulation, i.e. 2-3 months earlier compared to the natural conditions, trout babies will be born by the end of November, i.e. 2-3 months earlier than usual. By growing with additional 2-3 months in artificial conditions – by

February we shall get new-born up to 6 grams. In case of their release into the nature (rivers), they will reach 10 grams in weight and 10 centimeters in length by the time of temperature peak. With these measures we shall be able to avoid abolishment of trout babies born in huge amounts in the concentration areas during July-September.

In order to reduce negative impacts on trout multiplication caused due to climate change within the Ajara protected areas and in the neighborhood it will be necessary to create center of artificial production of trout. Thermal stimulation gives the trout fish roe in September and restocking will be done in February for the trout that reaches 6 grams.

Activities

Task #1 – creation of center for artificial reproduction of stream trout

1.1. Selection of area for establishment of center for artificial production of trout (in the neighborhood of the protected areas). For this reason, it will be needed to make special research to find special sections with relevant hydrological, hydro chemical and hydro physical indicators;
1.2. Projecting of the center; registration and legalization of the relevant documentation (licenses and permits for the construction);
1.3. Construction of the center: construction of water-gathering station, basins (for breeding, repairs, quarantine and growing), incubation factories, water release channels, construction of administrative, extra and storage buildings, etc;
1.4. Procurement of relevant inventory, nets for catch fishing and transportation means for fresh fish;
1.5. recruitment of qualified personnel.

Task #2 – formation of domestified herd from local genetic fond

1.1. Obtaining of relevant permit to catch production fish (the permits on the forms of trout included into the red list are issued by the Ministry of Environmental Protection of Georgia;
1.2. Catching of production trout in the rivers of Machakhlitskali and Kintrishi, no more than 500 units;
1.3. Transferring (transportation) of production trout into the artificial center and preparation to pre-adaptation.

Task #3 – periodic restocking of stream trout (in the rivers Machakhlistskali, Kintrishi, Chakvistskali, and korolistskali)

3.1 Maturing of production fish;
3.2 Getting fish roe and fecundation (September);
3.3 Incubation of roe/spain (September –October);
3.4 Incubation of larva (October-November);
3.5 Growing up of baby-borns (November-January);
3.6 Release of new borns into the rivers (February), at least 80 000 units per annum.

6.1.6.4 Partners and beneficiaries:

Partners:

- Department of Environmental Protection and Natural Resources of Ajara (allocation of land plot needed for creation of the center, - if the plot selected is located on the territory of forest fund);
- Administration of Khelvachauri and Kobuleti Municipalities (allocation of land plots needed for creation of center);
- Administration of Mtirala and Machakhela National Parks, Administration of Kintrishi protected areas;
- Ministry of Environment protection (issuance of license and permits for fish catching, control of illegal catching).

Beneficiaries:

- Population of Khelvachauri and Kobuleti Municipality (through the project implementation more visitors will be attracted);
- Administration of Mtirala and Machakhela National parks (through the project implementation, the mentioned municipalities will attract more visitors, bio-conservative value of the protected areas will be increased);
- Touristic agencies;
- Scientific and educational institutions.

6.1.6.5 Supporting factors for project implementation

Supporting factors are:

- In the rivers of Machakhlistskali, Kintrishi, Chakvistskali and Korolistskali it is still possible to gain/find stream trout and Black Sea salmon for production center;
- Hydrological, hydro chemical and hydro physical regime is acceptable for growth of stream trout;
- The most part of the stream trout sections of the rivers Machakhlistskali, Kintrishi, Chakvistskali and Korolistsali are located within the protected areas;
- There is a huge interest from the side of the local population and local management bodies towards rehabilitation/renovation of the mentioned sort of stream trout (it is possible to make permits after relevant changes in legislation only in case of sports and amateur fishing). This will significantly increase amount of visitors.

6.1.6.6 Barriers to the project implementation

- There is significant lack of qualified personnel having experience and knowledge in the fish economy field;
- Notwithstanding the fact that stream trout is included in the red list and attempts of control by the local environment protection bodies, there still are multiple cases of illegal catching of the trout, though it should be mentioned that such cases are not so often;
- There is a functional hydro plant on the river of Machakhlistskali (please see photo below), the effectiveness and influence on trout population has not been studied yet.

Photo 6.1.6.3. Hydro electrical plant of Machakhlistskali

6.1.6.7 Stages of implementation and costs:

Duration of the project: 2 years (+ 10 years on self-financing).

Tentative budget: 391 000 $.

Production center will get additional income after increase of trout to commercial size and its realization. Also from realization of cultural form of the trout (rainbow trout), this will support existence of the center during the next 10 years.

Actions	Implementing agency	Terms of implementation (in months) and budget (in USD)	Anticipated results
1.Selection of the territory for creation of production center	Local body of the protected areas together with the municipality	3 6 000	The area has been selected
2. projecting of the production center	Project management together with local bodies of the protected areas	3 6 000	The project is approved
3. construction of the production center	Project management, Construction company selected by the tender	12 220 000	The construction of the center is completed
4. procurement of relevant inventory and equipment	Project management together with the local body of the protected areas	4 80 000	Relevant equipment and inventory is purchased
5. recruitment of personnel	Local body of the protected areas	3 Is included into the management costs	Personnel of the center is recruited
6. gaining of special permit for catching the production fish	Local bodies of the protected areas, unit of environment protection and natural resources of Ajara, Ministry of Environment Protection of Georgia	3 Is included into the management costs	The permit from the Ministry of Environment Protection is gained to catch productive fish (for reproduction and multiplication needs)
7. procurement of catching nets and other necessary equipment needed for catching of production fish	Project management together with the local bodies of the protected areas	3 15 000	Relevant equipment is purchased

8. catching of production fish	Production center	4 20 000	We have 500 producers at the center
9. transfer of production fish to the center	Production center	4 6 000	
10. maturing of the production fish	Production center	7 5 000	Minimum 100 000 larva is gained
11. getting of roe and fecundation	Production center	3 2 000	
12. incubation of roe	Production center	3 3 000	
13. Incubation of larva	Production center	3 3 000	
14. growing of baby trout	Production center	4 15 000	New-borns are released in the rivers of Kintrishi, Machakhlistskali, Chakvistskali and Korolistskali.
15. release of baby trout into the rivers	Production center	3 10 000	

6.1.7 Piloting the establishment of farmers' union in Khala community (Kobuleti Municipality)

6.1.7.1 Description of the problem

The territory of Ajara is highly dismembered and most part of it is occupied by slopes having inclination of more than 10^0. Only 25.1% of the whole territory is used for agricultural purposes. The population in Ajara is very densely located, so agricultural land per person comprises 1.18 ha, arable land - 0.3 ha. The majority of population does not have private land plots, though the agricultural land in those, who have lands, varies from 0.2-0.5 ha. The anthropogenic pressure is quite serious on the agricultural areas and that is why it is important to reduce additional risks in agrarian sector that might be caused due to climate change. This concerns rise of temperature, increase of intensiveness of precipitation and growth in number of precipitation days. The mentioned reduction of risks will greatly assist in sustainable development of agricultural sector.

In 1990-ies decentralization and cancelation of collective economies were carried out in an incorrect, unplanned way, in other words - no relative transformation with alternative forms of farmers unions adopted in the whole world was applied. This caused degradation and ruin of family economies.

The degradation of collective economies was not followed by the establishment of alternative forms of land management. As a result, currently, there is no active form for collective economy, due to what farmers have to deal with agriculture separately, solely and not consider risk factors, including threats caused by climate change. The farmers do not possess relevant knowledge and information on the impacts caused

due to climate change in agriculture; they do not know what methods to use against the changes or how to prevent risks and threats. Private economies of population lack the information and methodology that was specially elaborated and provided to and for them during the Soviet times. Prevention and reduction of current risks, including climate change risks, is possible and would be more effective in the terms of establishment of farmers' unions, that would facilitate the mitigation of negative impacts caused due to climate change and would benefit to joint solution of problems that farmers are facing.

Assessment of climate change was made for Ajara region according to municipalities during the Third National Communication. This assessment outlined that the most vulnerable municipalities were Kobuleti and Keda, in future – Kobuleti and Khelvachauri. At the current stage, while making the forecast, it was admitted that everything might remain the same, only climatic parameters will changed and Kobuleti will still remain on top. At this stage while making future forecast, it was assumed that everything might remain unchanged and only climatic parameters would be changed and that Kobuleti would still keep the first place. There are 16 545 households and most of the farmers (2 115) are the ones possessing 0.06 ha and less land plots. The amount of farmers possessing 1-1.99 ha and more than 2 ha is very low (206 and 35 accordingly). This is the main characteristic that defines the vulnerability of this region, or else Khelvachauri region is much more vulnerable to climate change. The ability of adaptation of the Kobuleti municipality is very low just due to the low amount of land plots. Due to this reason, Kobuleti municipality was chosen as pilot municipality.

6.1.7.2 Objective of the project

The objective of the project is to create, via joint work and consultations with local farmers, scientists and business community, single chain based on international experience of other developed countries and on native traditions and potential of local economy taking into consideration climate change and its impact on agriculture. Through this the optimal model of incorporated farmers' union will be elaborated and member families will be able to effectively protect themselves from the negative impacts of climate change, increase productivity, effectively manage labor and intellectual resources, and benefit from the profit that will be related to the improvement of production, processing, storage and realization, taking into consideration climate change impact (especially on storage of harvest, quality of product, etc.).

The goal of the project is to voluntarily unite farmers involved into the community in order to jointly solve their problems. Those problems, which cannot be solved on one farmers' level, due to their complexity and expensiveness to combat them, should be highlighted. These problems are: climate change resulting in altering of local climatic parameters (like temperature, precipitation and its intensiveness, vegetation period, freezing, etc.); land erosion and decrease of productivity; market research; assessment of other risks preventing effective processing of agriculture. Joint implementation of recommendations in risk reduction process will significantly decrease risks/threats and costs.

It will be necessary to establish consultation centers and other services during this process, also development support. Namely these services are: development of infrastructure needed for sustainability of agricultural development in general (processing and realization objects); land inventory; research of soil and plants, etc. The outcome of the project should result in the increase of farmers' income, improvement of their social conditions and retention of youth in the villages.

The project is oriented to create supportive environment for agribusiness development in Ajara region, on usage of modern agro and processing technologies, development of agro-tourism, introduction of progressive forms and methods of agribusiness organization. Through the project implementation example of development of sustainable agriculture for separate municipalities will be demonstrated. This will greatly contribute to tourism development.

The Khala community in Kobuleti municipality was chosen as the project pilot community. This community covers only 1 875 ha of area, among which 688 ha is agricultural land; maximum amount of land owned by the farmers comprises 0.5 ha (approximately 50-60 households), the rest land plots cover 0.1-0.25 ha of land. Due to the climate changes agricultural lands/areas have decreased by up to 175 ha for the last ten years (landslides, mudflows, erosions). The population is densely settled and runs small-scale economies. Unfortunately, most of them do not possess relevant knowledge regarding usage of land resources in agriculture correctly. For instance, the selected community is located on the area with abundant precipitation (on the average the annual precipitation comprises 2 400 mm, amount of precipitation has been increased by 4% during the last 25 years, mainly on autumn-winter season, the amount of days with intensive precipitation also increased). Due to the abundant precipitation the soils are washed out, the land is exhausted due to insufficient nutrition elements needed for land. Appropriate preventive measures are not taken that is directly linked to the development of landslides processes, mudflows and decrease of agricultural lands area. The current changes at this territory negatively affect growth and development of plants, crops, harvest and its quality. Accordingly, farmers' harvest is not competitive and faces difficulties in realization. The motivation among the farmers is being lost and incomes are decreased.

The Khala community selected by us unites about 1 000 households for whom the main agricultural crops are citrus and subtropical fruit and fruit growing, vegetable growing and cattle-breeding being used as auxiliary sources. The objective of the project is to unite farmers and jointly solve their common problems. For example:

1. Protection and fertilization of soil. Due to climate change during the recent years direct effect of precipitation is extensively apparent on soils. The optimal system for soil protection and fertilization will be elaborated. The soils will be examined against main elements and indicators (humus N;P;K;PH) after what the farmers will be provided with relevant and precise recommendations;
2. Combat the plant diseases. Climate change has significantly increased damages of plants by the insects. To combat this problem and take preventive measures, optimal method will be elaborated within the project

taking into consideration consultations with the specialists in this field.

3. Enhancement of agro-technical activities. Optimal management of climatic factors is mainly connected to the growth and development of the plants. Thick crown of plants prevents optimal lighting and aeration around the plant that is directly linked to accumulation of necessary temperature for ripeness of plants, accordingly, the harvest time comes late and the crops are of low quality. The farmers will be provided with optimal recommendations to solve the mentioned problems.

The project also envisages regulation of other problems caused by changes.

The project will be focused on creation of supporting environment for the development of agribusiness, also on usage of modern agro and processing technologies; tourism development; introduction of progressive forms and methods into production. Within the project, example of sustainable development for specific municipalities will be demonstrated, contribution of which in tourism development might be significant.

In the process of formation of farmers' unions, it is very important to search and highlight their common problems, especially focusing on one main problem, so that they can jointly deal with it. For 1 000 households selected in Kobuleti municipality, such challenge is the reduction of climate change impacts, combating of which is difficult even for large and strong states and farmers. During the process of establishment of unions, it is also very important that the farmers realize risks and can clearly see the positive results gained from these kinds of unions. They should have a clear picture how to distribute these risks and support each other. The project also envisages implementation of such works that will support optimal growth of various crops on different agricultural lands, increase of soil productivity, establishment of modern agro-technologies, marketing research, and agro-tourism development. All the mentioned activities will separately be examined taking into consideration the current trends of climate change.

In the framework of the project the problems described above will be addressed: by using existing potential to the maximum extent; by jointly overcoming common problems of family economies; by demonstrating the necessity of modern technologies and by giving trainings and consultations to farmers.

6.1.7.3 Project implementation

Methodology

The main methodology of the project implies: study of international practice of farmers' unions and its adaptation to Georgian conditions; assessment of climate change impact on agricultural production on the pilot area and establishment of risk reduction activities, search for modern technologies and strengthening of local service centers' potential.

Activities

The following actions are planned to be carried out within the project:

- Study and analysis of various forms of farmers' unions in leading countries and preparation of recommendations for Georgia, precisely for Khala community pilot families (1 000 families in Kobuleti municipality, total area 1 875 ha, out of which 688 ha belongs to agricultural land);
- Preparation of pilot population for implementing the above recommendations. Every step should be planned and made in agreement with local administration. Some changes in legislation might as well be needed;
- Assessment of climate change risks and setting up of joint strategy for threat reduction for the pilot areas;
- Study of fertility of soils and preparation of recommendations for improvement;
- After analysis of the risks of establishing farmers' unions and assessment of soils, recommendations should be launched and particular activities should be carried out (renewal of species, introduction of modern technologies, cultivation and etc.);
- Increase of possibilities of agricultural service centers;
- Assessment of leading technologies and preparation of recommendations in order to increase competition in agriculture sector;
- Preparation of report and guidebook on reduction of risks related to climate change, increase and improvement of fertility of soils and the role of farmers' unions in risk reduction process. Printing and dissemination of materials.

6.1.7.4. Project partners and beneficiaries

Project partners are:

- Ministry of Agriculture of Ajara Autonomous Republic, the function of which will be to assure population in the benefits of farmers' unions and to define policy during the process of establishments of unions. Initiation of necessary changes in the legislation;
- Kobuleti Municipality, the function of which will be to provide well organized support to establishment of farmers' unions, which will serve up to 1 000 families and provide them with necessary materials and consultations;
- Department of Tourism Development which will provide support in determining what products are demanded in tourism sector, assist in the assessment of quality standards and aid in linking farmers and private sector engaged in tourism with each other;
- Agricultural service centers, where local potential for development of agriculture will be created.

Project beneficiaries are:

- More than 1 000 small farmers of the union, who will get all necessary knowledge, experience and support that is needed to develop farmers' economy, enabling them to solve their problems more effectively and with less efforts;
- All the above mentioned parties will get benefits. Namely: this project will assist the Ministry of Agriculture in strategy elaboration process. The optimal form for small economy management will be established in a system; productivity, quality of crops (harvest) and realization scale will be increased;
- The municipality will get benefit from it as well, since it will be easier to work with farmers' association and help them in problem solution, rather to deal with 1 000 small farmers separately;
- The potential of agro-service centers will be increased, that will accordingly increase quality and scale of services; their income will be increased and chances of business extension will be enlarged;
- The Tourism Department will benefit from supply of ecologically sound products to the tourists. It will also get benefit from tourism development.

The project implementation will support solution and settlement of significant problems existing in agrarian sector and will stimulate families' and farmers' activities. Space development will be also supported in small villages and communities. It will become possible to increase volume of attracted investments.

6.1.7.5. Factors supporting project implementation

Supporting factors for the project implementation are:

- Increase of competitiveness of agriculture and its productivity through quality improvement is the first priority of the Government, thus the project has support as from central as well as from Ajara region governments;
- Actual revealed negative impact of climate change is already confirmed fact and it is important now to correctly deliver this to the population. The pilot families should comprehend expected results of the joint activities. Namely, for 1 000 families the negative impact of landslide processes will be reduced, erosion and deterioration of soil fertility will be decreased, agricultural lands will be maintained, effective preventive measures against negative impact of climate change will be taken, productivity and quality of crops will be increased, tourism sector will be supported. Assessment carried out for Kobuleti municipality showed that notwithstanding high adaptation ability, Kobuleti, together with Keda, still remains one of the most vulnerable municipalities to the impacts of climate change;
- Interest and support of the local authorities in the implementation of this project. The management of the municipality considers results of this project as a serious step in the process of sustainable development;

- Interest of population (1 000 families) and demand to implement such projects in the near future;
- Agricultural service centers in the regions established by the Government.

6.1.7.6. Barriers to the project implementation

- No access for small farmers to the information regarding climate change and its negative impacts;
- After the collapse of the Soviet Union and collective farms, when the population was forced to be a member of such union, the attitude towards different types of unions is still negative and forms for effective management have not been elaborated yet despite several efforts made by the Governmental sector. This project proposal is acceptable and promising due to the interest and involvement of the local Government into the process.
- Lack of information on possible risks reduces farmer's motivation to import and adopt new technologies;
- Economic activity of the population is quite low (compared to political activity) and work in this direction is needed;
- Potential of newly established agricultural service centers is very low.

6.1.7.7. Implementation activities and budget

At least 2 years are required for project implementation.

Activities	Implementing agency	Terms of implementation (in months)* and budget (in USD)*	Anticipated result
1. Study and analysis of practices in leading countries and preparation of recommendations acceptable for Ajara, namely pilot families (1 000 families in Kobuleti municipality, total area 1 875 ha, out of which 688 ha belongs to agricultural land)	Ministry of agriculture of Ajara, authorities of the municipality and agriculture consultation centers	12 15 000	The leading experience is studied and the best model is selected for Khala community
2. Preparation of pilot population for implementation of the elaborated recommendations. Every step should be planned and made in agreement with local management. Some changes might be needed in legislation as well	Ministry of agriculture of Ajara, agriculture consultation centers	12 50 000	The population is prepared for the pilot project

3.Assessment of climate change risks and setting up of joint strategy for threat reduction on the pilot areas	Ministry of agriculture of Ajara, agriculture consultation centers	24 50 000	Risks related to climate change are assessed and actions are planned
4.Study of fertility of soils and preparation of recommendations for improvement	Ministry of agriculture in Ajara, agriculture consultation centers	24 30 000	Farmers' soils are examined, recommendations on proper cultivation and increase of fertility are worked out
5.Introduction of recommendations: farmers' unions are established, risks and soils are assessed and preventive measures are to be taken	Project management team, agriculture consultation centers Local population and authorities	24 500 000	Specific actions are made in order to establish farmers' unions
6. Capacity building of agricultural service centers	Project management, Consultation centers of agriculture	24 70 000	Local potential is strengthened
7. Assessment of leading technologies and preparation of recommendations (Technology Action Plans (TAP)) in order to increase competitiveness of agriculture center;	Project management team, Agriculture consultation centers	24 30 000	Leading technologies are assessed and recommendations (TAPs) on advanced technologies are prepared
8. Preparation of report and guidebook on reduction of risks related to climate change, increase and improvement of fertility of soils and the role of farmers' associations/unions in risk reduction process. Printing out and dissemination of materials	Project management	24 20 000	The report is prepared
Total		**765 000**	

6.1.8. Increasing tourism potential in Ajara region by effective management of climate-related diseases

6.1.8.1. Description of the problem

According to Georgia's state policy, the tourist industry will greatly contribute to the growth of Ajara's socio-economic potential and, in general, to the sustainable development of the region. Hence, aimed at the maximum use of Ajara's tourism potential, it is highly important to introduce those adaptation measures, which will provide the tourists with comfortable and healthy recreational environment.

While preparing Georgia's Third National Communication on climate change, the impact of climate change in Ajara's Health sector has been studied. As a result, it has been revealed that in Ajara region the increase in frequency of some climate-related

diseases (mainly the diarrheal infections) is taking place as well as the appearance of new, associated with climate change, non-specific for the region illnesses (anthropozoonotic pathologies) that may jeopardize the full deployment of region's tourist potential.

To reduce the number of mentioned above pathologies and their harmful impact, the improvement health sector services in relation to tourism is necessary, manifested in the mobilization of sector during the active tourist season and in provision of tourists with adequate health service. This is one of the important pre-conditions for the efficient development of tourism potential.

The survey carried out in the framework of the Third National Communication to the UNFCCC has demonstrated that the recurrence of climate-related illnesses in Ajara is essentially higher compared to other regions of Georgia. In particular, the incidence and prevalence of diarrheal diseases substantially exceeds the same in other regions of Georgia and, in general, the average data for the country (in 2009 the incidence of diarrheal infection pathologies in Ajara equaled to 925.4, while the averaged value for Georgia made 225.0; In 2010 the corresponding numbers made 14 768.2 against 2 626.3). The significant increase in the number of illnesses is usually revealed during the tourist season, at which 60-65% of cases are occurring.

It is notable that in recent years the cases of such anthropozoonotic infection sicknesses have been detected in Ajara that are characteristic to higher temperature and humidity. Due to the significant rise in temperature at the territory of Ajara, it could be assumed that non-specific for the region, newly emerged infections – leptospirosis and borelyosis will endanger the human health and their expansion, along with diarrheal diseases, could increase risks in the tourism sector. In particular, in Batumi and Kobuleti the mean annual temperature for the past half-a-century has risen by 0.2^0C and 0.5^0C respectively, and in summer season by 1^0C that is the highest index at the territory of Ajara. This rise of temperature is anticipated to keep on in future, the increment reaching to 1.8^0C (Batumi) and 2.1^0C (Kobuleti) in the summer and 1.6^0C for the mean annual value by 2021-2050. As to the air humidity, its growth is not yet revealed, but in the future its increase by 10-11% is projected in Kobuleti, especially in the summer, while at the Batumi territory no increase is foreseen.

Besides the discussed above changes, the increase in the frequency and duration of heat waves is observed at the Batumi and Kobuleti territories (in 1987-2010 compared with 1961-1986 the number of "very warm" days in Batumi increased by 125%, while in Kobuleti it decreased by 15%). Moreover, in the period of 2020-2050 against the 1961-1990, number of "very warm" days in Batumi is expected to grow by 200%, and in Kobuleti – by about 230% facilitating the increase in the frequency of pathologies associated with high temperature (heat stroke, heat exhaustion, loss of consciousness). This is particularly hazardous for chronic patients with cardiovascular diseases, elderlies and children, who are most vulnerable to climate change.

For the assessment of tourism potential at the territory of Ajara one more parameter – the Tourism Climate Index (TCI) has been used. Calculations have revealed that for the time being, its value is not altering significantly and it slightly improved in Batumi in June, and in Kobuleti significantly improved in April, though it worsened from

July to September. As to the future projections, due to the rise in temperature, this index at the Batumi territory may shift from the second (good) to the third (pleasant) lower category, while in Kobuleti the index will be uncomfortable only for 3 months (December, January, February). Some of these changes can negatively affect tourism development if no measures are taken to improve tourist environment and timely and adequately prevent pertaining to health risks.

Situation analysis – what the health sector is offering at present:

- In Ajara the medical service providing network is represented by the primary health care and hospital sector, as well as emergency medical centers, the services of which are not specifically oriented on serving tourists according to international standards. The personnel engaged in present medical service is not adequately informed and trained on the measures, which are to be taken against the risks related to the impact caused by the temperature raise and other climate extremes. There is lack of the same information among the personnel serving in the tourist sector; they do not possess practical skills of informing and providing medical assistance to tourists;
- It has to be noted that the Ministry of Labor, Public Health and Social Security is already preparing protocols on those diseases (except Laim-Borelyosis), which are included by the WHO in the list of climate-related illnesses. These protocols were to be approved in December 2012);
- Some initial efforts are being taken to improve tourist and holiday-makers services in the resort zones. E.g. the insurance company "Aldagi BCI" has created a small network of dispensaries (not more than 5-6) in the recreation zone and offers minimal insurance package at symbolic price of 1 lari. The package includes emergency assistance at the beach and mobile emergency services in the range of 55-200 lari. This initiative operated through 2012 recreation season;
- Recently the Ajara Tourism Department has undertaken an initiative aimed to improve the service offered to tourists. It consists of training managers engaged in the hotel and restaurants sector. However, the agenda of training appeared to be limited and it includes only few items in emergency medical assistance. The training was conducted once and certificates were issued to 109 participants (among them 57 graduated with excellence) while others were only regular attendants. The limited volume of trainings does not allow for embracing sufficient number of employees in the hotel sector, though the interest from their part to such trainings in very high.

6.1.8.2. Objective of the project

The objective of the project is to reduce risks of diarrheal infection pathologies, anthropozoonotic(so called "tropical") infection diseases and other pathologies induced by high temperature (heat strokes, etc.) in the Ajara tourism service sector, mainly in Batumi and Kobuleti areas.

The project basically will be directed towards the prevention and early diagnostics of diarrheal and anthropozoonotic infection diseases by means of mobilizing the health sector and introduction of relevant services according to modern standards, thus enabling to decrease risks related with these illnesses and create conditions more comfortable to tourists.

The second important direction will be the provision to mobilize the health sector in days of heat wave occurrence. In particular, this implies the staffing of tourism sector with the skilled personnel, specially trained to reduce risks, associated with climate-related diseases.

6.1.8.3. Project implementation

Methodology

The project methodology implies supporting the preparation of protocols on the climate-related diseases spread in Georgia and the adoption of already approved protocols, the rising of awareness on the climate-related illnesses in medical personnel and tourist-serving staff by means of trainings, preparation of trainers and, in general, capacity building among local medical personnel and hotel staff, creation of the early warning system and enhancement of coordination and cooperation between different groups pertaining to tourism, that is necessary for the perfect functioning of the early warning system.

Activities

The project consists of three basic components: 1) Training of medical personnel on the management of climate-related diseases; 2) Improvement of hotels' service quality and 3) Creation of the early warning system. For the implementation of each component of the project following activities should be carried out.

Component 1. Training of medical personnel engaged at the primary level of public health, in hospitals and tourism sector (hotels) in dealing with climate-related diseases and issuing of certificates.

The awareness rising of medical personnel on the risks of climate-related illnesses and their management makes it possible to timely prevent, identify and cure them, To implement this component, following measures should be taken:

1.1. Promoting the preparation of protocols on the management of climate-related diseases (except borelyosis) is in progress in Georgia. They were to be approved in December 2012. The protocols are prepared on each nosology separately and do not represent a textbook on the management of climate-related illnesses. Thus, in the project framework, all protocols on climate-related sicknesses in Georgia will be compiled and a single manual will be composed. The only pathology, on which the protocol is not elaborated, is borelyosis, though, if demanded, the Ministry of Public Health may work on this subject as well;

1.2. Training of medical personnel who imply training of physicians at the primary level of public health and training of medical staff attending hotels. In Batumi at the primary level of public health, there are engaged 110 physicians (in hospital emergencies – 22, district doctors – 35, in ambulance brigades – 53), in Kobuleti – 35 physicians (in hospital emergencies – 5, district doctor – 10, in ambulance – 20). From these physicians a group of 10-15 doctors should be selected which will undergo special training. The selection will be carried out according to criteria agreed in advance with the Ministry of Labor, Public Health and Social Security, and the Tourism Department. Staff of the hotels (managers), selected according to criteria agreed between the same Ministry, Department of Tourism and Hotel management teams will be trained as well;

1.3. Certification of medical personnel. At the end of training courses, trained personnel will be awarded with certificates. The medical personnel will be employed at the special dispensaries;

1.4. Facilitating establishment of special dispensaries serving tourism sector (tourists and, possibly, their serving personnel), which will possess advanced knowledge in climate-related diseases, pertaining to them risks and measures to reduce such risks, including the elementary assistance. The dispensaries will be organized and equipped on the basis of already operating medical facilities. Each dispensary will be staffed by one physician and one nurse. The number of dispensaries will be 3, including 2 in Batumi and 1 – in Kobuleti;

1.5. Collaboration with private insurance companies and promotion of the inclusion of climate-related diseases into the insurance package. Managers of private insurance companies should be informed on the climate-related illnesses and provided with the cost-benefit analysis, which will clearly demonstrate the financial effectiveness of prevention and timely treatment of climate-related diseases.

Component 2. Improvement of hotel services quality.

The improvement of hotel services will be targeted on the prevention of climate-related illnesses (by providing tourists with comfortable and healthy environment) and in case of emerging pathologies – on the timely and high quality treatment (via application of the climate-related diseases dispensaries).

2.1. Assessment of conditions existing in hotels (baseline situation) in order to evaluate risks of climate-related illnesses: assessment of the state and quality of heating and air-conditioning appliances, number and quality of sanitary units, quality of refrigerators in small family hotels. The assessment of these components is necessary to prevent cases of tourists' sicknesses caused by the high temperature in the summer (heat stroke, diarrheal infections);

2.2. Working out of recommendations on the minimal safety standards to avoid possible risks. For the hotels they will include requirements of temperature, sanitary and epidemiological standards. The Ajara Tourism Department is currently preparing a bill on tourism and resorts, which will include the public health component as well. Based upon these recommendations, it would be possible to perfect the low or to widen the health component by adding the demand to decrease the risks of climate-related diseases;

2.3. Training relevant structures interested in information systems application. Informing attending personnel of hotels on the capabilities of modern health services: informing owners of small family hotels on the items, concerning prevention/treatment of climate-related illnesses. Such system will facilitate timely identification and proper treatment of climate-related sicknesses; eliminate the discomfort and stress, which might be caused by the "primary ambulance" system (as it happens now). The Call Center should be set up, operating round the clock with hotels, and especially with small ones. This Call Center is a major part of the third component.

Component 3. Creation of the early warning system (EWS).

The EWS makes it possible to assess the risk in proper time and to prevent the climate-related diseases through mobilizing and informing relevant structures and population.

1.1. Establishment of continuous monitoring system on climate parameters and for timely identification and registration of initial cases in order to assess the increase in illness risk;
1.2. Preparation of tourism and healthcare sectors mobilization plan for cases when the risks increase;
1.3. Establishment of information network and provision of relevant stakeholders with necessary information. As the priority stakeholders medical personnel and tourism sector should be informed on possible hazards and ways for their prevention/reduction, as well as on methods of correct response to them. The awareness rising of tourists and population is also important. Information should be disseminated as special printed materials (flyers, booklets. etc.) through dispensaries, medical personnel of hotels, pharmacies, the tourist information services.

6.1.8.4. Project partners and beneficiaries

- The Ministry of Environment and Natural Resources Protection of Georgia which is focal point of the UNFCCC (UN Framework convention on Climate Change) and which is responsible for development and implementation of climate change strategy of Georgia including climate change risks reduction through adaptation/risks prevention activities. The utmost objective of this proposal is climate change related risks reduction in tourism and healthcare sectors through strengthening the local preventive capacities;
- The Ministry of Labor Health and social Affairs of Georgia;
- The Ministry of Health and Social Affairs of A.R of Ajara\Public Health Center of Ajara A.R;
- Department of tourism and Resorts of Ajara A.R;
- **Tourists**, who, in case of risk increase, receive general information on the prevention and treatment of climate-related illnesses and get timely and proper medical assistance from the medical personnel as well. As a result they will be at most protected at the tourist season from the climate-related sicknesses (diarrheal diseases, heat strokes);

- **Medical personnel**, who improve their professional skills on the management of climate-related diseases and obtain respective certificates allowing them to be directly engaged in the prevention, early identification, and timely treatment of illnesses;
- **Private sector – (a) Personnel of the hotels**, among them owners of small family hotels, which will receive detailed information on the essence, prevention and treatment of climate-related diseases. The information which will be disseminated in the hotels will increase awareness among tourists and ensure efficient protection from climate-related illnesses. This will result in the growing satisfaction of tourists, causing further development of tourism and the private sector. (b) **Private insurance companies**, which will be able to save the treatment expenses through the prevention of climate-related diseases;
- **Population of urban areas** which will receive the information on the prevention and treatment of climate-related sicknesses and virtually is widely involved in the private sector activities, owing small family hotels, being employed at hotels, restaurants, etc.;
- **The state**, which will increase tourist potential of the region, by means of creating comfortable recreation conditions for tourists through this project. At the same time, the state will be able to save the state insurance expenses by preventing the diseases.

6.1.8.5. Factors supporting project implementation

- High interest of stakeholders engaged in the project (Department of Tourism and Resorts of Ajara A.R, hotels' management, Public Health center of Ajara A.R.), expressed during the proposal preparation phase. Existence and readiness of hosting entities, where the trainings could be held (e.g. the Kobuleti Professional Training Center);
- Availability of protocols (being under elaboration and approval) which are necessary to provide the management of climate-related diseases. Only one disease, on which the protocol does not exist, is borelyiosis and the corresponding request should be submitted to the Ministry of Labor, Public health and Social Security;
- As it was mentioned above (2.2), Ajara Tourism and Resorts Department in the meantime is elaborating a bill on tourism and resorts, in which the public health component will be included. Moreover, while working on the perfection of already acting law, the extension of health component would be more feasible.

6.1.8.6. Barriers to the project implementation

- Lack of a single national protocol on the management of climate-related diseases, and what is more important – the absence of specific international guideline, which may be adaptable to Georgian, and first of all – to Ajara's conditions;

- Lack of awareness and information on climate change related diseases and their prevention. In Georgia virtually that is the first attempt to reduce the risks caused by climate change in health and tourism sectors;
- Insufficiency of studies carried out in the field of climate related diseases;
- Insufficiency of past observations of meteorological parameters and medical statistics in order to establish confident correlation between these two;
- Potential risk-factor for the successful implementation of the project may be the future sustainability of the process and the project results.

6.1.8.7. Implementation activities and budget

The project is represented by 3 major components: 1) Training of medical personnel in the management of climate-related diseases; 2) Improvement of hotel medical services quality; 3) Creation of the early warning system. Implementation of the project and each of its components will require 2 years with the execution of the following stages.

Activities	Implementing agency	Terms of implementation (months) and budget (USD)	Anticipated results
Training of medical personnel in the management of climate-related diseases risks			
1. Preparation of protocol for physicians. Compilation of guidelines concerning separate nosologies (diseases) into single Guidelines	Ministry of Labor, Public Health and Social Security (MLPHSS) of Georgia	3 25 000	The protocol will enable physicians to effectively manage climate-related diseases
2. Working out of criteria and selection of medical personnel using these criteria to undergo training and get certificates	MLPHSS of Ajara, private sector (hotels where this medical personnel is employed)	4 5 000	Capacity building in the local medical personnel, training of staff in managing risks of climate-related diseases
3. Training and certifying selected medical personnel	International experts, Ajara Tourism Department, MLPHSS of Ajara	3 30 000	Presence of skilled medical personnel to render timely and qualified assistance to tourists
4. Promoting the creation of special dispensaries	MLPHSS of Ajara, Batumi and Kobuleti Municipalities and Tourism Department	5 50 000	Dispensaries are ready to serve the tourists

5. Collaboration with private insurance companies	MLPHSS of Ajara	6 50 000	Private insurance companies express readiness to include prevention and treatment of climate-related diseases into private insurance package
Improvement of hotel services quality			
6. Assessment of health safety provision quality in small family hotels	MLPHSS of Ajara, Tourism Department	8 20 000	Information on small family hotels is gathered to work out recommendations for providing safe health care environment
7. Working out recommendations on the minimal health safety requirements for hotels	MLPHSS of Ajara, Tourism Department, International expert	5 50 000	Portfolio of recommendations, which may be used as a guideline by hotels (targeted mainly on small family hotels)
8. Training of relevant involved structures (hotels, tourist services, etc.) in the use of information systems and development of their potential	Ajara Department of Tourism	2 5 000	Delivery of information to the managers of hotels for providing correct response in case medical assistance is requested by tourists
Creation of the early warning system,			
9. Preliminary assessment of the increase of illnesses risk	Meteorological stations, MLPHSS of Ajara, National Center on Diseases Control and Public Health (NCDCPH), Ajara Department of Tourism, hotels	12 70 000	Projection methodology is selected for risk assessment
10. Preparation of mobilization plan	Meteorological stations, MLPHSS of Ajara NCDCPH, Department of Tourism, local municipalities	24 50 000	Readiness for operational activities in case of risk increase
11. Creation of information network and provision of stakeholders with necessary information	Ajara and national CDCPH, medical personnel (including pharmacies staff), Ajara Department of Tourism	24 10 000	
Total		**315 000**	

6.2. GHG mitigation proposals

6.2.1. Mitigation of GHG emissions from existing Batumi landfill

6.2.1.1. Description of the problem

The Batumi landfill operates since 1965. It occupies 19.2 ha in Batumi Adlia settlement 300 m away from the Batumi Airport and premises of local residents. The landfill also borders petrol service station and Duty-free Administration building, River Chorokhi and the Black Sea. Dominant winds dissipate emissions from the landfill towards the sea, creating discomfort to tourists.

The landfill is used for dumping waste from residential districts of Batumi and Khelvachauri municipalities.

At the entrance of the landfill there is a control station equipped with a bar. One part of the landfill is allotted to dispose remains of animals (cattle and pigs). The landfill has no waterproof system neither has it wastewater treatment and gas collection systems. The height of solid waste in some places exceeds 6 meters.

In the Soviet period a waste-processing mill was constructed near the highway but it never was operational due to political turmoil in 1989.

The company "Sandasuptaveba Ltd" registers waste transported to the landfill since 1990. About 700-850 m^3 of trash is delivered daily at the landfill, making 250 000-300 000 m^3 of waste annually. The waste is only rammed at the site that often causes its self-flaring up and consequent fires. Based upon the average amount of annually disposed waste (254 883 m^3), in the period of 1990-2012 (22 years) total amount of waste transported to the solid waste disposal site (SWDS) can be estimated as 5 607 419 m^3.

Till 1990 collection of solid waste in Batumi was not properly organized and daily amount of gathered waste varied in the range of 400-500 m^3. Assuming the average daily amount of waste equaled to 450 m^3, the annual amount of waste made 165 000 m^3, and total volume of accumulated waste in the first period of SWDS operation (1965-1989) equaled to 3 800 000 m^3, resulting in the overall amount of waste at the landfill to be 9 407 419 m^3.

The existing SWDS is used for heaping of harmful toxins and inert waste as well. No environmental protection measures are taken at the landfill and this transforms it into active pollutant of the environment. Its functioning causes the contamination of atmosphere, water reservoirs and soil.

During the handling of the waste sanitary and hygienic terms are being violated. Outsiders are conducting prohibited activities at the landfill such as collecting metal scrap, glass, and different domestic articles. During 1993-1997 part of the landfill was washed off by R. Chorokhi without impacting major dumping area. In 1998-1999 under the financial assistance of World Bank, a flood protection wall was constructed at the strip dividing landfill from the river and the wall partly held up the erosion of

landfill bank. In 2009, under the initiative of the Ministry of Environment, a 1 040 m long dam has been erected on the side of landfill along river Chorokhi, completely eliminating the risk of washing down the SWDS. In the nearest 2 years further consolidation of the bank down to the mouth of the river is planned in connection with the construction of a new bridge over the river. The landfill is located at the terrain having complex geological structure that hampers wastewater control. The only way of solving this problem is to close down the landfill and reconstruct the landscape at the earliest possible date.

6.2.1.2. Objective of the project

As it is generally known, the burial of organic or partly organic waste is always followed by its decomposition resulting in the emission of greenhouse gases, mainly of methane (CH_4) and carbon dioxide (CO_2). In order to reduce the GHG emissions, as it is requested by the UNFCCC, Party to which is Georgia, in many countries methane is being collected and flared, or used as a source of energy (electricity, gas). Otherwise, if methane is not collected, the unpleasant smell spreads over the area and GHGs are emitted into the atmosphere. As a rule, the origination of GHGs from organic waste begins in few months after burial and continues through the whole period of landfill functioning, that may last about 70 years.

As it was mentioned above, the approximate amount of waste accumulated up to now at the Batumi SWDS is about 9 407 419 m^3. According to 1990 Handbook data, 1 m^3 of waste corresponds in mass units to 0.22-0.24 tons. Hence, the total mass of waste at the Batumi landfill can be estimated as 9 407 419 m^3 * 0.22 t/m^3 =2 069 632 t. In line with the IPCC recommendations, which implies the generation of 100-200 m^3 of biogas from 1 ton of waste (depending on its composition and climate conditions), it can be assessed that during the full period of waste decay (70 years), no less than 206 963 200 m^3 of biogas will be emitted to the atmosphere. From this quantity a minimum 50% is methane which can be used to get electric energy or delivered to consumer as natural gas.

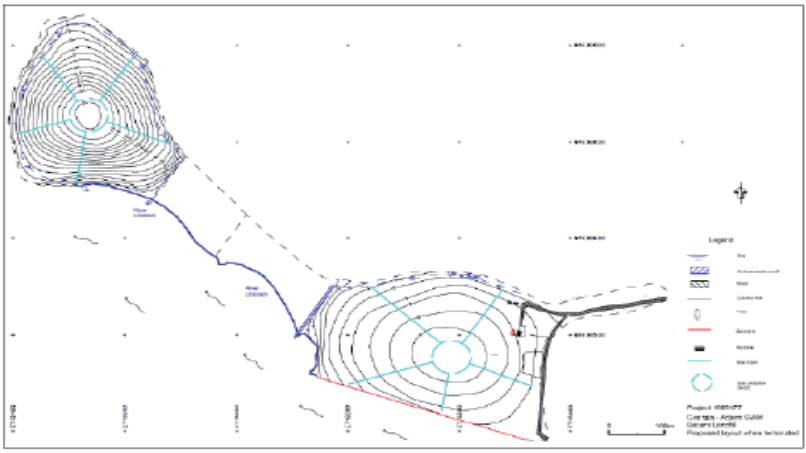
As it has been already pointed out, for 15-20 years after the shutting down of the landfill, the emissions of GHGs actively goes on. Thus, to reduce these emissions, it is expedient to arrange a gas recovery system (gas wells, gas collecting pipes, gas pump station, insulating trap, gas motors and gas flare) for the collection of originating gas and its application as an energy resource. However, it should be mentioned that if there is no interested consumer or relevant infrastructure nearby, it is cheaper to burn the gas at the site, thus reducing its emission into the atmosphere, eliminating its smell around the site and decreasing the risk of self-flaring. One of the complications of this project is the correct assessment of daily production of gas that sometimes significantly differs from theoretical calculations. Theoretical calculations show (Annex VII) that for the first 10 years the minimum amount of methane gas, which could be used for energy generation, is 800 m^3 per day. This amount should be taken as basis in case energy project is prepared.

The closing of examined landfill is planned in summer 2014, immediately after the opening of the new SWDS.

During the closing process, at the existing landfill the waste will be collected and disposed in two piles, at the flanks of which the water can freely pour down and they should not be eroded. The piles must be rammed to reduce their volume and further, it is planned to cover them with 0.5 m thick layer of waterproof ground. The upper part of the ground, consisting of at least 20 cm deep drainage stratum and 0.6 m thick ground layer, should promote the development of vegetation cover.

Monitoring after covering

To monitor the process inside the pile, two piezometric pipes are to be installed. One of them should be mounted 10 m away to the south-west from the dumpsite, and another – at the same distance to the north-east. The collection and examination of samples to determine the quality of water should be conducted at least once a year.



It ought to be mentioned that the transportation of total mass of waste accumulated at the closed landfill to the new SWDS with better sanitary conditions is a very complicated problem, which could not be solved due to its high cost. Hence, it is advisable, after its closure, to collect the generated biogas and to use the reclaimed territory for planting perennials to ameliorate the landscape.

6.2.1.3 Project implementation

Methodology

For the assessment of emitted methane quantity, the IPCC Tier 1 decay model is used. In the process of creation of the business-plan, practical measurements are to be carried out for 1 year to evaluate differences between theoretical and empirical estimations of generated gas amount. In case if consumer is defined and the supply of energy in the form of gas or electricity is decided, the minimal daily production of gas will be counted and the business-plan should be elaborated according to obtained results. As the project will reduce the emission of GHGs, their amount is to be certified in the framework of CDM or another mechanism and reduced emissions should be sold to alleviate the initial and current expenses of the project.

Activities

1. For an year observations must be carried out on the landfill and the amount of generated biogas (50% of which is methane) must be measured;
2. Preparation of business plan;
3. Preparation of the territory;
4. Purchase of gas recovery system;
5. Arrangement of gas recovery system (with vertical and upper connection);
6. Arrangement of biogas flaring or electric generation or gas supply systems;
7. Arrangement of project monitoring system (permanent measurement of flared gas or delivered electricity or gas, archiving of data, etc.);
8. Putting the system into operation.

6.2.1.4. Partners and beneficiaries

Partners and beneficiaries of this project are:

1. Local residents living at the adjacent to the landfill territory, enterprises and visitors coming for a relatively short time. The landfill area comprises 19.2 ha, on which outsiders gather scrap, domestic things, etc. A cattle let out alone is feeding on waste as well. The implementation of the project will put some activity limits to this part of the population, who at present is using the landfill. Nevertheless living conditions and safety will be significantly improved for more than 30 000 inhabitants, who reside and work in the environs of landfill;
2. Municipality of the city of Batumi. City of Batumi is one of the Parties to the Covenant of Mayors and it took commitment to reduce the GHG emissions from its territory by 20% for 2020. At the same time, it must be noted that near the existing landfill, close to the seashore, the construction of infrastructure utilities is actively going on, including building of a dwelling compound. Consequently, the mentioned area is included into the perspective zone of city development. So the closing of this landfill

applying modern, environmentally safe methods and the effective use of this territory for city development purposes represents one of the priorities for city Municipality;

3. Private construction sector, which is interested in the construction of residential or other types of buildings and the development of relevant infrastructure. Putting in order the landfill will significantly increase market price of buildings;
4. Department of Tourism, the primary interest of which is the provision of ecologically clean and safe conditions for the sustainable development of tourism all over the territory of Ajara and especially, in the coastal zone;
5. The company "Sandasuptaveba Ltd", which is directly responsible for the maintenance of landfills and their sustainable management;
6. Government of the country, as Georgia is a Party to the UNFCCC and it is committed to reduce GHG emissions from its territory wherever it is possible to the possible extent. Moreover, since Georgian government puts the sustainable development of tourism as one of its highest priorities, it is important for it to provide safe conditions for tourism;
7. Local residents and private sector at the neighboring to the landfill territory, who will get thermal energy (in the form of gas) in case of implementing energy part of the project. This depends on the potential of extracted methane that will be assessed during the first two years of project development and on the cost of infrastructure necessary to deliver this energy resource. At the same time major condition is to have energy consumer.

6.2.1.5. Factors supporting project implementation

Important supporting factors are:

- The Municipality of Batumi, as a Party to the Covenant of Mayors, is committed to reduce the GHG emissions from the territory of the city by 20% till 2020 compared to the baseline scenario;
- The Batumi Municipality and the company "Sandasuptaveba Ltd" are interested in establishing permanent monitoring on the reclaimed territory, which itself is a part of proposed project;
- The support of Ajara government, who is interested in the development of tourism in Ajara, that demands to bring sanitary conditions in the city and at neighboring territories to international standards;
- The company "Sandasuptaveba Ltd" has an interest to this project and will participate in its implementation as far as it will provide the guarding of landfill territory to exclude bringing in and dumping of waste by outsiders. This kind of monitoring will be combined with the monitoring under CDM program;
- In case of implementing this project, at the territory of Georgia it will be the first example of collection and application (in case of using as an energy resource) or flaring of landfill gas to reduce the GHG emissions and improve the local environmental conditions. (Earlier such an attempt was

unsuccessfully undertaken at the Tbilisi landfill);

- The project is actively supported by the Tourism Department and private sector which is interested in building on at the nearby territory;
- If the proposed undertaking is successfully registered as a CDM project, this will bring landfill owners additional investments even in case of only flaring of methane;
- Existence of plan for closing the landfill and presence of investor who will finance the closure.

6.2.1.6. Barriers for the project implementation

1. First and most important barrier is the determination of actual amount of waste (that is not defined accurately) and corresponding amount of methane that can be obtained from the landfill. This barrier can be overcome by installing experimental pipes and measuring the quantity of methane;
2. Even more important is the risk of washing out of the part of landfill by R. Chorokhi that happened some years ago. This event, in addition to injuring the methane collection and recovery system, will decrease the projected amount of methane, planned to be recovered and will pollute adjacent territories and reservoirs. This barrier can be overpassed with the planned prolongation of existing 1 040 m long dam along the bank of the river and this will almost eliminate the danger of repeating the mentioned event;
3. One of the barriers is the absence of spare cash in Batumi Municipality to finance the arrangement of methane recovery system at the landfill. In order to solve this barrier, the CDM preferential credit line can be used which will be repaid with the income received from emission reduction. However, before getting a credit the amount of methane must be assessed accurately as well as barriers that can prevent the implementation of this project;
4. One of the barriers is the lack of local skilled personnel, whose training increases project implementation cost;
5. There are no experts in the country, who have practical knowledge of such systems' technical parameters, which is very important in the process of purchasing the system. In such case, long-term maintenance service and guarantees should be requested, which substantially increases project expenses. Otherwise, the investor, who is interested in buying reduced emissions, should ensure themselves the quality of system performance;
6. It is important to define who the owner of the system is or who will be responsible for the territory after the closure of the landfill. If the owner is altered, the newcomer may decline to continue the project. (At the present stage the landfill is owned by the Batumi Municipality);
7. If no energy consumer can be identified at the nearby territory, actual impact of this technology on the region's economy will be reduced and no contribution to the development of heat energy sector will be provided. In the meantime the energy is not deficient in the discussed area and hence, large extra expenses in this respect should not be requested.

6.2.1.7. Project implementation stages and costs

At least 2 years are needed for the implementation of the project.

Activities	Implementing Agency	Terms of implementation (in months) and budget (USD)	Anticipated result
1. Observations should be carried out at the landfill during a year and the amount of recovered from existing waste biogas (50% of which is methane should be measured	Batumi Municipality in collaboration with Ajara Environment Protection Agency	12 20 000	The risk of project's inefficient implementation and incorrect economic calculations is reduced
2. Preparation of the business plan	The same	3 25 000	Business-plan is created for submission to investors
Preparation of ground			
3. Collection of waste in two piles	Executor selected on the basis of tender	4 40 000	Landfill is closed and brought in order
4. Profiling of two piles	The same	2 30 000	The same
5. Laying of at least 0.40 m thick final cover; Drainage stratum - 0.20 m width; Dividing stratum and soil layer 0.60 m width;	The same	6 1 560 000	The same
6. Construction of surface water draining canal	The same	4 13 000	The same
Total 1 643 000			
7. Purchase of gas recovery system	Project management team in cooperation with Batumi Municipality	6 10 000	System is identified and purchased at the international market
Arrangement of gas recovery system (with vertical and upper connection)			
8. Arrangement of gas wells	Construction company selected by means of competition (under the supervision of foreign expert)	4 26 000	System wells are arranged
9. Mounting of collecting pipes	The same	4 32 000	Gas system collecting pipes are assembled
10. Arrangement of gas regulation station	The same	3 78 000	Gas regulating station is mounted
11. Arrangement of gas pump station that will provide delivery of gas to consumer	The same	4 195 000	Gas pumping station is mounted
12. Arrangement of gas flare	The same	4 65 000	System for flaring of methane at the site (gas torch) is installed
Total 395 000			
Generation of electricity at the site and its delivery			

13. Purchase of gas electric generator and its mounting	Construction company selected by means of tender	300 000	Generation of electricity which, presumably, will be used for lighting nearby embankment
14. Linking up of generated electricity with the grid	The same	6 130 000	Generated electric energy is delivered to the grid
15. Arrangement of project monitoring system (permanent measurement of flared gas, or delivered electricity or gas, archiving of data, etc.)	Closed landfill management team which is to be determined	5 20 000	Monitoring system is established according to relevant standard
16. Putting the system into operation	Assembling foreign company, technology provider	2 10 000	System is put into operation
Grand total 2 544 000			

Hence, the total budget of landfill conservation, methane collection and recovery, and electricity generation equals to 2 543 000 USD. This sum includes 470 000 USD on expenses for methane collection, flaring at the site and arrangement of monitoring system. Depending on the amount of flared gas (tentatively 112 000 ton in total should be generated during 20 years in CO_2 eq) and considering the minimum price of 1 ton of certified CO_2 (minimum 5 USD), total income from flaring project could reach 560 000 in 20 years

6.2.2. Mitigation of methane emissions during the operation of Ajara new landfill

6.2.2.1. Description of the problem

Ajara Government and Batumi Municipality has planned to close down Batumi operational landfill, which has been functioning since 1965 by 2014[55]. The Landfill occupies an area of 19.2 ha in Batumi Adlia settlement, 300 m away from the Batumi Airport and premises of local residents. The landfill also borders gas station and Duty-free Administration building, River Chorokhi and the Black Sea. Dominant winds dissipate emissions from the landfill towards the sea, creating discomfort to tourists.

Instead of this landfill the arrangement of a new landfill or solid waste disposal site (SWDS), equipped according to EU standards, is planned 500 m away from the village Tsetskhlauri of Kobuleti municipality, at the territory of abandoned cattle-breeding farm.

The new SWDS is not intended to dispose harmful waste and will function in accordance with EU directive 1999/31/EC related to the establishment of environmental standards. New SWDS, in addition to the sanitary landfill, will include

[55] After the 2013 elections, the new government may, presumably, once more postpone this issue, since the new authority is not yet determined on the implementation of this project. The revision of all initiated and planned projects is going on in order to assess their expediency.

relevant buildings, weighing bridges, wastewater collection and treatment system, processing, sorting and storing facilities, and necessary operational machinery. It is also planned to introduce methane recovery system, which will be able to collect gas after 3-5 years from putting the landfill into operation.

After weighing and registration of waste and other materials at the entrance, they will be graded and piled on the special territory, where the harmful waste will be sorted out and placed into special containers outside the territory in order to transport them for obliteration or processing at the allotted site. Materials intended for processing mainly include metal, plastics, glass, paper, wood and other economically valuable stuff.

The area of the new landfill occupies 32 ha and has the depth of 12 m. Total permissible volume of disposed solid waste equals to 3.4 million m^3, and the duration until complete filling up – 35 years. The area of each cell of SWDS is 10 ha. According to the preliminary estimations, the landfill initially will take annually 42 000 tons (115 tons daily) of domestic waste collected in Batumi and five Ajara municipalities and will gradually increase received waste up to 80 000 tons per annum.

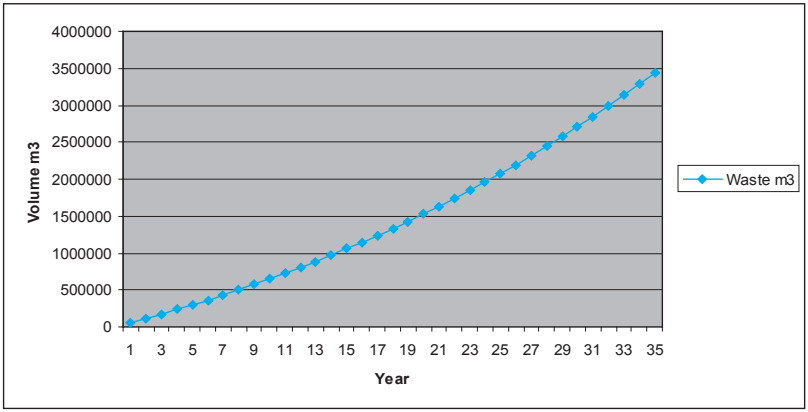


Fig. 6.2.2.1. Anticipated trend of waste generation at the Ajara's new landfill

The waste will be disposed at 10 ha cells to bring to the minimum regularly accommodated waste area. Step by step, when pile of waste reaches permissible height, the interim cover will be laid for pouring off the surface waters and mitigation of wastewater origination.

The covering of waste will be performed at 3 different levels with alternative methods: daily covering, creation of interim layer and final coverage.

Daily covering will be executed at the end of each day and will consist of laying 5cm or deeper stratum of soil or other relevant material. It is aimed at weakening direct impact on organic materials, which causes unpleasant smell and risk of pollution by light trash, such as plastic and paper.

The interim layer consists of about 50 cm wide waterproof soil stratum that prevents spreading of polluted surface water out of waste cell. This type of coverage is used for surfaces that were not subject to waste dumping for six months. The layer must be put before the mounting of gas wells that makes it possible to use a sub-pressure system for landfill gas extraction system without intrusion of oxygen into the core of the waste.

Each cell of waste will be gradually filled up to the prescribed final level. The surface will have an inclination of not more than 1:3 (vertical: horizontal) to provide corresponding working conditions and to create a possibility for laying final coverage at the closing up of the landfill. Maximum inclination is used also in order to decrease the slope erosion risk.

After reaching the maximum height of the pile, its slope will be slightly inclined towards a small ridge in the center of landfill, supporting the pouring down of surface waters. Minimal inclination should be 1:20 to prevent flooding of the territory. Surface waters must be transferred to avert the washing off of the waste and to protect the environment from pollution.

After the complete filling of the cell, according to existing regulations, it will be covered by the final layer.

The place allocated for the new landfill is located in the extreme north-western part of Ajara, characterized by humid subtropical climate. The mean annual temperature in this area for the past half-a-century increased from 13.7 to 13.9^{0}C and the annual sums of precipitation also grew almost by 5% from 2 380 mm to 2 490 mm. The daily maximum rainfall can reach 230 mm here. Absolute minimum temperature can drop down to -14^{0}C and absolute maximum in some areas goes up to 41^{0}C in this area. According to climate change forecast for this region, the rise of mean annual temperature in Kobuleti by 1.6^{0}C is anticipated by 2050, accompanied with the growth of annual precipitation by 12%.

6.2.2.2. Objective of the project

Objective of the project is the arrangement at the Ajara's new landfill of a gas extraction and flaring at the site or its utilization system. The primary concept implies mounting perforated gas wells at the piles of waste after the coating relevant territory with insulating interim cover. Sub-pressure for gas recovery will be produced at the gas pump-station by wind machines. From the environmental viewpoint, the final result will be burning gas (methane) at the site of landfill, accompanied by emission of carbon dioxide in small quantities. Often, according to local needs, the recovered methane is delivered to the heat supply system or is transformed into electricity. In this specific case, with great probability, the gas will be supplied to local population or facilities/enterprises.

As it is generally known, the burial of organic or partly organic waste is always followed by its decomposition resulting in the emission of greenhouse gases, mainly

of methane (CH_4) and carbon dioxide (CO_2). In order to reduce the GHG emissions, as it is requested by the UNFCCC, the Party of which Georgia is, in many countries methane is being collected and flared, or used as a source of energy (electricity, gas). Otherwise, if methane is not collected, the unpleasant odor spreads over the area and GHG is emitted into the atmosphere. As a rule, the origination of GHGs from organic waste begins in few months after burial and continues through the whole period of landfill operation that may last about 70 years.

As it was mentioned above, the approximate amount of waste that will be accumulated at the new SWDS during 35 years of its operation, can reach about 3 400 000 m^3, which is equivalent to 748 000 tons in mass units (conversion factor: 1 m^3= 0.22 ton). According to IPCC recommendations, 1 ton of waste, depending on its composition and climate conditions, generates 100-200 m^3 of biogas. In this project proposal, the most conservative assumption is made, that implies extraction of 100 m^3 of biogas from 1 ton of waste. Therefore, it can be assessed that during the complete period of waste decay (70 years), 74 800 000 m^3 of biogas will be emitted into the atmosphere from the total amount of delivered waste. From this quantity, at least 50% is methane, which can be used to get electric energy or supplied to consumer as natural gas.

6.2.2.3. Project implementation

Methodology

For the assessment of emitted methane quantity, the IPCC Tier 1 decay model is used. In the process of creation of particular business plan, practical measurements should be carried out for 1 year to evaluate differences between theoretical and empirical estimations of generated gas amount. In case consumer is identified and it is decided to the supply of energy in the form of gas or electricity, the minimal daily production of gas will be calculated and business plan should be elaborated according to obtained results. As the project will reduce the emission of GHGs, their amount is to be certified in the framework of CDM or another mechanism and reduced emissions should be sold to alleviate the initial and current expenses of the project.

Activities

The system of methane recovery from landfill must be arranged in the SWDS construction process. In particular, foundations for gas extraction pipes should be mounted in the lower cover of the landfill.

Photo 6.2.2.1. Part of methane collection system mounted at the Tbilisi new landfill

The assembly of gas extraction system at active landfill (3-5 years after putting it into operation) should be performed after the layer reaches maximal height and the interim cover is disposed in appropriate part of the landfill in a way that prevents the risk of oxygen intrusion.

1. For the first 2 or 3 years observations must be carried out on the landfill and the amount of extracted biogas (50% of which is methane)should be measured;
2. Business-plan must be prepared;
3. Gas recovery system must be arranged (gas wells, gas collection pipes, gas pump-station, condensate channel, flare);
4. Arrangement of biogas flaring or electric generation or gas supply systems;
5. Arrangement of project monitoring system (permanent measurement of flared gas or delivered electricity or gas, archiving of data, etc.);
6. Putting the system into operation;
7. Raising awareness of population on the usage of landfill and recovered methane according to modern standards.

6.2.2.4. Partners and beneficiaries

Partners to the project:

1. **Municipalities of Batumi, Khelvachauri and Kobuleti** at the first stage and later on – that of Keda, Shuakhevi and Khulo, as far as this landfill will actually serve municipalities of Khelvachauri and Batumi, who are responsible for operation of the landfill and for protecting local residents from unpleasant smell and methane self-flaring;

2. **Department of Tourism,** the primary interest of which is the provision of ecologically clean and safe conditions for the sustainable development of tourism all over the territory of Ajara and especially, in the coastal zone. Hence, the carrying out of landfill from the Batumi coastal zone to safer and more appropriate territory that decreases factors hampering the development of tourism, falls into the sphere of interests of this Department;
3. **Company "Hygiena-2009 Ltd",** which will be responsible for operating the landfill, its maintenance, safety and management applying the principles of sustainable development;
4. **Government of the country**, as Georgia is a Party to the UNFCCC and it is committed to reduce GHG emissions from its territory wherever it is possible to the attainable extent. Moreover, since Georgian government puts the sustainable development of tourism as one of its highest priorities, it is important for it to provide safe conditions for the development of this sector;
5. **EBRD** which finances the arrangement of modern, conforming to European standards landfill near the village Tsetsklauri of Kobuleti municipality.

Beneficiaries of the project:

1. **Local population** living in the vicinity of landfill, who will not be disturbed by the unpleasant odor from the decay of organic waste;
2. **Local residents and private sector** at the neighboring to the landfill territory, who will get thermal energy (in the form of gas) in case energy part of the project is implemented. Its amount and effectiveness depends on the potential of extracted methane that will be assessed during the first two or three years of project development and on the cost of infrastructure necessary to deliver this energy resource. At the same time major condition is to have the energy consumer;
3. **Municipality of Kobuleti,** which can get additional income from the reduced emissions through different financial channels operating under the UNFCCC.

6.2.2.5. Factors supporting project implementation

Important factors supporting the project are:

- The support from Batumi Municipality, which will be the user of this landfill and will perform closing down of old SWDS, located in Batumi. The latter is harming tourism and city infrastructure, being developed by the Batumi Municipality;
- The support from Ajara government, which is interested in the development of tourism in Ajara that requires sanitary conditions in the city and at neighboring territories to meet international standards;
- The problem, which is related to the identification of the new landfill management team and which represents one of important barriers to other project proposals, is already solved (company "Hygiena-2009 Ltd");

- In case the project is implemented, it will be the first example at the territory of Georgia of collection and application (in case of using it as energy resource) or flaring of landfill gas to reduce the GHG emissions and to improve the local environmental conditions. (Earlier such an attempt was unsuccessfully undertaken at the Tbilisi landfill);
- If the proposed undertaking is successfully registered as a CDM project, this will bring landfill owners additional investments even in case of only flaring the methane;
- The sum required for the arrangement of the new landfill is already allotted and the only problem is to raise additional funds to protect the environment and population from the adverse impact of the landfill.

6.2.2.6. Barriers to the project implementation

- Local residents living in the vicinity of projected landfill, who still consider it associated with insanitary conditions and source of different deceases. To remove this barrier, active awareness raising campaign that demonstrates the safety of the landfill, should be launched;
- One of the barriers is the absence of spare cash in Batumi and Kobuleti Municipalities to finance the arrangement of this additional system at the landfill. To overcome this barrier, the CDM preferential credit line could be used, which will be repaid with income generated from the emission reduction. However, before getting a loan, the amount of available methane must be assessed accurately as well as barriers that can prevent the implementation of this project;
- One of the barriers is also the lack of local skilled personnel, whose training increases project implementation costs;
- There are no experts in the country who practically know technical parameters of such systems and such knowledge is very important in the process of purchasing the system. In this case, long-term maintenance and guarantees should be requested, that will substantially increase cost of the project. Otherwise, the investor who is interested in buying reduced emissions should ensure the quality of system performance themselves;
- If no energy consumer can be identified at the nearby territory, this will reduce the actual impact of this technology on the region's economy and will not provide possible contribution to the development of heat energy sector. At this stage the supply of energy to local population in the village of Tsetskhlauri is under discussion.

6.2.2.7. Implementation activities and budget

At least 2 years are necessary for the implementation of the project.

Activities	Implementing agency	Terms of implementation (months) and budget (USD)	Anticipated results
1. For the initial 2 or 3 years observations should be carried out at the landfill and the amount of recovered from existing waste biogas (50% of which is methane) is to be measured.	Company "Hygiena-2009 Ltd".	12 20 000	The risk of project's inefficient implementation and incorrect economic calculations is reduced
2. Preparation of business plan	Project management team, possibly EBRD	3 25 000	Business plan is drown up to be submitted to investors
3. Purchase of gas recovery system	Company "Hygiena-2009 Ltd"	6 10 000	System is identified and purchased at the international market
4. Arrangement of gas wells and collecting pipes	By means of tender. Presumably with the assistance of foreign experts	8 58 000	Methane collection system is assembled
5. Arrangement of gas regulating station	The same	3 78 000	The same
6. Arrangement of gas pump-station to provide the delivery of gas for flaring or for supplying it to consumer	The same	4 195 000	The same
7. Arrangement of gas flare	The same	4 65 000	Methane security system is arranged
8. Arrangement of project monitoring system (permanent measurement of flared gas, or delivered electricity or gas, archiving of data, etc.)	Company "Hygiena-2009 Ltd"	5 20 000	Monitoring of results and certifying reduced emissions
9. Putting the system into operation	Company "Hygiena-2009 Ltd" in cooperation with the project implementing group	2 10 000	System is put into operation
10. Raising the awareness of population	Project management team	12 20 000	Population is well informed on present demands brought to landfills and is constantly monitoring the compliance of landfill operation with relevant standards
	Total	**501 000**	

Thus, the total budget of the landfill arrangement, installation of methane collection and recovery including monitoring equals to 501 000 USD. This sum does not include the expenses on the arrangement of infrastructure aimed for the delivery of gas to population. During 20 years of exploitation, assuming the minimum amount of waste to be 42 000 tons annually, 531 900 tons CO_2 eq (Annex VIII) of methane will be rendered harmless. If the price of 1 ton CO_2 eq is supposed to be at least 5 USD, the sum brought by this project in CDM terms may reach 2.7 million USD.

6.2.3. Measure to mitigate GHG emissions from the transport sector in Batumi – Electric Taxi

6.2.3.1. Description of the problem

Batumi is one of the most densely populated and fast growing cities in Georgia. According to official statistics, in 2003 its population comprised 121.0 thousand; by 2010 this number has grown to 140.4 thousand and in 2011 it reached 170.8 thousand. In line with population growth, traffic density increased significantly resulting in the increase of CO_2 emissions from transport sector, along with concomitant phenomena – overloaded traffic, loss of green line, environmental pollution and excessive noise.

In 2011 GHG emissions from Ajara energy sector[56] comprised 276.4 thousand tons in CO_2 equivalent, from which 53% fell on the transport subsector. Major part (86%) of transport sector emissions originated at the territory of Batumi.

According to 2011 data, the overall intensity of annual traffic at the Ajara territory comprised about 500 000 vehicles, from which essential loading came on Batumi. This city is also the main tourist center in Ajara that results in additional surcharge of traffic with vehicles coming from aboard. Traffic intensity in Batumi is divided into 2 phases – seasonal and non-seasonal. The season consists of about 3 months, during this time traffic intensity exceeds that of unseasonal period by 25-60%. The main surcharge comes on passengers' cars.

Apart from the tourist season, intensive traffic in Batumi takes place the year round. Data on the intensity of regular taxi traffic for the last 3-year period are presented in Table 6.2.3.1.

[56] These emissions include electric energy consumption emissions as well with the average electric grid emission factor of 0.0915t CO_2/MW per hour for 2010.

Table 6.2.3.1. Data on the increase of regular taxi traffic in Batumi in 2009-2011

Vehicle type according to fuel	Taxi		
	2009	**2010**	**2011**
Gasoline	368	489	510
Diesel	230	310	560
Electric energy	0	0	0
Compressed natural gas (CNG)	5	4	17
Total	603	803	1 087
Daily run (km/car)	41	41	41
Number of daily carried passengers	10	10	10
Average consumption of gasoline by 1 car (l/100 km)	14	14	14
Average consumption of diesel by 1 car (l/100 km)	9	9	9
Average consumption of CNG* by 1 car (m^3/100 km)	3	3	3
Total fuel consumption – gasoline (l)	772 800	1 026 900	1 071 000
Total fuel consumption – diesel (l)	310 500	418 500	756 000
Total fuel consumption – CNG (m^3)	2 250	1 800	7 650

* Compressed Natural Gas

About 70% of taxies running in the city in an unorganized manner are privately owned and are not state-registered. Their majority is obsolete, with injured fuel regulation system, that causes increased exhaust emissions and risk to passengers' safety. The rest of taxi fleet is owned by companies possessing traffic management infrastructure. The share of taxi in overall city traffic makes about 5-7%.

The traffic on taxi service depends, besides of fuel price, on seasonal conditions. In the tourist season the tariff is usually higher. The average tariff in the city equals to 0.6-0.7 Lari/km, that is not cheap and hence, the majority of population cannot afford to use the taxi service.

Thus, the improvement of taxi service system and introduction of lower emission new vehicles can greatly contribute to the mitigation of GHG emissions and perfection of public transportation in the city, as well as to the growth of Batumi attractiveness for tourists.

6.2.3.2. Objective of the project

The objective of the project is to promote the demonstration, on the example of Batumi, of advantages of using electric taxi over internal combustion driven taxi. The project implies bringing in of 100 electric taxies and creation of infrastructure required for their operation. The project will contribute to the implementation of voluntary commitment of Batumi Municipality under the Covenant of Mayors to reduce GHG emissions from the city territory. In case the project is successful, Batumi Municipality plans to further increase the number of electric taxies, especially

in tourist service sector, substantially reducing the transport sector loading on the environment. Besides, apart from the environmental objective, the project is aimed at the perfection of taxi service system and driving out of obsolete taxies from the market by the increase of competitiveness.

On the occasion of successful implementation of the project, Batumi Municipality plans to facilitate the substitution of 70% of taxi fleet with electric taxies in the long run perspective (more than 10 years).

6.2.3.3. Project implementation

Methodology

For the achievement of project goals, it is planned to introduce 100 electric cars for taxi service in Batumi. At present, negotiations are held with some car manufacturers, after which the model, color and design, that fits best the city landscape and that meets required safety criteria of the car, will be selected.

At the same time the legislative basis will be prepared that must ensure creation of municipal electric taxi system and implementation of its effective management.

Activities

The following actions are planned to be carried out in the process of project implementation:

1. The perfection of legislation at the local level and in case of necessity – the initiation of a bill in the Supreme Council of Ajara Autonomous Republic that will exclude any disparities between project goals and local legislation in the future. Some organizational measures should be taken as well, related with the management practices and ownership of the new company "Batumis avtotransporti Ltd";
2. Importing of cars after negotiations with manufacturer are over;
3. Selection by the city Municipality of some places to arrange taxi parking;
4. Equipment of cars with counters and portable radio to monitor their traffic and provide implementation of the call;
5. Selection and training of car drivers and maintenance personnel, giving the priority to local and experienced drivers well aware of local geographic conditions. The selection of drivers will be carried out by means of competition, taking into account physical appearance, knowledge of city geography, work experience and knowledge of foreign languages. After selection, the drivers will undergo relevant training on these subjects during several days. The training of maintenance personnel by the manufactures' company will take place at the site (in Georgia) or at its facility elsewhere;
6. Creation of necessary conditions for the maintenance of cars:

6.1. Arrangement of small repair-consulting base in a suburban area of the city;
6.2. Setting up of the "Call Center", which will permanently control and guide the functioning of electric taxi service system;
6.3. Arrangement of electric charge stations;
Two charging stations are to be mounted in different districts of the city. The installation of each will cost 20 000 USD, annual running costs make also 20 000 USD, from which 15 000 USD goes to service personnel salaries. The duration of one battery charge is 30 min. Station will operate 16 hours daily without days off. The price of currently sold 500 volt DC "Nissan" type charger is about 17 000 USD, which provides charging of a battery by 80% of its capacity in half-an-hour;
7. Parallel to these activities, negotiations and awareness raising campaign will be held with large hotels and tour-operators in order to assure them to replace traditional taxies with electric ones;
8. Carrying out of regular opinion polls in taxi users to define the quality of offered taxi service;
9. Controlling the reduction of exhaust emissions in the air;
10. Lobbying the integration of the discussed component in the urban development strategy.

6.2.3.4. Partners and beneficiaries

During the entire period of project implementation, major **partners** will be both state authorities and private entities, among them:

- Local government of the city of Batumi, which is actually main executor of the project, having commitments under the EU Covenant of Mayors to reduce GHG emissions. Batumi Municipality is one of the co-financiers of this project;
- The Ajara Environment Protection Administration, which is interested in the protection of air quality in the city and in adhering to air pollution norms. This authority will be involved in the monitoring of taxi exhausts in the air;
- Municipality of Tbilisi, which will share its experience in drawing up of Action Plan in the framework of Covenant of Mayors;
- Government of Georgia in the person of Ministry of Environment Protection, who is responsible for the fulfillment of commitments under the UNFCCC that implies, along with other items, mitigation of GHG emissions from the territory of Georgia;
- Local private sector, interested in creation of a new type of business requiring new services and the development of new infrastructure;
- Ajara Government, Ajara Ministry of Finance and Economics, who are interested in the creation of new jobs and promotion of ecologically friendly and attractive business development.

Beneficiaries of the project are:

- Population of Batumi, who will get cheaper, safer, comfortable and ecologically cleaner transport that will essentially lessen exhaust emissions and improve air quality in the city;
- Foreign and local tourists, who will be served by cheaper, safer, more comfortable and ecologically cleaner transport, that will greatly improve their holiday and recreation conditions;
- Batumi hotels and tourist agencies, which will provide ecologically cleaner tourism, being more attractive to visitors;
- Neighboring and other Municipalities which will get perfect example and experience in improving their vehicles and promoting cleaner environment;
- Transport and passenger transportation companies, whose income and competitiveness will significantly increase.

6.2.3.5 Factors supporting of project implementation

Major factors ensuring the successful implementation of the project are those supporting factors, that existed before the beginning of the project and that create the basis for the actual realization of this undertaking. These factors are:

- The emission reduction commitment, taken by Batumi Municipality, has to be fulfilled in any case. If the project will be implemented, by 2020 the emissions of GHG from the territory of Batumi could be reduced by 3 400t in CO_2 eq. annually, resulting in reduction of local pollution with soot, ozone, lead, etc.;
- Positive results of negotiations already held with electric vehicle manufacturing companies. Ahead of negotiations Batumi Municipality has surveyed the market;
- Readiness of Batumi Municipality to implement the offered project;
- Presence of experts in the field of transport development. The Batumi Municipality has adequate experience in managing such projects. In particular, Batumi Municipality has established the company "Batumis avtotransporti Ltd". In 2008 under the agreement between Batumi Municipality and EBRD, the project has been prepared on the improvement of municipal transport infrastructure and services, for which the Ajara government has increased the capital of the company by 2 000 000 Lari. With this sum the company has purchased 25 buses of "Zonda" model. Also, the EBRD raised a loan of 25 000 500 €, the tender has been carried out, under which 76 "Zonda" buses and machinery costing 150 000 € were purchased;
- Readiness of population and its awareness on measures to reduce the pollution level in the city;
- Existence of infrastructure part (central motor roads, regulated transport infrastructure) promoting the accomplishment of the project;

- Availability of local co-financing (budget resources) to promote the implementation of the project;
- Favorable geographic and landscape disposition (Batumi mainly occupies the flat terrain, that is desirable for electric taxi traffic);
- Cheaper fare compared to the same for fossil fuel driven taxi. According to relevant assessment, the fare will vary in the range of 0.35-0.40 laris per 1 km. After municipal purchase electric taxies will remain at the balance of the Municipality for 5 years, however, it will be possible to rent them to other persons with a purchase option and after 5 years the car will be transferred to private ownership;
- Readiness of private entities (hotels and tourist agencies) to take part in the project that was suggested at preliminary meeting with the representatives of private sector. At present 25 tourist agencies and 35 hotels are operating in Batumi. Among them 5 hotels have vehicle, serving passengers at their disposal. These vehicles comprise both minibuses and taxies. Majority of other hotels lease cars during the tourist season. As for the tourist agencies, only minority of them own cars that serve tourists on the tourist routes. Majority of vehicles are minibuses.

Taking into consideration the fact that most part of users of this transport are foreign visitors, its replacement with electric cars will benefit hotel managers and will result in comfortable traffic. While holding project negotiations with hotels and tourist agencies, efforts will be directed to the substitution of fuel powered cars with electric taxies. Electric cars will be transferred to them under certain form of ownership that implies both the direct purchase and leasing, which implies gradual repayment of the total price of the car.

- One of the main conditions ensuring successful implementation of the project is the economic and ecological advantages of offered technology.

1. Engine efficiency. The internal combustion engines are relatively inefficient as great part of energy released by combustion is lost in the form of heat. To the contrary, electric engine is more energy efficient. Usually, the gasoline-fueled engine uses 15% of fuel energy for driving, and the diesel-fueled engine-about 20%, while the electric car uses 80% of the battery energy. Electric vehicles consume from 10 to 23 KWh of energy per 100 km. The energy efficiency of contemporary widely manufactured and experimental electric car models is shown in Table 2.

Table 6.2.3.2. Energy consumption by different models of electric cars

Model	Tesla Roadster	Ford Focus Electric	Nissan LEAF	Smart fortwo electric drive	Mitsubishi I MiEV	Citroen Cl ev'ie
Specific energy consumption in the city KWh/100 km	17.4	20.7	21.5	12.0	18.7	14.4

In case of well-developed infrastructure, the fuel-driven cars have virtually unlimited run. While creating the infrastructure for electric cars, it is necessary to consider that their run is much shorter than that of ordinary cars. The time required for charging is also to be taken into account. For these reasons it is assumed that the application of electric cars is advisable only at small distances within the limits of a city. Hence, one of the means of successful introduction of this technology is the mounting of charge stations on the roads to provide charging of 80% of battery capacity in 30 min. The second option is to arrange the replacement of battery that will require only minutes to continue the journey. This technology is much cleaner and faster than the filling of tank with fuel.

2. Air pollution and CO_2 emissions. Electric cars practically don't pollute air in the city, as they give no exhaust containing such pollutants as soot, volatile organic compounds, hydrocarbons, carbon monoxide, ozone, lead and nitrogen oxides. In this respect, the ecological benefit is conditional, because the electric energy, consumed by electric car, may be generated in other place using fossil fuel. The same applies to CO_2 emissions, depending on the intensity of emission from the energy source, car efficiency and energy losses during the charging process.

In this project, for the calculation of CO_2 emissions reduction, the Georgian electric grid 2010 average emissions factor value equal to 0.0915tCO_2/MW per hour was used. Based on these data at the initial stage of the project, about 500 t of CO_2 will be saved annually, and in the long run, 70% of operating taxies will be replaced by electric ones, after 10 years, considering anticipated increase in their use, the annual saving will reach 3 540 t of CO_2. It should be noted that because the major part of electricity in Georgia grid is generated using hydro resources, the electricity emission factor is sufficiently low. Furthermore, in near future the share of hydro-generation is expected to grow even more, that will decrease the electric energy emission factor and increase the amount of emissions saved by the project.

3. Electric car efficiency (approximate assessment). The approximate financial calculations were performed to assess whether it is financially worth for a person or some entity to purchase electric car instead of fuel-driven car. According to "Nissan" data, the Nissan LEAF battery during the full operational period guaranties the 160 000 km run, after which it must be replaced. It is assumed that the annual run of the car equals to 20 000 km annually. Hence, the calculations were carried out for the 8-year period. The following circumstances were taken into consideration. The electric energy consumption Nissan LEAF makes is 0.212 KWh/km; Fuel consumption by diesel-powered car (Nissan Qashqai 1.5 dCi Acenta 110 hp) is 0.059 l/km and the

gasoline consumption by the Nissan Qashqai 1.6. Acenta 115 h/p is 0.084 l/km while driving in the city. In Georgia the electric energy tariff equals to 18 tetri/KWh or USD 0.109/KWh. The price of 1 litre of diesel fuel is 2.2 lari on the average (USD 1 333/L) and that of gasoline is the same.

According to Nissan experts estimate, the monthly maintenance costs of electric car equals to 30 USD while that of fuel-driven car is much higher and reaches 100 USD. To secure the reliability of results, calculations were performed with less differing respective values of 40 USD (USD 480/yr) and 80 USD (USD 960/yr). Several options are considered for comparison:

Option 1. Self-charging of electric car battery by the own source and charger. The cost of electric car includes price of battery charger- about 2 000 USD.

Option 2. Charging of battery with commercial fast charger. Presumably, the fast charger regularly will be used by a group of drivers, the majority of them – only in separate cases. The current price of 500 v direct current fast charger produced by "Nissan" equals to about 17 000 USD. This charger requires half-an-hour to charge a battery by 80% of its capacity.

According to calculations, the annual operational expenses for an electric car makes 1 423 USD (943 USD- electric energy cost and 480 USD – maintenance costs) in case of self-charging. Model values of "Nissan LEAF" electric car operational expenses are given below, in Table 6.2.3.

Table 6.2.3. Operational expenses of "Nissan LEAF" electric car

Annual run, km	electricity					Maintenance costs, USD/yr	Total expenses USD/yr
	Specific consumption, kWh/km	Annual consumption, kWh	Tariff		Cost, USD/yr		
			lari/kWh	USD /kWh			
20 000	0.2125	4 250	0.3660	0.2220	943	480	1 423

It has been revealed that difference between PV (Present Value) of operational expenses for electric car and car with internal combustion engine equals to 5 925 USD (diesel) and 9 482 USD (gasoline) respectively.

Preliminary calculations demonstrated that the propulsion by the electric car (Nissan LEAF) with own charger will be more profitable than: by the gasoline-fueled car (Nissan Qashqai 1.6 Acenta 115 hp) if the price difference between cars is less than 12 038 USD; by the diesel-fueled car (Nissan Qashqai 1.5 dCi Acenta 105 hp) if the price difference between cars is less than 8 481 USD.

6.2.3.6 Barriers to the project implementation

Some barriers could arise during the process implementation period, which should be envisaged beforehand. In particular:

- Road coating. In the historical part of the city (Old Batumi) roads are covered with ornamental tiles, negatively affecting running gear and electric parts of electric car. However, in the future it is foreseen that historical part of Batumi will be completely relieved from car traffic;
- Limited run (no more than 170-200 km) of the car with single battery charge. Due to the absence of charging stations, at the initial stage, the travel distance of electric cars could be limited to relatively small distances. To remove this barrier, presumably 25 from 100 purchased cars will be of hybrid type. Such diversification could enable the electric taxi fleet to cover the whole territory of Ajara;
- Skeptical attitude to innovations from both the population and private entities. The car importing companies do not introduce electric cars in Georgia and hence, they are not advertised. To overcome this barrier, a serious awareness raising campaign should be launched among taxi users, as well as in service personnel, who will be involved in running the electric taxies;
- Absence of relevant technical personnel. This barrier is common to any new technology and it deserves special attention, that is envisaged in item (5) of project work-plan;
- Batumi streets rehabilitation works that will partly restrict coverage of the entire territory of city by taxi service.. However, this barrier is temporary and hampers other activities as well;
- High prices of electric cars, compared to fuel-powered cars. The initial investment will be allotted by Batumi Municipality and co-financier investor (20%) that will decrease the starting costs. At the same time, in the framework of project proposal the Municipality examines different preferential schemes for purchasing electric cars by private sector;
- At the initial stage, some competition could arise with drivers of ordinary taxies. This barrier, presumably, should be removed by legislation to avert the impediment to electric taxi operations;
- Inadequate level of environmental awareness among population. To increase the popularity of this new kind of transport, local residents must be well-informed about environmental benefits of using electric cars. This could be easily substantiated in case of Georgia, where most part of electric energy is generated with clean hydropower resource;
- Unstable economic and political environment. The project proposal was prepared in 2012. At the end of this year new political party came to power, the priorities of which may disagree with that of previous party. Therefore, some ideas and projects may be revised. However, in this process the environmental efficiency of this project and its role in the development of Batumi as an ecologically clean tourist city will be certainly considered.

6.2.3.7. Implementation activities and budget

The two-year period is necessary to implement this project. The work-plan for its implementation is as follows:

Activities	Implementing agency	Terms of implementation (in months) and budget (USD)	Anticipated results
1. Perfection of legislation	Batumi Municipality, Ajara Supreme Council	2 30 000	Legislation facilitating coordinated and organized operation of electric taxi is created and adopted
2. Purchase and import of cars	Batumi Municipality	9 4 000 000	At least 100 cars are purchased and brought in Batumi
3. Selection and allocation of electric taxi parking areas	Batumi Municipality	2 50 000	A number of places are selected and allotted by Batumi Municipality for electric taxi parking
4. Equipment of taxies with counters and portable radio	Batumi Municipality	2 10 000	Taxies are equipped with counters and radio sets and operate in an organized way
5. Selection and training of drivers and maintenance personnel	Manufacturer of electric cars	2 50 000	Electric taxies are operated by qualified drivers and served by trained personnel
6. Creation of necessary conditions for the maintenance of cars: • Arrangement of small repair-consulting base; • Setting up of the "Call Center"; • Construction and arrangement of charge station.	Batumi Municipality	9 500 000	• Electric taxies are attended by the repair base, staffed with trained technicians • Electric taxi operational service center is created guiding the electric taxi service system • At the initial stage, at least 2 charge stations are arranged for charging taxies
7. Conducting negotiations with hotels and tour-operators	Batumi Municipality	24 15 000	Hotels and tour-operators are completely informed on all advantages of electric taxies
8. Conducting regular opinion polls during the 2-year period	Batumi Municipality's Transport Service	21 60 000	All stakeholders are periodically questioned to assess advantages and shortcomings of electric taxi service system
9. Arrangement of the system to control the reduction of noxious exhaust emissions from the transport sector	Batumi Municipality, Ajara environmental protection and natural resources Administration[5]	15 55 000	Continuous monitoring is conducted on noxious exhausts from the transport sector
10. Lobbying electric taxi integration into Batumi urban development strategy	Batumi Municipality	24 30 000	Lobbing is undertaken according to the results of regular opinion polls
11. Project management	Management team selected under the tender	24 655 000	Project is implemented
Total		**5 455 000**	

Table 6.2.3.4. The work-plan for its implementation is as follows:

#	Designation of the work	Quarter							
		I	II	III	IV	V	VI	VII	VIII
1	Perfection of legislation								
2	Purchase and import of electric cars								
3	Selection and allocation of electric taxi parking areas								
4	Equipment of taxies with counters and portable radios								
5	Selection and training of drivers and maintenance personnel								
6	Arrangement of small repair-consulting base								
7	Setting up of the "Call Center"								
8	Construction and installation of charge stations								
9	Holding negotiations with hotels and tour-operators								
10	Carrying out of regular opinion polls								
11	Controlling the reduction of noxious exhaust emissions from the transport sector								
12	Lobbying integration of electric taxi into the Batumi urban development strategy								

The item implies carrying out of periodic measurements in cooperation with the staff of Environment Protection Administration of exhaust concentrations in the air using special device (gas analyzes).

Project main components and services are financed by Batumi Municipality. The donor organization finances only 20% (1 180 000 USD) of total expenses that will be mostly spent on the purchase of first pilot batch of taxis (20 cars) and training of technical personnel.

6.2.4. Conversion of Batumi public transport to natural gas fueling

6.2.4.1. Description of the problem

The dynamic development of the city of Batumi and closeness of some densely populated settlements of neighboring municipalities required the enlargement of the city territory, as a result of which the city boundaries have changed twice:

- Till 2009 the city territory equaled to 19.5 km^2;
- From 2009 to 2011 – to 25 km^2;
- Since 2011 - 64.94 km^2.

Expansion of city limits, growth of population and consequent increase in transportation has caused increase of GHG emissions from city territory. In 2011 the emission of GHGs from Ajara energy sector made 276.4 thousand tons in CO_2

equivalent[57], from which 53% comes on transport sector. Most part (86%) of these emissions is attributed to the Batumi territory.

The specific feature of the city is that it is built according to Roman planning that implies crosscutting of parallel streets and creation of square districts, simplifying the traffic.

For the last half-a-century, the functional structure of Batumi streets underwent some important changes: pedestrian zones have emerged along with bicycle paths.

According to 2011 data, the overall intensity of annual traffic at the Ajara territory comprised about 500 000 vehicles, from which essential loading came on Batumi. This city is also the main tourist centre in Ajara that results in additional surcharge of traffic with vehicles coming from abroad. Traffic intensity in Batumi is divided into 2 phases – seasonal and non-seasonal. The season lasts about 3 months, when traffic intensity exceeds that in non-seasonal period by 25-60%.

Major characteristics of public transportation in Batumi are presented in Table 6.2.4.1.

It has to be noted that most part of buses and minibuses are running in the city in an organized manner, though the majority of vehicles are obsolete, having injured fuel regulation system, that causes increased exhaust emissions and creates risk to passengers' safety. Minibuses and buses used for passenger transportation in the city are owned by companies, and the rest – by private persons.

Table 6.2.4.1. Basic features of public transportation fleet in Batumi

Vehicle type according to fuel	Buses			Minibuses		
	2009	**2010**	**2011**	**2009**	**2010**	**2011**
Gasoline	43	52	52	120	118	85
Diesel	250	256	350	800	1 100	1 568
Electric energy	0	0	0	0	0	0
Compressed natural gas (CNG)	0	0	0	11	5	3
Total	**293**	**308**	**402**	**931**	**1 223**	**1 656**
Annual run (km/vehicle)	103 680	103 680	103 680	61 200	61 200	61 200
Number of transported passengers	52 740 000	55 440 000	72 360 000	16 758 000	22 014 000	29 808 000
Annual passenger turnover (passenger. Km)	369 180 000	388 080 000	506 520 000	117 306 000	154 098 000	208 656 000

[57] These emissions include electric energy consumption emissions as well, with the average electric grid emission factor of 0.0915 t CO_2/MWh for 2010.

Average consumption of gasoline by 1 vehicle (l/100 km)	20	20	20	13.5	13.5	13.5
Average consumption of diesel by 1 vehicle (l/100 km)	25	25	25	13.5	13.5	13.5
Average consumption of CNG by 1 vehicle (m^3/100 km)	0	0	0	13.5	13.5	13.5

City passenger buses belong to the company "Batumis avtotransporti Ltd", which is by 100% established and subsidized by Batumi Municipality, that costs about 2.5 million laris annually. Main part of these subsidies goes to the purchases of fuel and hence, the company and Municipality are interested in reducing expenses by converting to natural gas fueling.

Under the market economy conditions, passenger minibuses establish traffic tariffs mainly according to fuel expenses. For this reason, the fossil-fueled minibuses found themselves uncompetitive with buses, offering preferable tariffs due to municipal subsidies.

6.2.4.2 Objective of the project

The objective of the project is to reduce environmental impact of public transport in Batumi by converting city passenger minibuses (200 units) and buses (67 units) to natural gas consumption. This fleet comprises about 13% of city's public traffic. The implementation of this objective will contribute to the fulfillment of voluntary commitments by Batumi Municipality under the EU initiated Covenant of Mayors to reduce GHG emissions from the city territory. In case of successful accomplishment of the project, Batumi Municipality in its long-term strategy plans to further increase the re-equipment scale and facilitate the transfer of no less than 60% of motor fleet to this environmentally more friendly technology, thus minimizing the environmental impact of transportation sector. Calculations have suggested that in such case the annual reduction of GHG emissions will reach 30 500 tons in CO_2 equivalent by 2020.

6.2.4.3 Project implementation

Methodology

Project methodology implies the re-equipment of city passenger minibuses and buses in Batumi with gas-burning technical means, thus promoting the emissions reduction of GHGs and other gases as well. The research carried out in many countries has shown that natural gas vehicles (NGVs) produce less emissions compared to vehicles fueled by oil products or liquefied petroleum gas (LPG). Namely, the CNG engines emit 20% less CO_2,, 70% less CO, 87% less NMVOCs and 87% less nitric oxides (NOx) than oil or LPG fueled engines.

Activities

The following actions are to be implemented in the framework of the project.

- Nowadays passenger traffic companies in Batumi possess about 550-600 minibuses. The rest of minibuses belong to different services or private persons. At the initial stage of the project, carrying out of a competition is planned to reveal 200-250 minibuses having best parameters and technical features, that step-by-step will be re-equipped to replace diesel-fueled engines with CNG fueled engines;
- The same re-equipment will be performed with 67 city passenger buses owned by the Batumi motor-transport company, the expenses of re-equipment will be covered by Batumi Municipality in the form of subsidy;
- About 10 gas stations will go into operation by the end of 2013 to provide the refueling of natural gas vehicles that will ensure their uninterrupted traffic within the city boundaries. These CNG stations will be organized by petroleum products refueling companies, already operating at the territory of Ajara;
- Arrangement of safety provision and control system;
- Training of serving personnel to attend CNG stations and natural gas vehicles;
- Arrangement of regular control system to rate the reduction of harmful emissions into the atmosphere. The system will be jointly installed by Batumi Municipality and the Ajara Environment Protection Administration. Annual expenses on the functioning of this system within the city limits will be covered by Batumi Municipality.

6.2.4.4 Partners and beneficiaries

During the entire period of project implementation, major **partners** will be both the state authorities and private entities, among them:

- Local government of the city of Batumi, which actually is the main executor of the project, having commitment under the EU, initiated Covenant of Mayors process to reduce the GHG emissions. The Batumi Municipality is one of the co-financiers of this project;
- Passenger transportation companies, which are co-financiers and executors of the project. They are interested in safer and more comfortable conveyance of passengers and in paying less fines for the local air pollution. (The penalties system is not yet functioning, but it will be gradually introduced even in the Covenant of Mayors framework);
- Owners of gas stations, without participation of which the project cannot be implemented. This private sector, surely, will get benefit in case of successful implementation of the project. It will get the trained personnel and safety provision system free of charge;
- The Ajara Environment Protection Administration, which is interested in

protecting air quality in the city and in keeping norms on air pollutants. This authority will be engaged in the monitoring of noxious exhausts in the air;
- Municipality of Tbilisi, which will share its experience in drawing up of Action Plan in the framework of Covenant of Mayors;
- Government of Georgia and, in particular, the Ministry of Environment Protection, which is responsible for the fulfillment of commitments under the UNFCCC, that implies, among other items, mitigation of GHG emissions from the territory of Georgia. That is one of the principal objectives of the project.

The **beneficiaries** of the project are:

- Population of Batumi, who will get cheaper, safer, more comfortable and ecologically cleaner transport, that will essentially reduce exhaust emissions and improve air quality in the city;
- Foreign and local tourists, who will be served by cheaper, safer, more comfortable and ecologically cleaner transport, that will greatly improve their holiday and recreation conditions;
- Neighboring and other Municipalities, which will get perfect example and experience in improving their vehicles and promoting cleaner environment;
- Transport and passenger transportation companies, whose income and competitiveness will significantly increase;
- In the long-run perspective, when the transportation companies convert their vehicles to CNG as well, foreign and local investors will get cheaper services from them.

6.2.4.5 Factors supporting of project implementation

Major factors ensuring the successful implementation of the project are those supporting factors, that existed before the beginning of the project and which create the basis for the actual realization of this undertaking.

- The attractive and beneficial features of the project are as follow:
  1. ***Vehicles operating on natural gas do not cause respiratory illnesses.*** The significant increase in asthma cases (especially in babies) is directly connected with air pollution by vehicle exhausts. Engines operating on natural gas virtually do not emit carbon monoxide, methane, nitric oxides and other toxins and hence, they are relatively harmless for the health;
  2. ***The leakage of natural gas does not create considerable problems to ecology***, while the spills of petroleum and its products often cause ecological disasters;
  3. ***Safety.*** The compressed natural gas is relatively safe product, the inflammation danger of which is much smaller than for other fuels. This is caused by its volatile character, determining rapid dispersion in the air, while gasoline and diesel spread about at the surface. The CNG tank is mounted at a very safe place;

4. ***Prolongation of engine running period.*** The fueling of CNG increases the operational period of the vehicle engine. Burning of natural gas does not leave any waste as far as it is completely volatile and is burned by 100% in contrary to other types of fuel. Hence, the engine is not polluted, that provides the prolongation of its operational period.

- Fulfillment of voluntary commitment on the reduction of GHG emissions taken by Batumi Municipality under the EU initiated Covenant of Mayors, in which one of main sectors is the Transport sector;
- Positive results of preliminary negotiations held with passenger transportation companies and their willingness to take part in the project;
- Readiness of Municipality and other state authorities to implement the offered project;
- Presence in Georgia of relevant experience in managing such projects (presence of local experts in this field);
- Willingness of Batumi Municipality to implement measures against air pollution in the city;
- Presence of supporting infrastructure (central roads, regulated transport infrastructure);
- Availability of co-financing (budget resources) to promote the implementation of the project;
- Economic attractiveness and high competitiveness of project results (cheaper fare compared to fossil fuel driven taxi);
- Presence of corresponding legislation.

6.2.4.6 Barriers to the project implementation

During the accomplishment of the project some obstacles can arise that may be regarded as barriers to project implementation. In particular:

- Allocation of initial expenses for the re-equipment of vehicles and arrangement of gas stations that should be covered by the private sector. Despite the preliminary verbal agreement some difficulties may arise, for resolution of which the Batumi Municipality should have a reserve plan. E.g., the gas stations may be mounted by Municipality and sold afterwards;
- In spite of relative safety of natural gas, the strict safety measures have to be taken while dealing with it. For the prevention of any accidents, the vehicles must be carefully controlled after every 1 000 km run that will be performed by the specialists of "Batumis avtotransporti" company, trained according to the relevant criteria;
- Relatively short run with a single refueling of tank, that will be definite barrier to the project in case of the lack of gas stations located at the optimal distances from each other. This barrier should be removed by designing relevant scheme and arrangement of stations according to it;
- Opinion widely spread among the population that gas-fueled transport is

less safe than gasoline or diesel fueled transport. Proper campaign should be undertaken and safety measures have to be provided as the maximum extent;

- Irreproachable and safe operation of gas stations and gas-fueled vehicles in compliance with international standards is essentially important for getting final results. The offered project proposal is mainly directed to the removal of this barrier. The training of serving personnel to provide the safety of operation and monitoring of compliance with the standards are planned in the project;
- The lack of gas stations could turn out as a certain barrier on the way to project success. To prevent this obstacle, correct planning of gas stations and traffic routs is essential along with the provision of necessary minimum number of stations already at the first stage of the project.

6.2.4.7 Implementation activities and budget

At least 2 years are necessary to implement the project

Activities	Implementing agency	Terms of implementation (months) and budget (USD)	Anticipated results
1. Tender on minibuses selection and drawing up agreement with minibus owner companies	Batumi Municipality	6 20 000	Agreement with minibus owner companies on the re-equipment of vehicles (minibuses) is signed
2. Conversion of minibuses (200 vehicles) by the minibus owner companies	Minibus owner companies	21 500 000	At least 200 minibuses are converted to compressed natural gas (CNG) fueling
3. Re-equipment of buses (67 vehicles) owned by the company “Batumis avtotransporti Ltd” with CNG devices	Batumi Municipality	24 335 000	At least 67 passenger buses are converted to CNG fueling
4. Arrangement of gas refueling stations	Companies already owning refueling stations in Ajara	12 These expenses are not included in the project budget at the present stage	At least 10 gas refueling stations are arranged
5. Introduction of safety provision and control system	Batumi Municipality	6 25 000	Safety measures are adopted
6. Training of personnel serving at gas stations and CNG vehicles maintenance centers (especially on safety provision)	Batumi Municipality	6 15 000	Group of professionals is created. Safety control is continuously carried on

7. Arrangement of system to control the reduction of exhausts from the transport sector	Batumi Municipality jointly with Environment Protection Administration	15 55 000	System to monitor the reduction of noxious exhausts is created
	Total	950 000	

Project's main direction is financed by Batumi Municipality, while the conversion of 10 buses (Activity 3), training of personnel (Activities 5,6), arrangement of monitoring system and its operation for one year period (Activity 7) are financially supported by the donor, that makes 14% of project total cost.

The project work-plan:

#	Designation of the work	Quarter							
		I	II	III	IV	V	VI	VII	VIII
1	Tender on minibuses selection	X							
2	Drawing up and signing of agreement with minibus owner companies		X						
3	Conversion of minibuses by the minibus owner companies		X	X	X	X	X	X	X
4	Re-equipment of buses with CNG fueling devices by the company "Batumis avtotransporti Ltd"	X	X	X	X	X	X	X	X
5	Arrangement of gas refueling stations		X	X	X	X			
6	Introduction of safety measures provision and control system			X	X	X			
7	Training of personnel serving at gas refueling stations and CNG vehicles maintenance centers (especially on safety provision)			X	X	X			
8	Carrying out control on the reduction of noxious exhausts from the transport sector				X	X	X	X	X

ANNEXES

Annex I

Table 1. Changes in climate parameters between 1961-1985 (I) and 1986-2010 (II) periods at Ajara's six metrological stations.

Climate index	Spring						Summer						Autumn						Winter						Y Year					
	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass
T,^{0}C	-0.1	-0.2	0	0	-0.1	-0.1	+0.9	+0.6	+0.8	0.6	+0.7	+0.8	+0.4	+0.1	+0.6	+0.8	+0.2	+0.2	-0.4	-0.4	-0.1	+0.3	-0.3	+0.1	+0.2	0	+0.4	+0.5	+0.1	+0.2
P,%	-8	-5	-5	+28	+5	-26	-5	-1	±0	+14	+14	-20	+9	+16	+9	+17	+14	-16	-3	+3	+6	+10	+13	+1	±0	+5	+4	+16	+11	-15
RH, %	-1	±0	±0	+3	-1	+4	-2	+1	±0	+2	±0	+3	-2	±0	±0	+3	-1	+2	+2	+2	+1	+5	+2	+4	-1	+1	±0	+3	±0	+3
FD0, night	-3	+12	-8	+15	+15	-275	–	–	–	–	–	-16	–	+5	-3	+5	+13	-202	+24	-33	-22	-10	+60	-272	+7	-26	-70	-38	+22	-1015
ID0, day	-2	-2	-1	-2	+5	-31	–	–	–	–	–	-2	–	–	–	–	+13	-4	-6	-2	-1	-11	+121	-123	-8	-4	-2	-15	+122	-331
SU25, day	-29	-82	+9	+46	+9	–	+204	-77	+397	+216	+256	+10	+103	+21	+211	+205	+65	+1	-8	-3	-1	+4	–	–	+272	-141	+617	+473	+330	+11
TR20, night	+14	0	-1	+8	+2	–	+381	+138	+297	+204	+13	–	+68	+2	+46	+35	+6	–	–	–	–	–	–	–	+463	+140	+342	+247	+21	–
R10, day	-27	-62	-9	+55	+16	-134	-40	-86	-6	+31	+14	-118	+24	-29	+61	+14	+26	-103	+18	-43	+34	+47	+47	-27	-64	-247	+48	+127	+78	-430
R20, day	-23	-40	-8	+44	+13	-22	-23	-53	-5	+30	+17	-27	+13	-13	+44	+9	+28	-45	-8	-23	+20	+5	+36	-18	-63	-149	+29	+74	+83	-130
R50, day	-8	-10	-3	+3	-2	–	-4	-10	+1	+2	+2	-4	+16	-2	-1	+20	+8	0	0	-6	+14	+25	+13	-1	-1	-33	+12	+48	+17	-5
R90, day	–	–	-1	0	-1	–	+4	-4	+2	-3	–	–	+13	-2	+7	+11	-1	–	+1	-4	+2	+3	–	+1	+17	-12	+10	+11	-2	+1

- *In the II period observations were ceased in 2006.*

Average for periods
T _ mean air temperature, ^{0}C
P _ seasonal/annual sums of precipitation (change in %)
RH _ mean air relative humidity (average in %)
Total for periods
FD0 _ seasonal/annual number of frosty nights (Tmin <0°C)
ID0 _ seasonal/ annual number of frosty days (Tmax <0°C)
SU25 _ seasonal/ annual number of hot days (Tmax>25°C)
TR20 _ seasonal/ annual number of tropical nights (Tmin>20°C)
R10 _ seasonal/annual number of days with heavy rainfall (≥10mm)
R20 _ seasonal/annual number of days with heavy rainfall (≥20 mm)
R50 _ seasonal/annual number of days with heavy rainfall (≥50 mm)
R90 _ seasonal/annual number of days with extremely heavy rainfall (≥90 mm)
±0 – nearly unchanged value
0 _ unchanged value
(-) _ not observed

Table 2. Anticipated changes in climate parameters in Adjara between 2021-2050 and 1961-1990 periods

Climate index	Spring						Summer						Autumn						Winter						Y Year					
	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass	Batumi	Chakvi	Kobuleti	Keda	Khulo	Goderdzi Pass
T,^{0}C	1.2	1.8	1.3	1.7	1.4	1.3	1.8	2.1	2.1	1.6	2.1	2.4	2	0.9	1.1	1.3	1.8	1.1	1.9	1.8	1.8	1.9	1.4	1.7	1.7	1.6	1.6	1.7	1.7	1.6
P,%	-0.5	11	-0.9	48.3	3.3	-1.3	-0.7	28.2	11.5	17.9	-0.1	17.2	0.3	29.9	25.5	-24.9	-2.9	-8.3	2.6	21.2	3.8	-8.1	27.9	28.1	1.3	23.1	11.9	1.8	9.2	8.3
RH, %	76.9	77.8	82.4	73.7	67.3	83.9	78.6	81.3	82.6	82.2	77.2	86.1	76.2	81.5	85.0	86.4	70.7	82.4	69.9	75.8	78.2	81.3	70.9	89.7	75.4	79.1	82.1	80.9	71.5	85.5
FD0, night	5	-2	15	6	-8	-132.5	0	-	0	-	0	-12.5	0	-	5	-4	-69	-217.5	-20	-73	-145	-192	-301	-87.5	0	-80	-148	-194	-380	-452.5
ID0, day	0	-	-	-20	-30	-127.5	0	-	-	-	0	-2.5	0	-	-	-28	-5	-35	0	-	-	-383	-143	-215	0	-	-	-435	-183	-390
SU25, day	28	238	158	137	271	5	683	193	338	413	857	35	343	363	420	83	335	7.5	5	98	15	18	0	0	1043	898	928	648	1462	47.5
TR20, night	3	48	60	25	4	-	1153	840	748	728	108	-	226	185	120	41	15	-	0	0	0	1	0	-	1375	1073	925	794	126	-
R10, day	-28	-8	-28	56	41	47.5	240	35	-120	52	7	2.5	555	5	-55	177	154	-80	146	50	-25	147	191	145	958	85	-230	480	410	115
R20, day	-47	0	-15	40	27	27.5	-8	8	-70	6	-19	-37.5	-15	-2	-45	184	24	-42.5	-35	58	-23	96	71	45	-87	-60	-155	350	113	-10
R50, day	-12	3	5	-60	2	2.5	-50	3	-13	-74	1	-5	-122	2	10	-38	-9	0	-40	18	3	-210	16	5	-227	20	7	-374	10	2.5
R90, day	0	5	0	2	-1	0	-5	0	3	-2	0	0	-25	18	20	97	-2	1	0	0	0	-2	3	1	-33	28	23	95	-1	2

Average for periods
T _ means air temperature, ^{0}C
P _ seasonal/annual sums of precipitation (change in %)
RH _ mean air relative humidity (average in %)
Total for periods
FD0 _ seasonal/annual number of frosty nights (Tmin <0°C)
ID0 _ seasonal/ annual number of frosty days (Tmax <0°C)
SU25 _ seasonal/ annual number of hot days (Tmax>25°C)
TR20 _ seasonal/ annual number of tropical nights (Tmin>20°C)
R10 _ seasonal/annual number of days with heavy rainfall (≥10mm)
R20 _ seasonal/annual number of days with heavy rainfall (≥20 mm)
R50 _ seasonal/annual number of days with heavy rainfall (≥50 mm)
R90 _ seasonal/annual number of days with extremely heavy rainfall (≥90 mm)
±0 – nearly unchanged value
0 _ unchanged value
(-) _ not expected

Annex II - Measures to combat sea coastal zone erosion in Ajara

Table 1. State of Ajara sea coastal zone and measures to combat seashore erosion

#	Name of the section	Current state	Required measures	Notes
1	2	3	4	5
1	Sarpi coastal zone	In seashore zone the deficit of alluvion has been created by the use of beach inert material for constructing the Sarpi custom-houses. Customs territory is reinforced with iron rabbets (Georgia) and broken stone berma (Turkey)	To prevent destructive impact of heavy storms systematic reinforcement of central highway is required, guarantying stability under the rising eustazy and growing intensity of storms	Coastline is rising at the rate of 2 mm/yr. but does not catch up the sea level rise
2	Kalendere Cape	Between Sarpi and Kvariati 2-km long rocky cost is located, crossed by the central highway. Highway is constructed at the rocky embankment being systematically in some degree washed off by the sea	Highway built at the embankment requires reinforcement with broken stone berma ensuring stability under the rising eustazy and growing intensity of storms	Highway connects Georgia with Turkey since 1997
3	Kalendere Cape – mouth of R. Chorokhi (Adlia)	Beaches in southern part of the section are in the stable condition while in northern part of section seashore erosion is going on at the rate of 4-5m/yr, presumably accelerating in future. At stable part multistory houses and hotels are being built, though due to ceasing of sediment feeding from R. Chorokhi the activation of erosion processes is expected at this part as well, along the washing down of coastline and destruction of building	Seashore territory requires artificial nourishment with inert material, the amount of which significantly increases with sea level rise	Section contains Goonio and Kvariati settlements. In southern part the width of beaches exceeds 70m. Ceasing og sediment feeding is caused by the construction of HPP cascade on R. Chorokhi in Turkey, aggravated by sea level rise and increase in wave intensity
4	R. Chorokhi mouth-Batumi Cape	At southern part at this section - from R.Chorokhi waterfall to Airport runway – intensive washing away of seashore is in progress. In the mid-art, from Airport to R. Mejinistskali mouth stability of coastline is retained by beach artificial nourishment (100 thousand m^3 annually), resulting in widening of beach by 40-50 m. Northern part includes Batumi Cape, coastal boundary of which is adjacent to sources of Batumi underwater canyon. Subwater landslides are causing coastal instability that could trigger waterside crumbling and collapse of constructions built at the cape	As the Southern part of section represents non-recreational zone, coast reinforcement is advisable with broken stone berma. At the medium portion coast protection should be continued by beach nourishment at current rate growing in case of necessity, and at Batumi Cape construction of planned multi-story buildings is to be prohibited	At southern part without carrying out coast protection measures the beach would be washed off and all utilities will be found in the sea. At medium portion conduction of coast protection measures is of utmost necessity. Otherwise territory of new boulevard will be washed away. At the background of global warming acceleration of washing down processes is expected.

1	2	3	4	5
5	Makhinjauri Cape – Green Cape	Resulting from piling of large amount of inert material in 1982-1989, beach parameters have increased to such an extent that coastline is in stable condition up to now. Coast protecting walls erected earlier were submerged under the beach. Allovion brought by small rivers is feeding only limited localities of the section	Monitoring is to be conducted on coast parameters to determine necessity of inert material piling in future taking into account current global warming	Before the upset of Chorokhi single lithodynamic system the main source of seashore feeding was R. Chorokhi's sediment
6	Green Cape - Tsikhisdziri	North from Green Cape to Botanical Garden coastline is reinforced with broken stone berma and shoreline is in stable state. In the central part of Chakvi segment under the impact of wave-repelling wall wide beaches and stable coast are created at outlying areas but in central part itself damaged areas have emerged	In the central part of Chakvi segment for restoring recreation zone along the walls one-time heaping of 0.5 million m^3 inert material is required followed by systematic nourishment with small amount (30 000 m^3) of material annually. Increase in annual nourishment could become necessary	At this section allovion of R. Chakvistskali is utterly insufficient for the feeding of coastline, is far more wider, relatively fine-grained and most of all perspective from the recreational standpoint
7	Tsikhisdziri-Kobuleti R.Choloki mouth	Owing to heaping in 1983-1990 of 2 million m^3 of inert material, in Bobokvati and Kobuleti seashore has increased by 25 ha. Further nourishment was conducted in 2007 (120 thousand m^3) being insufficient to compensate stopping of sediment transported from R. Chorokhi. At northern peripheries of Tsikhisdziri Cape wave - repelling wall along the railway is destroyed and beach is narrowed. In Bobokvati coast is reinforced with iron rabbets causing contraction of beaches along them and widening on edges. At the central part of Kobulti segment stepped wave repelling tall walls and spurs are located being unable to provide coast stability. The territory of new boulevard is in critical state. North to the wall (in Pichvnari) beach is wide (80-100 m) and waterside is protected	In the southern part of this section, at Tsikhisdziri segment, arrangement of broken stone berma is necessary to restoration of massive heaping of inert material is required accounting for changes due to current global warming. North to Kobuleti central segment the started coast protection measures are to be continued with the building of constructions similar to present walls. In the northern segment (Pichvnari) eradication of spurs are located being unable to provide coast stability. The territory of new boulevard is in critical state. North to the wall (in Pichvnari) beach is wide (80-100 m) and waterside is protected	Seashore at this section, unlike other sections of Ajara coastline, is far more wider, relatively fine-grained and most of all perspective from the recreational standpoint

Annex III - Problems revealed in Agriculture and changes in vegetation periods

Table 1. Main problems revealed in Agriculture

Municipality	Culture	Problem	Start of vegetation (^{0}C)	Sum of required temperature (^{0}C)
Kobuleti	Mandarins	It cannot ripen until December, due to what the fruit is damaged due to November frosts. It requires systematic prevention from wracks, otherwise the fruit is useless.	11-12	4 000
	Oranges	It requires grand totals of active temperatures and cannot ripen until the mid of December, accordingly, the fruit is sour and damaged due to December frosts	11-12	4 500
	Kiwi	Vegetation periods starts early, it is collected at the beginning of November and is not damaged due to frosts. The basic price is higher, than citrus. Is resistant towards wrecks.	8	3 500
Khelvachauri	Mandarins	It cannot ripen until December, due to what the fruit is damaged due to November frosts. It requires systematic prevention from wracks, otherwise the fruit is useless.	11-12	4 000
	Oranges	It requires grand totals of active temperatures and cannot ripen until the mid of December, accordingly, the fruit is sour and damaged due to December frosts and snow	11-12	4 500
	Kiwi	Vegetation periods starts early, it is collected at the beginning of November and is not damaged due to frosts. The basic price is higher, than citrus. Is resistant towards wrecks.	8	1 500
Keda	Grapes (Chkhaveri)	Is more sensitive towards the disease that Tsolikauri, but due to the grapes and high quality of wine made of it the request on it is higher and market price comprises 3-5 Gel per kilo.	8	4 200
	Grapes (Tsolikauri)	The harvest is high, the wine is good, so it is the most perspective culture after Chkaveri	8	4 000
	Tomatoes	Is very damaged by the wrecks, that is why systematic preventive measures should be taken	12	3 000

Khulo	Potatoes	Is one of the most perspectives from the annual cultures in high mountainous Ajara. Needs rebranding.	4-6	2 000
	Pastures	Although pasture areas are large, they have not been refreshed during the recent years, that is why all the pastures are degraded.	2-4	1 500
Shuakhevi	Pastures	The refreshment of pastures has not been carried out for years, that is why fertilization of soils is needed	2-4	1 500

Table 2. Changes of parameters of vegetation periods between 1961-1985 (I) and 1986-2010 (II) according to the 5 meteo stations of Ajara. Differences are given between the periods I and II

Margin temperature	12^{0}C			11^{0}C			8^{0}C			6^{0}C		
parameter / climatic zone	Δt Day	ΔT ^{0}C	ΔP mm	Δt Day	ΔT ^{0}C	ΔP mm	Δt Day	ΔT ^{0}C	ΔP mm	Δt Day	ΔT ^{0}C	ΔP mm
Batumi	-6	+58	-9	+1	+129	-12	-4	+372	+120			
Chakvi	-2	+22	+72	0	+103	+32	-7	-26	+12			
Kobuleti	0	+137	+71	+3	+134	+71	-2	+118	+39			
Keda	+1	+132	+146	+6	+193	+176	-3	+3	+193			
Khulo	-1	+70	+63	-4	+40	48	-1	+71	+64	0	+50	+42

Symbols: Δ*t –duration of the vegetation period*
Δ*T – totals of active temperatures during the vegetation period*
Δ*P – totals of precipitation during the vegetation period*
Δ- *difference between the periods I and II*

Table 3. Forecasted changes between the parameters of vegetation periods between the two periods 1986-2010 (I) and 2020-2050 (II)

Margin temperature	12^{0}C		11^{0}C		8^{0}C		6^{0}C		4^{0}C	
Parameter / Meteo-station	Δt Day	ΔT ^{0}C	Δt day	ΔT ^{0}C	Δt day	ΔT ^{0}C	Δt day	ΔT ^{0}C	Δt day	ΔT ^{0}C
Batumi n b	+31	+693	+22	+820						
Chakvi	+37	+588	+44	+626						
Kobuleti	+23	+539	+19	+527						
Keda	+22	+489	+26	+488	+43	+701				
Khulo	+30	+686	29	+679	+23	+624	+31	+694	+57	+1 350

Symbols: the same as per Table 2

The difference between the considered periods show significant changes. These changes are caused due to increase of the vegetation period. For example, transfer period to 4^0C in Khulo comprised 686 days for 2026 (04.03.2026-18.02.2026). There were also several cases that caused increase of vegetation period and accordingly, resulted in increase of totals of the active temperatures.

The dates of transfer of low temperatures are not calculated, since solid transfer does not happen on such temperatures.

Table 4. Changes in climatic parameters during the two periods(1961-1985 and 1986-2010) used in multicriteria analysis

Extreme indexes / Batumi meteo-stations	SU25	R(50)	SPI[58]
Batumi meteo-stations	+272	-1	+3
Chakvi	-141	-33	+3
Kobuleti	+617	+12	+9
Keda	+473	+48	+9
Khulo	+330	+17	-5
Goderzi	+11	-5	+5

Table 5. Changes of climatic parameters between the two periods (1961-1990 and 2021-2050)

Extreme indexes / Batumi meteo-stations	SU25	R(50)	SPI[59]
Batumi meteo-stations	+1 043	-227	-6
Chakvi	+898	+20	+4
Kobuleti	+928	+7	+2
Keda	+648	-374	+15
Khulo	+1 462	+10	+14
Goderzi	+48	+3	-3

[58] Changes in extreme draughts are taken for the past period
[59] Changes in strict draughts are taken for the future period

Annex IV- Vulnerability assessment parameters

Parameters for the assessment of vulnerability per each municipality

1. Amount of farmer organizations (farmers unions)
2. Employment of women in agriculture (amount or %)
3. High education (amount or %)
4. Special agricultural education
5. Amount of domestic animals
6. Average income per person
7. Amount of population
8. Amount of elementary, secondary and high schools, colleges and hospitals and persons with internet access
9. Number (amount) of asphalted (or good quality) roads (km)
10. Amount (number) of farmers' markets
11. Common area of the municipality
12. Total area for the agricultural land
13. Areas for meadows and pastures
14. Areas of forest
15. Amount of local species (agricultural breeds and species)
16. Amount of women
17. Amount (number) of kids
18. Amount of population below the poverty margin (or in %)
19. Speed of increase of population
20. Amount of small farms (when the area is less that 1 ha)
21. Land degradation (areas in ha, all types of degradation)
22. Production of agricultural products for all types of agricultural products: crops, vegetables, cattle (live-stock), poultry, fruit and others;
23. There are active areas in agriculture for the time being
24. Areas of crops
25. Migration of the population
26. Number of employed in agriculture

Annex V- Health vulnerability indicators

Description of criteria used in multicriteria assessment of health sector

1. CLIMATE CHANGE ADAPTATION CAPACITY

Social capital:

Social capital is defined via using the following indicators (index): according to the number of persons who get existing (living) aid, pensin and people with healthcare police (insurance), also according to the number of employeed women.

Persons receiving existing minimum aid, pension and owners of medical insurance (police): Presumably, people
who get social financial aid from the Government should be more protected and accordingly, possess more adaptation capacity rather than those, not having such kind of support. the municipaliyt, where the share of the socially protected people is the lowest should be considred as the most vulnerable and will be rated with coefficient 1.00. The coefficient of vulnerability decreases when the number of socially protected people increases.

Emplyment of women: Participation of women in labor is the indicator of level of public development. We tried to gain information regarding the percentage of employeed women per each municipality, though we failed to get this info. We decided that all municiaplities are aqual and rated all of them with coefficient 1.00.

Human capital:

For defining the human capital three indicators are used: reading and writing skills, amount of qualified staff and qualified medical personnel.

Level of reading and writing skills: The municipality, where the indicator of writing and reading skills is the lowest, is considered to be the mostly unprotected (vulnerable) and is rated with coeffcient 1.00. Unfortunatelly, no reliable data regarding the writing and reading skills in Ajara region existed. Due to the above, we assumed, that the level of writing and reading skills was equal in all of the 4 regions and all of them were rated with the equal coefficient 1.00.

Level of high education: Municipality, where the educational level is comparatively low, can be assessed as more vulnerable and be rated with vulnerability coefficient 1.00.

Qualified staff: We considred, that the municipality, having more qualified personnel, possesses more economic potential and higher capacity. The municipality with the lowest indicator, is considered as the most vulnerable and is rated with coefficient 1.00.

***Qualified medical personnel*:** We used the level of qualified personnel as the general indicator of the development of sociaty and municipality. We included doctors and medical nurses into the qualified medical personnel. The staff engaged in the municiaplity medical field are considered as the most vulnerable and are rated with coefficient 1.00. With the increase of the medical personnel this coefficient will dicrease.

Financial capital:

Financial capital is evaluated by the amount of the owners of private medical insurance number of people below the poverty margin and annual average salary/income.

Private medical insurence: The owner of the private insurance package is either the family or the individual who can use corporative insurance, accordingly is either employeed or pays for the insurance himslef, i.e. is the owner of certain capital that allows him to use the expensive priviledge. Such kind of population can easily adapt. Those municipality that is less covered vy such kind of private insurance package is considered as the most vulnerable and is rated with coefficient 1.00.

Average salary: Regions with high average salaries are considered to be rich, thus the population has more bilities to get prepared for negative conditions and be ready. Municipalities with the lowest average salaries were rated with the coefficient 1.00.

Population below the poverty margin: Those part of population that according to the rating points are below the poverty margin possess low potential for adaptation, accordingly, their vulnerability coefficient was rated as 1.00.

Physical capital:

Physical capital is evaluated according to the development of infrastructure, accecc to medical services and amount of emergency medical centers.

Infrastructure: Infrastructure is calculated as follows: the amount of population of the municipality is divided to the number of preliminary, beginning and interim schools, also to the number of colleges, universities and hospitals. Via this we get information on how many person come per school, college, university and hospital. The region with the higest indicator is considered as the most vulnerable and is rated with the coefficient 1.00.

Availability on medical services: The acceccability to the medical services is calculated by summing up of indicators of medical centers and roads. Accordingly, the more medical services are and the more asphalted roads are the higher is the access to the high medical service. The calculation of accessibility to medical services is calculated as follows: the amount of medical centers in the municipality is divided to the amount of the population; the indicator of asphalted roads is calculated by dividing the whole length of roads (km) to the area of the municipality (sqm). So, the

higest indicator corresponds to the most protected munucipality. At the same time, the lowest indicator of accessability corresponds to the most vulnerable municipality and was rated with the coefficient 1.00.

Medical emergency centers: Emergy medical centers are assessed as physical capitals needed for adaptation of the municpalities. Municipalities with the lowest indicator of centers were rated with the coefficient 1.00.

2. IMPACT OF CLIMATE RISKS

According to our methodologies, different/changing impact of climate change on systems is defined via average temperature changes, heat index, tourism climate index and extreme events.

Changes in average temperature: Changes in temperature is expressed as difference between the temperature between the years 1981-2005 and 1956-1980. We took the changes of indicators of the average temperature for Summer, since climate related diseases mostly occur in summer and can serve as the most exact indicator. The municipality with the highest indicator of temperature change is considered to be the most vulnerable and is rated with the coefficient 1.00.

Heat Index (HI): Heat index gives opportunity to define exactly what temperature is accepted by the human in humuduity conditions. Special tables show how high temperature can affect the human organism. We selected maximal indicators of heat index per municipalities ("dangerous" days) and those municipalities having the highest amount of days were considered as the most vulnerable and granted with vulnerability coeffcient 1.00.

Tourism climatic index (TCI): Tourism climatic index is used for the assessment of tourism potential of the region and describes the level of climatic comfort. Those municipalities that have high indicators are more profitable for tourism development. The municipalities with the lowest indicators were rated with vulnerability coefficient 1.00.

Extreme events: According to the experts, increase of extreme events is linked to climate change. The more such kind of events occur, the higer is the number of health problems. So, the municipality with the highest number of such extreme events is rated with the coefficient 1.00. The extreme events related to climate change are the following: draught, intensive precipitation, flashfloods, landslide, mudflow, avalanches, strong winds, storms.

3. VULNERABILITY AGAINST THE RISKS RELATED TO CLIMATE CHANGE

Other environmental risks:

Contamination of water: High indicators of water contamination refer to non-profitable environment conditions and accordingly, the municipalities with high indicators are more vulnerable to climate change risks. Relevantly, these municipalities were rated with the coefficient 1.00.

Pollution of air: Similar to contamination of water, municipalities with high indicators of air pollutions were rated with vulnerability coefficient 1.00.

Contamination of land: Similar to contamination of water and air, municipalities with high indicators of land contamination were rated with coefficient 1.00.

Vulnerability of local communities to climate change risks:

Women: Climate chnage most probably has unproportional affect on women, compared to men. Changes of natural resources caused to climate change most probably more affect women via direct or indirect ways. For example, women's organism is physically less prepared against extreme events, especially during the pregnancy period, when the woman becomes more sensitive to climate changes. The municipality with the higest percentage indicator is considered to be the most vulnerable and is rated with the coefficient 1.00.

Kids: Tentatively, kids are even more vulnerable to extreme events. The municipality with the highest percentage amount is considered the most vulnerable and is rated with the coefficient 1.00.

Older people: According to the International experts, older people, like kids, are seperated as the most vulnerable group to climate changes. In the older age the number of chronical diseases (cario-vascular) is higher and more vulnerable to the climate change. So the municipality with the ighest indicator is considered as the most vulneravle and is rated with the coefficient 1.00.

Increase of population: Increase of popualation is assessed as the positive trend and thus, the municipality, where the increase of population has the lowest indicator, was rated with the coefficient 1.00.

Healthcare sector:

Assessment of healthcare sector was carried out according to diarrhea diseases, phychological disorders, zonal infections, indicators of health problems and death. also according to the number of people injured by the extreme events and amount of general profile doctors.

Diarrhea diseases: Diarrhea diseases are included into the climat-related group and are more frequent in Ajara region, compared to other regions of Georgia, especially, in Summer. Increase of diarrhea diseases can be linked to worsening of natural cooditions (extremely high temperature) and to improper work of the healthcare system in the region. The municipality with the higest indicator of diarrhea diseases was assessed as the most vulnerable and accordingly, was rated with the coefficient 1.00.

Psychological disorders: Psycholigical disorders, like diarrhea diseases, belongs to the climate-related group of diseases. According to the international experts, increase of the number of phychological disorders are noted especially after extreme events (catasropes). Increase of phycholocal disorders is possible due to the same reasons as in case of diarrhea diseases. The municipality with the highest indicator was considered as the most vulnerable and rated with the coefficient 1.00.

Zonal diseases: From the zonal diseases in Ajara we can mention Borelosus and Leptospirosus. These are the diseases directly linked to climate change.the municipality where such diseases are expressed is considered as the most vulnerable and is rated with the coefficient 1.00.

Diseases: According to the diseases we can judge on the general status of health of the population. The condition of the helathcare sector can be assessed as well. The municipalities with high indicators of diseases were rated with the coefficient 1.00.

Death: Indicator of death, is similar to disease indicator. The municipality with the higher death indicator was rated with the coefficient 1.00.

Injured by extreme events: People, injured due to extreme events, often suffer fomr different health problems (traumas, phychological disorders, etc) and need financial support fomr the Government. These kind of municipalitiea are the most vulnerable and were rated with the coefficient 1.00.

Doctors of general practice: Doctors of general practice mainly represent the integral part of the primary healthcare group addressed by the population when the health problems occur. Accordingly, adequate amount of such centers is necessary for proper helathcare system. Those municipalities that have the lowest amount of general practice doctors were rated with the coefficient 1.00.

Annex VI - Some recommendations on the Black Sea seashore management

Extract from the Dutch experts assessment

"For centuries River Chorokhi (south to Batumi) was transporting the sediment (both sand and pebbles) to the coastline, as a result of which the delta has been formed. City of Batumi is disposed at the delta of R. Chorokhi. In the course of decades the Batumi seashore is experiencing erosion caused by:

- Autonomous development;
- Alluvion generated from R. Chorokhi;
- Construction of hydropower plants on the R. Chorokhi.

In 1980-es the nourishment of shoreline has been performed to stabilize the beaches. Since early 1990-es, after obtaining independence by Georgia, the nourishment of coastline was ceased due to the lack of funding. However, the shoreline erosion process was going on. Means to rehabilitate the Batumi coastline has been studied in recent years by several consultants. The survey to be conducted in the presented report is believed to be an improved version of other studies, especially performed by the Dutch company "Alkion 2009" and "Alkion 2010".

The coast protection alternation measures have been determined at the preliminary design level (Alkion 2009). The envisaged protective constructions considered as a best option of Batumi shoreline development, will produce an essential impact on it. Instead of slightly eroded coastline, the seashore between the R. Chorokhi waterfall and the Batumi Cape will become stable. Owing to the necessity of fitting the protective structures to the present city development plans, the integrated and enlarged planning is needed to provide the successful implementation of offered undertakings.

According to the results of conducted survey finalized in 2009, the coats protection system has been selected containing wavebreakers along the shore. In places where wavebreakers are unacceptable, the coast is to be cobbled (in case of underwater canyon existence). Sections of shore between wavebreakers are filled with sand.

Accounting for city development, in the northern part of Batumi shoreline, the preference is given to sandy beaches. Sandy coasts require maintenance and hence the enclosed beaches are regarded as a best mean to protect sandy beaches.

The mentioned enclosed beaches have slanting form. This form has been selected considering the disposition of wavebreakers, related with the incoming waves. In 2010 (see Alkion 2010) the detailed design of coast protection measures has been finalized (plan see in Fig. 1).

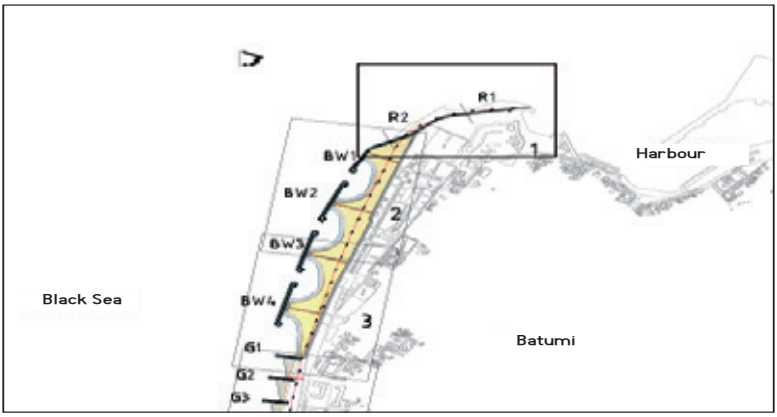


Fig. 1. Details of slanting enclosed beach at the northern part of Batumi seashore

The detailed coast protection design has been approved by the Government of Ajara. However two aspects of the design remained not to be complied by 100%:

1. To reach a compact coast scheme, the priority is given to steep inclination of the beach. To achieve this goal sandy beach CD+3 m has been chosen. It is desirable as well to use sandy beach in the waterside.
2. To provide adequate safety and prevent significant damage during the storm, wavebreakers of CD+5 m level should be used (which would be elevated by 1m above the boulevard). Such large constructions, on the one hand, will significantly alter the seashore area and, on the other hand will limit the view on the sea from the boulevard.

Annex VII - Methane from existing landfill of Batumi

Table 1. Daily production of methane for 15 years since the closure of Batumi old landfill

Year	Gg/yr	Kg/yr	m^3/yr	m^3/per day
2014	0.665476	665476.0	924272.2	2532.25
2015	0.576745	576745.4	801035.3	2194.62
2016	0.501650	501650.2	696736.4	1908.87
2017	0.437965	437965.3	608285.1	1666.53
2018	0.383837	383836.9	533106.7	1460.57
2019	0.337720	337720.0	469055.5	1285.08
2020	0.298327	298326.6	414342.5	1135.18
2021	0.264582	264582.5	367475.7	1006.78
2022	0.235591	235591.3	327210.1	896.47
2023	0.210605	210604.7	292506.5	801.39
2024	0.188998	188997.6	262496.7	719.17
2025	0.170248	170247.6	236455.0	647.82
2026	0.153918	153917.7	213774.5	585.68
2027	0.139642	139641.9	193947.1	531.36
2028	0.127114	127113.8	176546.9	483.69
2029	0.116076	116076.2	161216.9	441.69
2030	0.106313	106313.3	147657.4	404.54

Annex VIII - Methane from Ajara new landfill

Table 1. Generation of methane (CH_4) when the annual amount of residential waste is 42 000 tons and doesn't increase

Year	Gg/yr	Kg/yr	m^3/yr	Year	Gg/yr	Kg/yr	m^3/yr
2014	0	0	0	2032	1.815507	1815507.0	2521538.0
2015	0.270362	270361.9	375502,7	2033	1.839964	1839964.0	2555505.0
2016	0.500378	500378.1	694969,6	2034	1.862132	1862132.0	2586295.0
2017	0.696558	696557.6	967441,1	2035	1.882295	1882295.0	2614299.0
2018	0.864328	864327.5	1200455.0	2036	1.900692	1900692.0	2639850.0
2019	1.008215	1008215.0	1400299.0	2037	1.917528	1917528.0	2663234.0
2020	1.131999	1131999.0	1572221.0	2038	1.932980	1932980.0	2684694.0
2021	1.238834	1238834.0	1720603.0	2039	1.947198	1947198.0	2704442.0
2022	1.331356	1331356.0	1849105.0	2040	1.960313	1960313.0	2722657.0
2023	1.411768	1411768.0	1960789.0	2041	1.972437	1972437.0	2739496.0
2024	1.481915	1481915.0	2058216.0	2042	1.983670	1983670.0	2755097.0
2025	1.543341	1543341.0	2143529.0	2043	1.994095	1994095.0	2769576.0
2026	1.597340	1597340.0	2218528.0	2044	2.003788	2003788.0	2783039.0
2027	1.644998	1644998.0	2284720.0	2045	2.012815	2012815.0	2795577.0
2028	1.687228	1687228.0	2343372.0	2046	2.021233	2021233.0	2807269.0
2029	1.724796	1724796.0	2395550.0	2047	2.029094	2029094.0	2818187.0
2030	1.758349	1758349.0	2442152.0	2048	2.036443	2036443.0	2828394.0
2031	1.788433	1788433.0	2483934.0	2049	2.043321	2043321.0	2837946.0

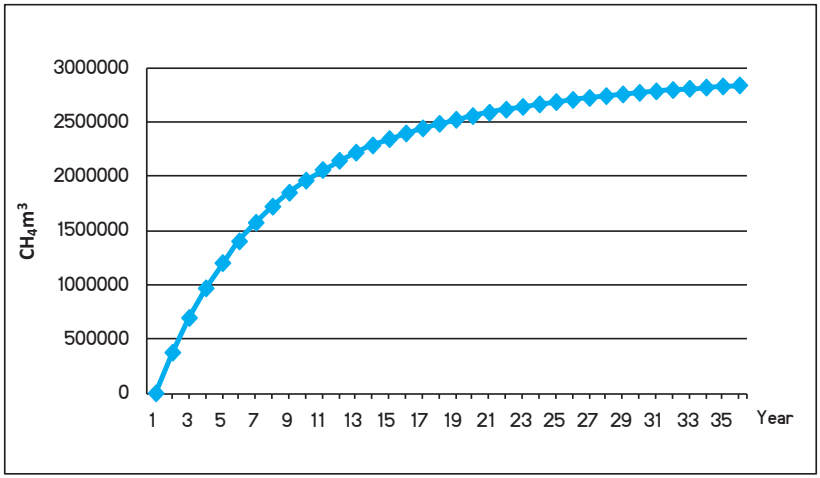


Fig. 1. Methane generation curve from the sanitary landfill during the supposed exploitation span (35 years) in case of the annual amount of waste doesn't increase (annual amount 42 000 tons)

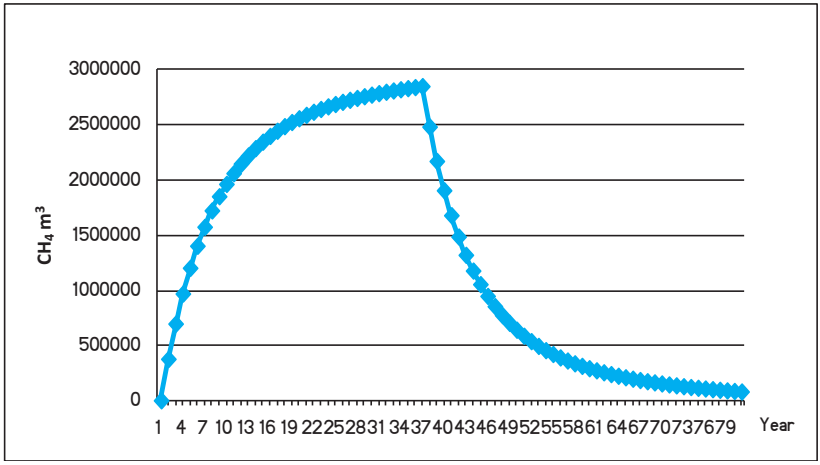


Fig. 2. Methane generation curve for the total life span (70 tears) of sanitary landfill

Table 2. Methane generation in case when the amount of residential waste increases over 42 000 tons and reaches 80 000 tons annually

Year	Gg/yr	Kg/yr	m^3/yr	Year	Gg/yr	Kg/yr	m^3/yr
2014	0	0	0	2052	2.880052	2880052.0	4000072.0
2015	0.270362	270361.9	375502.7	2053	2.523142	2523142.0	3504364.0
2016	0.500378	500378.1	694969.6	2054	2.219129	2219129.0	3082124.0
2017	0.709432	709431.9	985322.1	2055	1.959505	1959505.0	2721534.0
2018	0.901029	901029.4	1251430.0	2056	1.737172	1737172.0	2412739.0
2019	1.078087	1078087.0	1497342.0	2057	1.546210	1546210.0	2147514.0
2020	1.243029	1243029.0	1726429.0	2058	1.381676	1381676.0	1918995.0
2021	1.397874	1397874.0	1941492.0	2059	1.239442	1239442.0	1721447.0
2022	1.544300	1544300.0	2144862.0	2060	1.116057	1116057.0	1550079.0
2023	1.683705	1683705.0	2338479.0	2061	1.008634	1008634.0	1400880.0
2024	1.817250	1817250.0	2523958.0	2062	0.914758	914758.2	1270497.0
2025	1.945903	1945903.0	2702643.0	2063	0.832405	832405.3	1156118.0
2026	2.070469	2070469.0	2875652.0	2064	0.759878	759877.8	1055386.0
2027	2.191620	2191620.0	3043917.0	2065	0.695751	695750.6	966320.3
2028	2.309913	2309913.0	3208213.0	2066	0.638826	638825.7	887258.0
2029	2.425815	2425815.0	3369187.0	2067	0.588095	588094.7	816798.2
2030	2.539712	2539712.0	3527378.0	2068	0.542707	542707.4	753760.3
2031	2.651929	2651929.0	3683234.0	2069	0.501946	501946.1	697147.3
2032	2.762734	2762734.0	3837131.0	2070	0.465203	465203.4	646115.8
2033	2.872354	2872354.0	3989380.0	2071	0.431965	431964.6	599950.8
2034	2.980975	2980975.0	4140244.0	2072	0.401792	401792.4	558045.0
2035	3.088755	3088755.0	4289938.0	2073	0.374315	374314.5	519881.3
2036	3.182951	3182951.0	4420765.0	2074	0.349213	349213.1	485018.2
2037	3.265593	3265593.0	4535546.0	2075	0.326216	326216.0	453077.8
2038	3.338384	3338384.0	4636645.0	2076	0.305090	305089.7	423735.7
2039	3.402755	3402755.0	4726048.0	2077	0.285633	285633.0	396712.6
2040	3.459906	3459906.0	4805425.0	2078	0.267672	267672.2	371767.0
2041	3.510849	3510849.0	4876180.0	2079	0.251057	251056.6	348689.7
2042	3.556438	3556438.0	4939497.0	2080	0.235655	235655.0	327298.6
2043	3.597391	3597391.0	4996376.0	2081	0.221353	221353.0	307434.7
2044	3.634318	3634318.0	5047663.0	2082	0.208050	208050.3	288958.7
2045	3.667734	3667734.0	5094075.0	2083	0.195658	195658.4	271747.8
2046	3.698078	3698078.0	5136220.0	2084	0.184100	184099.5	255693.8
2047	3.725724	3725724.0	5174616.0	2085	0.173304	173304.3	240700.4
2048	3.750989	3750989.0	5209707.0	2086	0.163211	163211.1	226682.1
2049	3.774146	3774146.0	5241870.0	2087	0.153765	153765.0	213562.4
2050	3.795430	3795430.0	5271430.0	2088	0.144916	144916.3	201272.7
2051	3.300066	3300066.0	4583424.0	2089	0.136621	136620.8	189751.1

Published in Georgia