TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY ACTION PLANS FOR CLIMATE CHANGE ADAPTATION

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Ministry of Environment Protection of Georgia

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PREFACE

On 2 July 2010 the Government of Georgia adopted governmental program "UNITED GEORGIA WITHOUT POVERTY". The program lists short-term priorities of the Government which should be fulfilled for reaching the devoted objective of the Government of Georgia "United Georgia without Poverty". Among these short-term priorities are: development of infrastructure (energy, road and water supply), village development towards development of agriculture, revitalization of Georgian cities and recreational territories, minimizing a risk of natural catastrophes pursuant to early notices. All these directions as well as others require high advanced technologies and in this regard the establishment of advanced/inn0vative technologies university in Batumi city of Adjara Autonomous Republic, has been several times declared by the Government. Another strategic document developed in the country and adopted by the Government is the "State Strategy on Regional Development of Georgia for 2010-2017". This document also considers technologies as one of the priority directions in the sustainable development of regions. Chapter VI of the Strategy considers the support to the development of innovations, new technologies and entrepreneurship. The Strategy highlights that "Comprehensive technological progress entails the growth of competition, its scale and speed amongst nations with competitive knowledge and innovation capacity playing a determining role in this process. The growing competition in the world makes it clear that Georgia's economic development and security require the creation of a regional economic strategy which is oriented towards a knowledge of economy, innovations and new technologies". Support to the creation of Regional Innovation Centres is one of the tasks planned in the Strategy and this approach echoes the international process on technology transfer initiated at the Rio Summit in 1992 and intensified after Poznan's decisions regarding the climate change related technologies.

Georgia is actively involved in the technology transfer negotiation process under the UNFCCC and welcome the idea of establishment of regional centers of excellences. Conducting the national level technology needs assessment process is being considered by the Government of Georgia as very important contribution from the UNFCCC and GEF to the development of indigenous know-how and transfer of climate change adaptation and mitigation technologies within the framework of international process. Several advanced technologies and action plans are recommended by the project for their import and implementation. Development of technology database in the framework of techwiki system could be considered as the most important achievement of the project which should be further extended by the country with the support of the Centres of Excellences.

George Zedginidze

Minister

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ABBREVIATIONS

ALM	Adaptation Learning Mechanism
BAU	Business-As-Usual
BSEC	Organization of the Black Sea Economic Cooperation
CC	Climate Change
CDM	Clean Development Mechanism
CIDA	Canadian International Development Agency
COP	Conference of the Parties
DCP	Desertification Climate Potential
DNA	Designated National Authority
DOE	Designated Operational Entity
EBRD	European Bank for Reconstruction and Development
EPR	Erosion Potential of Rain
ESCO	Energy Service Company
FAO	Food and Agriculture Organization of the United Nations
FOD	First Order Decay
GAM	Global Average Method
GCM	Global Circulation Model
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GEL	Georgian Lari
GFSIS	Georgian Foundation for Strategic and International Studies
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GTZ	German Technical Cooperation
GWP	Global Warming Potential
HPP	Hydro Power Plant
HTC	Hydrothermal Coefficient
HWI	Heat Wave Index
ICAM	Integrated Coastal Area Management System
IDP	Internally Displaced Person
INC	Initial National Communication
INTAS	International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Right
LPG	Liquefied Petroleum Gas

LULUCF	Land Use, Land-Use Change and Forestry
MOE	Ministry of Environment Protection of Georgia
MoEdS	Ministry of Education and Science of Georgia
NCSP	National Communications Support Programme
NGO	Non-Governmental Organization
NMVOC	Non-Methane Volatile Organic Compound
OECD	Organization for Economic Co-operation and Development
PDD	Project Design Document
PPP	Public-Private Partnership
PIN	Project Idea Note
QA/QC	Quality Assurance / Quality Control
REC	Regional Environmental Centre for the Caucasus
SERI	Stockholm Environment Research Institute
SHPP	Small Hydro Power Plant
SIDA	Swedish International Development Agency
SME	Small and Medium size Enterprises
SNC	Second National Communication
SRES	Special Report on Emissions Scenarios
TACIS	Technical Assistance to the Commonwealth of Independent States
TAP	Technology Action Plan
TED	Technology and Environmental Database
TFS	Technology Fact Sheet
TNA	Technology Needs Assessment
TRACECA	Transportation Corridor Europe-Caucasus-Asia
TTD	Technology Transfer and Deployment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	United States Dollar
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organization

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Part I

Technology Needs Assessments Report

Executive Summary

The current process of Technology Needs Assessment (TNA) is the continuation of already accomplished and ongoing climate change studies in Georgia, including Georgia's Initial and Second National Communications, previous TNA process conducted in 2000-2002, regional climate change studies survey on removing barriers to the local utilization of renewable energy sources, studies on energy efficiency and renewable energy potential of Georgia, etc. In line with the common approach, the TNA process was developed in two directions – adaptation and mitigation.

Stocktaking exercise for the selection of priority areas for adaptation technologies has been carried out by the Adaptation team leader, the Project Coordinator and the representative of the Ministry of Environment Protection in close cooperation with the PSC members and different stakeholders. As a result three priority sectors have been identified: The Black Sea coastal zone represented by a new segment (Anaklia) not considered in previous studies, extreme geological events (landslides, mudflows, floods) and agriculture (land degradation, water erosion and irrigation).

Two sets of criteria have been considered for the selection of technologies: general, country level criteria based on country's priorities and sector specific criteria. Country wise general criteria were used for the assessment of most vulnerable to the climate change sectors and ecosystems, while sector wise specific criteria were considered in selecting technologies for different subsectors. Based on general criteria for the Black Sea coastal zone protection, particularly in the tourism development areas and free economic zones, land degradation caused by water erosion and natural disasters in mountainous ecosystems were selected as highest priority sectors and ecosystems. Along with these priorities assessment of irrigation systems and irrigation technology needs have been commissioned by the PSC to the TNA Adaptation team.

Current status of technologies in the selected sectors (Agriculture, the Black Sea coastal zone and Extreme Events) has been assessed using available information on their deployment through the second half of the past century. An overview of multiple coast protection efforts undertaken since 1940es in the Poti segment of the Black Sea coastal zone has indicated that in accumulative coasts it is reasonable to conduct the protection and fortification of separate damaged areas within a single litho-dynamic system. In Agriculture sector different soil water erosion prevention technologies are reviewed along with the survey of current status of irrigation systems in the Kakheti region of East Georgia, and in Extreme Events sector a number of measures are discussed currently used for the protection of territories from landslides, mudstreams and floods.

For the Black Sea coastal sector a number of coastal zone protection technologies are discussed. They include beach nourishment using inert material from nearby sources, construction of sediment-retaining piers and system of boons, creation of stone and rock piles and artificial capes, artificial expansion of coastal dunes in width and in height, creation of artificial underwater reefs, setting up of decentralized early warning system, etc. Different sets of technologies have been considered for different vulnerable segments of the Black Sea coastal zone.

For the Anaklia segment of the Black Sea coastal zone a combination of 5 different coastal zone protection technologies are recommended, including:

- Artificial filling with inert material, including creation of gravel-pebble beaches;
- Creation of artificial capes;
- Artificial extension of coastal dunes (knolls) in width and in height. In case of rapid sea-level rise – construction of dams;
- Creation of artificial reefs using reef-balls;
- Setting up of decentralized early warning system.

In the Rioni Delta segment following technologies are prioritized according to their ranking:

- Setting up of early warning system;
- Increase of Poti City Canal capacity;

- Construction of sediment-retaining pier at the Poti Canyon and boons south to the “Didi” Island;
- Pilling of rocks and stones, beach nourishment in the area of “Didi” Island.

In the Chorokhi Delta (Adlia) segment of the Black Sea coastal zone following technologies are prioritized according to their ranking:

- Beach nourishment at the Adlia emergency section;
- Construction of the boon system in the Batumi-Adlia coastal zone;
- Creation of stone piles at the emergency strip near Adlia;
- Construction of sediment retainers in front of Batumi underwater canyon.

R. Rioni Delta and Anaklia segment are identified as the most vulnerable segments as far as these two segments are particularly focused by the Government as economy and tourism development priorities. New detailed mapping of flood risk areas at the Black Sea coastal zone and application of computer models for monitoring and forecasting climate change impact on a sea coastal zone are recommended as general needs for the implementation of adaptation measures and risk mitigation. It would be almost impossible to prepare, implement and monitor adaptation measures without the relevant local infrastructure on site and national/regional adaptation policies.

In the Agriculture sector 2 technologies are considered against soil water erosion: the USLE method and terrace. Based on estimations of soil losses caused by water erosion and assessed through the special equation, different combinations of tillage and sowing could be recommended to local households and farmers. Making qualified recommendations on specific measures requires special education and training. The TNA team has prepared the pilot project proposal/TAP to adopt and implement this technology in Georgia (in Adjara region).

Three types of technologies have been assessed and prioritized as wind erosion protection measures: low-till technology, no till technology and windbreakers. Among them the highest priority is given to Agroforestry – the rehabilitation and planting of wind-breakers. The prioritization of technologies against soil salination resulted in giving highest priority to biological melioration, followed by liming of alkali soils and, finally, to desalination by washing salts into deep layers of the soil.

The survey of irrigation technologies in the Kakheti region led to the following conclusions: the highest priority is to be given to the drip irrigation technology and the second priority – to the artificial raining technology. The rehabilitation of traditional irrigation systems facing new types of barriers after breaking the Soviet Union is also considered to be quite important for the country.

In the Natural Disaster sector the prioritization of technologies for the management of extreme geological events led to the conclusion that the first priority must be given to the low-cost protective measures against the landslides. The second ranking technology appeared to be cleaning and leveling of riverbeds against mudflows. Third priority is mapping of hazardous geological sites and providing long-term forecast of their development.

All these technologies listed above are included in the technology data system (www.tnageorgia.wikispaces.com).

Chapter 1

Introduction

At COP 4 in Buenos Aires with Decision 2/CP4 Parties to the UNFCCC requested the GEF to provide funding to developing country Parties to enable them identify and submit to the COP, their prioritized technology needs, especially as concerns key technologies needed in particular sectors of their national economies conducive to addressing climate change and minimizing its adverse effects. Based on this decision countries have received the financial support and initiated TNA process as phase two of the initial national communications in 2000. Georgia implemented the project in 2001 and only energy sector and energy efficient technologies have been selected by the Country as priority that time.

In 2008 the Poznan Strategic Programme on Technology Transfer was adopted by the CoP 14 which initiated the new phase of TNA process. There are three funding windows to support technology transfer under the Poznan Strategic Programme, namely: (1) technology needs assessments (TNAs); (2) piloting priority technology projects; and (3) dissemination of GEF experience and successfully demonstrated environmentally sound technologies (ESTs). The GEF has also proposed a Long-Term Programme on Technology Transfer, which was presented to COP 16 in 2010. Under GEF-5 (2010-2014), funding pledge for climate change mitigation program has expanded to approximately $1.4 billion, and the climate change strategy now embraces technology transfer as a priority, with the entire portfolio supporting it directly or indirectly. Today, the GEF is supporting technology transfer activities in almost 100 developing countries.

The current Global TNA project, deriving from window (1) of the Strategic Program on Technology Transfer, is designed to support 35 to 45 countries to carry out improved Technology Needs Assessments within the framework of the UNFCCC. The assessments will involve amongst others in-depth analysis and prioritization of technologies, analysis of potential barriers hindering the transfer of prioritized technologies as well as issues related to potential market opportunities at the national level. National Technology Action Plans (TAPs) agreed by all stakeholders at the country level will be prepared consistent with both the domestic and global objectives. Each TAP, which will outline essential elements of an enabling framework for technology transfer consisting of market development measures, institutional, regulatory and financial measures, and human and institutional capacity development requirements, will also include a detailed plan of action to implement the proposed policy measures and estimate the need for external assistance to cover additional implementation costs. The project will also help provide feedback to fine tune methodologies and contribute to the revision of the new TNA Handbook through an iterative process involving the national project partners and regional centers of excellence (www. http://www.thegef.org/gef/greenline/september-2011/community-sustainable-management-traditionally-protected-natural-forest-res).

This project is the part of global TNA process. Both adaptation and mitigation sections are being considered in this phase of TNA. Based on the results of Georgia's SNC and other ongoing and implemented climate change projects adaptation is the first priority within the climate change policy of the Country. Land degradation, extreme events and the Black Sea coastal zone are priorities identified and considered in the adaptation TNA. In addition special attention has been given in the TNA process to local know-how.

A strong national leadership is needed to conduct a TNA successfully. Considering that the ultimate mandate of TNA extends beyond the mandate of one ministry, the TNA process has been led by an inter-ministerial Steering Committee that includes experts from all relevant ministries and/or agencies for the TNA. Principle constrain identified in the TNA implementation process are the lack of knowledge among the national experts about advanced technologies available at the market and therefore the main conclusion of the TNA process is that international support in development of technologies relevant to the national and local needs (this is important particularly for the adaptation technologies) and availability of required technologies at the market should be provided through the regional centres of excellences planned to be established by the international society. Urgency of establishment of such centres is obvious.

Chapter 2

Institutional arrangement for the TNA and the stakeholders' involvement

2.1 TNA team and national project coordination

Current process of Technology Needs Assessment (TNA) is the prolongation of the already accomplished and ongoing climate change studies such as: Georgia's initial and second national communications, previous TNA process conducted in 2000, regional climate change studies, removing barriers to the local utilization of renewable energy sources (particularly hydro and geothermal), etc. All these studies consider different technology options for adaptation or mitigation measures in different ecosystems and sectors of economy. Recently there is not any inter-ministerial coordination body considering climate change issues. Reason is frequent changes in high level government officials requiring high frequent update of such a Board. Therefore, the current practice of the government is a case-by-case (project-by project) establishment of a Project Steering Committee (PSC) for the purposes of coordination of project related processes, identification of project strategy and monitoring of its implementation. For the TNA project such committee was established by the Ministry of Environment Protection which is the UNFCCC national focal point. The PSC was established on 26 November 2010 under the Ministerial Order #i603 and consists of 11 members, representatives of different Ministries: Deputy Minister of Environment Protection, head of PSC. Full list of PSC members and contacts are provided in Annex IV and Fig. 1 demonstrates the TNA implementation structure.

One of the barriers identified to the TNA process is absence of one responsible for the process national body or unit.

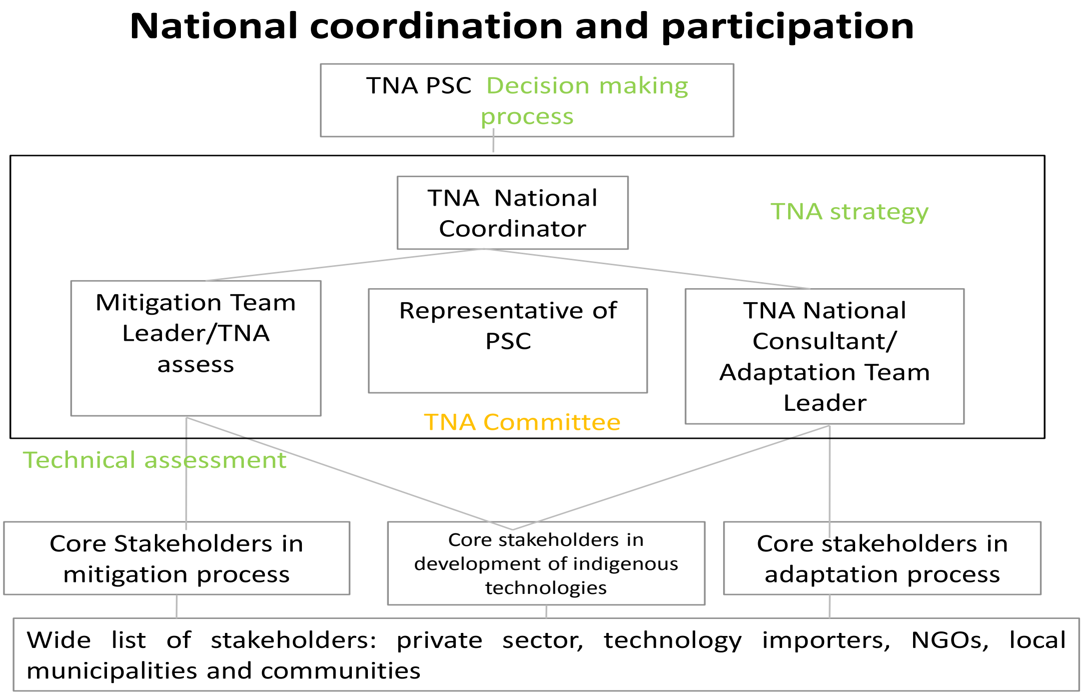

Fig. I-2.1 National coordination of TNA project

Adaptation and mitigation teams have been separately established for conducting the TNA process. Structure of adaptation team is provided in the Fig. I-2.1

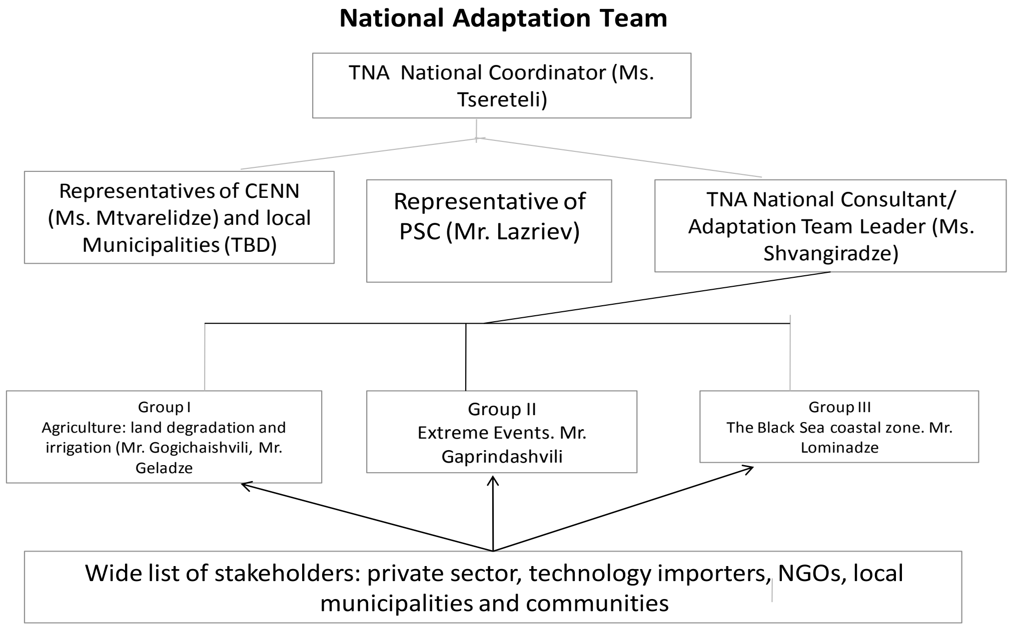

Fig. I-2.2 Implementation structure of adaptation section of TNA Georgia

2.2 Stakeholder Engagement Process in TNA – Overall assessment

Broad stakeholder consultation process involving technical experts from different sub-sectors considered for adaptation and mitigation has been initiated in the beginning of the TNA process. The first stakeholder consultation meeting for selection of priority sectors was conducted on 9 September 2010. Technology Fact Sheets (TFS) have been distributed amongst the stakeholders for filling up with information on the relevant technologies. Minutes of stakeholder consultation meetings and workshops as well as the lists of stakeholders for each sector are provided as Annex IV.

The PSC is another group of stakeholders dealing mainly with prioritization of sectors and selection of indicators for prioritization of priority sector related technologies. Interpretation of criteria was challenge for the PSC consultation process and for the technology selection process. TNA team has done a lot consultation with each expert in order to ensure the common understanding of selection criteria. In case of proposal development more close consultations have been conducted with the local municipalities (Municipality of Khulo and Keda regions in Adjara).

Lack of awareness and information gaps, in particular technology implementation and maintenance costs, were another impediment to needs assessment process.

Chapter 3

Sector prioritization for adaptation

Stocktaking exercise for selection of priority areas for adaptation technologies has been carried out by the adaptation team leader (Ms. Marina Shvangiradze), the project coordinator (Ms. Maka Tsereteli) and the representative of the Ministry of Environment (Mr. G.Lazriev, Head of Climate Change Unit). Two different processes have been established in parallel reviewing climate change impact related studies such as: Initial and Second National Communications of Georgia [2,4]; first TNA project document [3]; CC risk assessment in the South Caucasus Region implemented by three Caucasus countries (Armenia, Azerbaijan, Georgia)[6]; a project implemented by the CENN (Caucasus Environmental NGO Network) considering the impact of CC in 6 municipalities of West and East Georgia (ongoing); some other studies performed by different research institutions and NGOs and interview consultations with climate change related society; representatives of Ministries (Agriculture, Infrastructure Development, Health) and NGOs (CENN, REC, Green Movement, Green Alternative, etc) and others. The list of interviewed experts is attached to this report as Annex IV.

The results of this stocktaking exercise were presented to the PSC at its first meeting on 23 December 2010. Based on the decision of PSC on priority sections for adaptation, the adaptation team of TNA project was established. The diagram of TNA adaptation team structure is showed in Fig. 2 above.

Three priority sectors have been agreed by the PSC. Most of the areas of the Black Sea coastal zone have well developed infrastructure, are densely populated and are being developed as touristic areas or free economic zones. Changes, such as the sea level raise and intensification of high waves, observed for the last decades in the Georgian segment of the Black Sea coastal zone, give confidence that the anticipated risk from the sea is increasing and is considered as a number one threat because of its suddenness and intensity. Next to the coastal zone problems, extreme geological events (landslides and mudflows) are considered as priority for assessment and risk reduction. Georgia has 34% high mountainous territories suffering from landslides, mudflows and land erosion. Land erosion is slow developing process and comparatively easy for adaptation to climate change, while landslides are accelerated by geological processes and not always allow protecting population and infrastructure. Very intensive consultations were conducted on priority areas for adaptation until submission to the PSC for its final approval. As a result the Black Sea coastal zone is approved as the first priority for adaptation needs followed by extreme geological events and land degradation processes.

Based on the PSC's decision to investigate technologies for three priority adaptation sectors, the project Adaptation team consists of three groups of experts. These three groups cover: the Black Sea coastal zone including a new segment (Anaklia) which was not considered in other studies; extreme geological events (landslides, mudflows, floods) and land degradation (agriculture and irrigation). Criteria for prioritization of adaptation sectors are developed by the Adaptation team and agreed with the PSC. Results of prioritization are presented in section 3.2.

3.1 An overview of sectors and climate change impact on sectors in Georgia

Georgia is situated in the south-east of Europe, between the Black Sea and the Caspian Sea. Its total area is 69,700 km^2. Mountainous landscape determines the variety of Georgia's physical geography: there are humid subtropical lowlands and wetlands, plains, semi-deserts, highlands, mountains covered by forests and glaciers, some lakes and plenty of rivers. Mountains cover a significant part of the territory, 54% of it is located at an altitude exeeding 1,000 m above the sea level.

The Black Sea coastal zone has a humid subtropical climate. The average annual temperature there is 14-15^{0}C, with extremes ranging from -15^{0}C to +45^{0}C, and annual sums of precipitation vary between 1,500 mm and 2,500 mm. The Black Sea influences climate of West Georgia, resulting in mild winters, hot summers and abundant precipitation. Here in the mountainous and high mountainous areas, the annual air temperature ranges from 2-4^{0}C to 6-10^{0}C with an absolute minimum between -30^{0}C and -35^{0}C, and annual amounts of precipitation range between 1,200 mm and 2,000 mm.

Climate in the plains of East Georgia is dry: it is dry and subtropical in the lowlands, while it is alpine in mountainous areas. The average annual temperature is 11-13^{0}C in the plains, and 2-7^{0}C in the mountains with absolute maximum of +42 ^{0}C. The absolute minima are -25^{0}C and -36^{0}C respectively. In the high mountains (the slopes of Mount Kazbegi), the absolute minimum reaches -42^{0}C. Annual amounts of precipitation vary within the range of 400-600 mm in the plains, and 800-1,200 mm in the mountains.

Three main regions of Georgia having different problems caused by the climate change were identified in the Second National Communication (SNC) of Georgia prepared in 2006-2009. These regions are: the Black Sea coastal zone with coastal zone erosion, floods and high storms, Dedoplistskaro in East Georgia with the accelerated process of desertification and one of the mountainous regions - Kvemo Svaneti - with landslides, river floods and mudflows. The SNC of Georgia is the main strategic document describing climate change impact on different regions, ecosystems and economic sectors, produced by the country and submitted to the CoP. Along with the SNC another strategic document prepared by the Ministry of Environment and approved by the Government in November 2011, the NEAP (National Environmental Action Plan) [5] of Georgia, has been also considered. The results of all other supplementary studies and projects implemented in the country by the local and regional NGOs or bilateral and multilateral donors have been also taken into consideration. The TNA project considers the same problems which were identified in the SNC but are mainly focused on other regions (Adjara, Anaklia segment of the Black Sea coastal zone) not targeted in the SNC.

Climate change past trends and future scenarios used in this report are the same established in Georgia's SNC.

Climate change scenarios. The current change in climate elements in Georgia, and in priority regions in particular, has been assessed within the SNC of Georgia based on actual observation data. Two regional models have been used for the assessment of future climate scenarios: PRECIS and MAGICC/SCENGEN. The MAGICC/SCENGEN model was used for selecting the most suitable GCM for East and West Georgia, for each season and each climatic parameter. Two runs of the PRECIS model were used for the forecast of future localized changes. The results of these models in West Georgia show an increase by 3.5^{0}C in mean annual temperature to the end of this century, accompanied with a decrease in precipitation by about 6%, while in East Georgia the air temperature is expected to rise by 4.1^{0}C, and sums of precipitation could fall down to 14%. This process of reverse changes in temperature and precipitation is anticipated to be sharpened in summer when both tendencies are more distinct than in other seasons.

Mean air temperature and temperature extremes, precipitation, relative humidity, wetting regimes and wind were investigated, as well as trends of extreme events (high winds, drought, landslides, floods, etc.), characteristic to each of the examined regions. Change trends in mean annual air temperature, mean annual precipitation, and humidity regime, were estimated between two time periods 1955–1970 and 1990-2005.

The climatic parameters have been also assessed for whole territory of Georgia (West and East). Annual precipitation trends in the Western and Eastern parts of Georgia differ from each other and do not coincide with the results obtained for local conditions of selected regions. For example, the annual sums of precipitation show a decreasing trend in Western Georgia (average value), while locally in Poti (the Black Sea coast) and Lentekhi (mountain zone), until present time, a small increase is still observed. As much as it was allowed by a model resolution, the local trends and changes have been taken into consideration when assessing the future impact of climate change on the local territories.

Sectors considered under the climate change vulnerability

Following sectors have been considered and assessed on vulnerability to the climate change within the TNA process:

Agriculture is one of the most important and traditional sectors of Georgia's economy. In 2012 the sector has been declared by the Government as priority in development of economy. The production of corn (both for food and forage) and grapes was and continues to be an important item for Georgia's agrarian sector.

Social and political turmoil in 1990es has greatly affected the country's economy and agricultural sector in particular. Arable land, including hayfields and pastures were transferred to private ownership and this process is not over yet. As a result of abolishment of big farms, the sown area has decreased. From 2000 to 2009 the sown area has decreased by 50% from 610.8 to 308.3 thousand ha and in 2009 the sown area made only 38% of ploughed fields in 2003. Production of major crop – the wheat has fallen sharply in the last 4 years, making on the average 65% decline compared to 2000-2005 period. For the last 4 years the harvest of main crops underwent a 2–fold decrease, that is very disturbing result. The productivity of cereals and leguminous crops in Georgia is 2-3 times lower per ha compared to developed countries.

Overview of agriculture sector in Georgia shows that this branch of economy has serious prospects for development. Various studies show that at the territory of Georgia the warming of the climate can promote important positive results in agriculture only in case of rational and efficient management and implementation of soil protecting measures because land degradation is one of the highest risks for the sector. Along with the anthropogenic factor the significant climate change impact on land erosion is revealed in Georgia. In particular:

- More than 30% of Georgia's arable land (205.7 thousand ha) is degraded as a result of water erosion (increase in precipitation);
- More than 28% of arable land in East Georgia is eroded under the impact of wind erosion (102.5 thousand ha) (combination of wind and winter droughts);
- In East Georgia saline and alkali degraded lands occupy 359.56 thousand ha, among which 202.77 thousand ha are saline (56.4%) and 156.73 thousand ha are alkali (43.6%). Main reason of salinization is incorrect exploitation of irrigation systems in the past.

Extreme weather phenomena such as drought and strong winds significantly affect agriculture in East Georgia regions. Under the impact of climate change, the severity of these phenomena has increased markedly in the past 50 years: the annual duration of the drought period has extended from 54 to 72 days, and the frequency of its occurrence has risen twice. The frequency of high speed winds ($\geq$ 30 m/s) has increased five times since the beginning of 1980s (particularly in the south –east regions).

Mountainous Adjara region is one of the most vulnerable regions to soil water erosion in Georgia. 95% of Adjara's territory is mountains and foothills. At the same time, the region, neighboring the Black Sea, is rich of atmospheric precipitation that creates favorable conditions for the development of soil water erosion (SWE) processes. According to the latest official statistics, total arable land area in Adjara is 8,800 ha, from which 5,300 ha (60.2%) is eroded to different degree. For the whole territory of Georgia this percentage makes 30.5, indicating the urgency of SWE problem in Adjara. However, there are other mountainous regions (Imerety, Racha-Lechkhumi) in West Georgia also facing water erosion problem.

During the recent years some measures have been undertaken to combat the land erosion processes in rural areas of the Adjara region. In 2004 under the special program of the Adjara Ministry of Agriculture 5000 saplings of nut-tree were planted at the erosion endangered slopes in different mountain districts. In 2005 this activity was continued with planting 5515 more saplings of nut-tree, known for its deep root system, preventing the soil erosion.

Georgian ***Black Sea coastal zone*** represents a central part of the Caucasian coast of the Black Sea, with climate, relief and oceanographic conditions essentially different from other parts. Georgia's coastal zone is affected by a variety of geophysical processes (tectonic movements, rising sea level, tidal waves, floods, underwater currents, river sedimentation, etc.), some of which are being intensified by current climate change. This zone is considered as the most vulnerable territory to climate change in Georgia. In the past century, mean rate of sea-level rise (eustasy) at the eastern coast of the Black Sea was 2.6 mm/yr. In 1924-1996, the sea surface temperature decreased by 1.0^0C. However, in 1990-2006 it increased by 1.3^0C, resulting in the warming of the sea surface temperature by 0.2^0C. Owing to the increase in maximum wind velocities, the frequency of powerful storms (force 5 to 7) has increased by three times in Poti and Batumi during past four decades.

Photo 1. Water erosion process in Adlia segment of the Black Sea coastal zone

Georgia's coastal zone has a complex outline and relief, being partitioned by many tributaries, among which the most important are Chorokhi, Rioni, Enguri, Kodori and Bzipi. These rivers, according to international classification, form the Black Sea coastal river type, the specific features of which are: catastrophic floods almost in all seasons, rich sediment and intensive sedimentation processes in the mouths of glacier-fed rivers. The coastal zone is deeply intruded into the sea, where the river gorges descend by several kilometers to the bottom of the sea, in the form of an underwater canyon. In such portions, the river sediment produces spits, peninsulas and islands. At the same time, the accumulation processes are more intensive, where the rate of sinking of the coast is higher, while the sediments are richer.

Extreme events (landslides, mudflows and floods) is the next most vulnerable sector after the Black Sea coastal zone in Georgia. In general mountainous regions have been identified as ecosystems vulnerable to various disastrous weather conditions, significantly enhanced by global warming. As a result of increased frequency and intensity of these phenomena (floods, landslides and mud torrents), land erosion has been intensified and greatly damaged agriculture, forests, roads and communications.

In the period of 1967-2009 about 3000 settlements (63% of total number) appeared in the geological hazard risk zone in Georgia:

- 60 000 families have been resettled under the status of eco-migrants;
- Number of victims of geological disasters has exceeded 1000, among which 600 cases took place after 1987;
- More than 400 000 houses and constructions were damaged and appeared in the hazard risk zone;
- 1,5 million ha of arable land has been damaged and turned out of use;
- 560 km of motor roads were damaged and required rehabilitation;
- In 1973-1975 economic losses caused by geological hazards amounted to 650 million USD, and in 1987-1988 this figure exceeded 1 billion USD.
- In 1991-1992 losses caused by earthquakes, landslide-gravitational and mud-flow processes made 10 billion USD.
- In total, losses conditioned by geological disasters in Georgia through 1995-2009 amounted to 1 308 billion USD and resulted in 71 casualties.

Photo 2. Most recent extreme geological event. 18 June 2011. More than 100 mm rain during two hours were observed on 18 June 2011 at the Rikoti Pass. As a result 6 persons were died, highway infrastructure was destroyed in this segment and more than 1000 housing estates were flooded and damaged by mud stream.

Investigations based on geological and hydrological monitoring data have clearly indicated that critical situations related to natural geological disasters in Georgia first of all are caused by significant excess of annual sums of precipitation in areas with sensitive geological environment. At a smaller time scale this effect is strongly pronounced in cases of prolonged successive rainy days, stipulating high degree of humidity. It has been revealed that 70% of landslides in Georgia are generated due to these conditions, which are promoting the processes of mud-flow, land erosion, flood and snow avalanche development. Hence, the climate factor plays a decisive role in the formation and activation of these disastrous processes.

In particular, it has been revealed that in case of 100-200 mm excess of annual sums of precipitation over the climate average norm, a slight activation of landslide processes begins, that increases at 200-400 mm excess and transforms into stress conditions at 400-600 mm extra sums of annual precipitation. In these conditions the activation of virtually all “sleeping” landslides and the generation of new landslides take place. Such paradigm has occurred in West Georgia in 1967-1968 when the area of “landslide explosion” embraced 300 thousand ha; up to 20 thousand houses were destroyed. In 1987-1989 the extreme geological disasters have spread all over the territory of Georgia, resulting in the activation and generation of more than 7700 landslide-gravitational bodies. Correlation between the meteorological parameters and different geological extremes are provided in Annex VI (iii).

Impact of climate change on the ***forest sector*** is not yet relevantly assessed in Georgia. Within the Georgias’s SNC some impact has been assessed on Kvemo Svaneti forest sector. Main conclusions made are that the changes in air temperature and precipitation in Kvemo Svaneti, for the past half-century, are still in the range of natural variability and they could not have significantly affected the forests but for the last 15-20 years, the growing spread of pests and diseases has been observed in the forests of the region. In particular, if these indexes of pests and diseases in 1986-1996 did not exceed sanitary norms, in 1997-2005, the number of spruce trees hurt by Ips typographus had increased up to 8%, and the number of Dioryctria splendidella up to 7.3%. The spread of Phellinusa pine (7.6%) and Armillatia mellea (3.5%) had also grown in the coniferous species. Given the background of the recent rises in temperature, the number of injured (to 20%) and excessively dry (to 8%) trees, have increased as well, transforming the Lentekhi region forests into a highly vulnerable category. The projected trends of climate change for the region, if they come about, may presumably further increase the vulnerability of the Kvemo Svaneti forests. General problems of forest sector in Georgia are low quality and diseases for other regions as well but they are not studied yet.

Based on the results of the survey of the ecological status of the forests of the Lentekhi region, a number of degraded forest groves were selected in different areas, whose rehabilitation will be necessary to avoid the already developing processes of landslide formation, and the development of other negative phenomena.

Tourism sector, including mountainous tourism, winter tourism and coastal zone tourism, has been intensively developing in Georgia since 2004. Impact of climate change on the sector is not assessed yet. However, within the Third National Communication (TNC) of Georgia it is planned to assess the Tourism Climate Index and Heat Index past and future trends in touristic areas as well as an existing preventive infrastructure and readiness for emergency cases. There are some initial assessments on indirect impact of climate change on tourism in particular through observed changes in the protected areas which are the priority recipients of tourists but there is no any significant findings so far.

Energy sector (hydropower potential) has also been considered as vulnerable to climate change. Hydro power has a share more than 80% in Georgia's electricity grid and energy sector security and independence significantly depends from hydro power resources and changes in this resource. These issues are not yet researched for the largest hydro-power rivers but are planned to be investigated in the TNC. However, glaciers feeding some hydro-power rivers in the west Georgia have been estimated within the SNC for one particular segment of Caucasus Range. In particular, the upper catchment of the river Tskhenistskali has been evaluated. According to direct topographic measurements carried out in 1953-1958, twenty small glaciers were registered in the basin of the Tskhenistskali River, a total area which reached 12.5 km^2. Among them, the most significant was the Koruldashi Glacier covering the Caucasus Mountains; the glaciers of the Tskhenistskali River basin are currently undergoing a process of intensive degradation. In particular, direct observations undertaken during 1965-1990 revealed that the rate of retreat of the Koruldashi Glacier varied in different years, from 2.0 m/yr to 4.6 m/yr, making on average a retreat of 3.4 m per annum.

Due to an absence of measurements data since 1990, to assess the trend of this ongoing glacier degradation, in the Tskhenistskali River basin, the results of a co-operative survey of the Central Caucasus glaciers, performed by researchers from the Reading and the Moscow State Universities, were used in the SNC. According to these results, based upon the analyses of satellite images, obtained for the period 1985-2000, it was determined that in the examined period, the mean rate of the glaciers retreat was equal to 8 m/yr, and that the area covered by glaciers had decreased by 6-9%. The assessment based upon these results has shown that for the past half-century, the total area of glaciers in Kvemo Svaneti may have decreased by 25%, and their total volume may have been reduced from 1.2 km^3 down to 0.8 km^3, which corresponds to the present stock of water in them, equal to 700 million m^3. The projected rise in temperature, up to 2050, may result in the total disappearance of glaciers in Kvemo Svaneti. It's anticipated that glaciers melting will result in decreasing the power potential of largest rivers in west Georgia used for power generation. As it was mentioned above some of these rivers will be assessed in the TNC.

Infrastructure development sector which is basis for tourism development is one of the first priorities for the Government. Recently the sector is focused mainly on the road infrastructure development in order to improve the accessibility to the touristic areas and coastal zone development for sea tourism. In most cases the road infrastructure as well as beaches are affected by geological extreme events (landslides, mudflows, river floods, the Black Sea floods). To take the climate change phenomena, activating extreme geological processes, into consideration when developing the infrastructure development projects is crucial. In this TNA study this sector is covered by extreme events sector and the Black Sea coastal zone sector and therefore was not assessed separately.

Water resources sector have been considered from the perspective of irrigation water deficit. With the threat of potential aridisation of the territories in East Georgia two main rivers traditionally used for irrigation, the Alazani and Iori, the main water suppliers of the territory have been assessed through the hydrological model WEAP. The results have demonstrated the possibility of a 10% decrease in the annual runoff of R. Alazani in the period 2071-2100. However, the modeling of water deficit in the irrigation systems has shown that even in case of a 50% decrease in the river runoff, and the increase in water consumption by the same percentage, the demand will be met in all months except August. The same methodology applied to R. Iori has revealed an anticipated 11% decrease in river runoff and the impossibility of meeting a future water demand increase of even 10%. Water resources for and technologies for irrigation are considered in agriculture sector along with the soil degradation.

In addition the computer model CropWat (FAO model) has been applied to assess the influence of climate change on water deficit for some crops and pastures. The shortage of water for winter wheat, sunflower and pastures was revealed for the past (1960-2005) and assessed for the projected period 2021-2100. Some more details about water deficit in the east Georgia are available in Annex VI (ii).

"Determination and implementation of adapting activities towards Climatic changes in the arid and semi-arid ecosystems of the South Caucasus and Ensuring agro-biodiversity conservation and its sustainable application" project is recently ongoing in Georgia. The project is focused on East Georgia where semi-arid territories are typical and one of the tasks is to reveal those semi-arid regions where water deficit has increasing trend. Four (4) districts: Gardabani, Gori, Eldari and Udabno are identified by the project as the most vulnerable territories in Georgia to water deficit.

Health sector is also among the vulnerable to climate change sectors in Georgia. First attempts to assess the impact of climate change on the sector have been done in the SNC. As for the morbidity rate, the main causes of death in the adult population are first blood circulation system illnesses, secondly, infectious and parasitic diseases, then ailments in digestion, and illnesses of the respiratory and endocrine systems. Two of them have been targeted and assessed in the SNC of Georgia: infectious diseases and heat waves. Among the infectious diseases, only malaria and leishmaniasis have already spread in Georgia, and the targeted hotbed of malaria is believed to be Kakheti, and to a lesser extent the neighboring Kvemo Kartli region. Unlike cases of malaria, the dynamics of leishmaniasis cases in Georgia (mainly in Tbilisi) for the same period of time shows an increase up from 15 in 1995 to 160 in 2005. The number of registered cases at the present time does not give enough reason to say that there is an epidemic of leishmaniasis, and moreover of malaria, in Georgia. Nevertheless, in case of a growth in the mean annual temperature, an increase in the frequency of these parasitic infections shall follow this trend. The Dedoplistskaro region is a very favorable territory for the spreading of malaria.

Along with the above-mentioned diseases, human health is threatened by heat waves, the frequency of which has increased significantly in relation to global warming. To define the intensity of these waves, different indices are used, including the Heat Index (HI), which is calculated by a combination of air temperature and humidity, and the wind speed. The values of HI were calculated for the periods 1955-1970 and 1990-2005, using the records of the meteorological stations Lentekhi, Tbilisi and Dedoplistskaro. Most of the years reaching hazardous limits were observed in Tbilisi during the second, in July and August, and in Lentekhi for the first period – in May. Occurrence of heat waves considerably increased in Tbilisi city. Further assessment of this index in touristic areas is planned within the Third National Communication (TNC) of Georgia.

3.2 Process and criteria of prioritization

Two sets of criteria have been considered for selection of technologies: general, country level criteria based on country's priorities and sector specific criteria. Country wise general criteria are listed below, while sector wise specific criteria are considered in the sector related chapters.

First step in decision making process is the assessment of sectors and ecosystems most vulnerable to climate change. Responsibility for vulnerability assessment and prioritization of sectors according to the level of vulnerability, through broad stakeholder process, lies on the climate change unit of the Ministry of Environment. The Ministry of Environment is the National Focal Point for implementation of the UNFCCC and Kyoto Protocol. Criteria for assessment of vulnerability vary by sectors and therefore are considered in the relevant sections. The next step is to select priority sectors for country from a set of vulnerable sectors. Responsibility in this case lies on the PSC which is inter-ministerial body established by the Ministry of Environment for the purpose of the TNA project implementation. In addition, prioritization of technologies has been done in two steps. The first step was prioritization of sectors most vulnerable to climate change and in the second step prioritization of technologies within the sectors. In the first step of decision making the role of PSC is decisive. Main stakeholders in this process are representatives of different Ministries, Agencies, Departments and other decision making bodies and the driven criteria in this process is country's priority, of course in accordance with vulnerability level.

The scheme below shows the main responsible structures in decision making process;

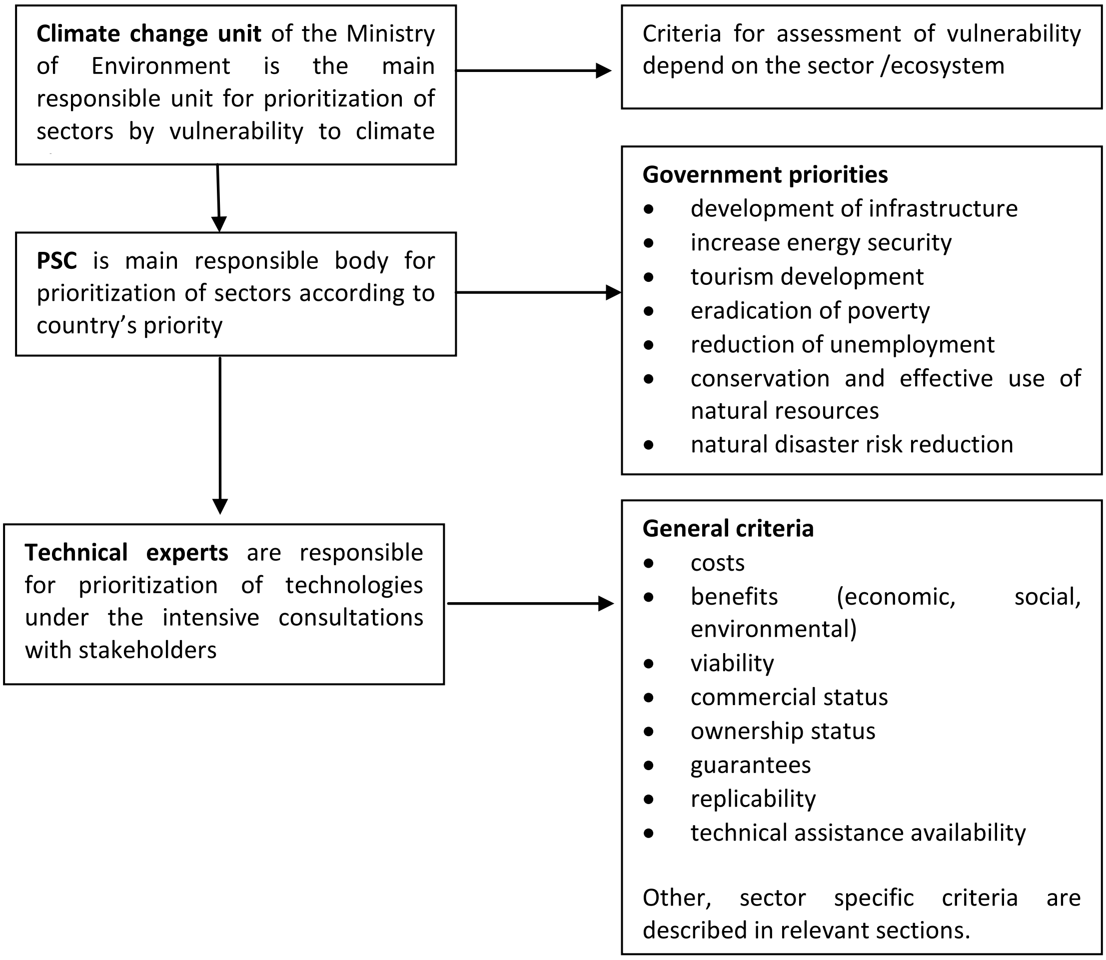

Fig. I-3.1 Distribution of responsibilities in prioritization of technologies

The sets of criteria have their weights reflecting the importance of criteria in decision making process.

Criteria for sector prioritization:

- Vulnerability to climate change (**20**)
- Contribution to regional development (**10**)
- Governmental priority (**60**)
    - national level (30)
    - regional level (10)
    - community level (20)
- Contribution to sustainable development (**10**)

These criteria have been assessed against country priorities identified in the Government's Program –"United Georgia without Poverty" (02.07.2010). The first priority of the country is "Fast Economic Development" covering development of infrastructure, enhance of energy security and tourism development. In social sphere eradication of poverty and reduction of unemployment are priorities. Conservation and effective use of natural resources and natural disaster risk reduction are the first priority in the field of environment protection. Based on these priorities the Black Sea coastal zone protection, particularly in tourism development areas and free economic zones, land degradation caused by water erosion and natural disasters in mountainous ecosystems have been approved by the PSC as highest priority sectors and ecosystems. Along with these priorities' assessment of irrigation systems and irrigation technology needs have been commissioned by the PSC to the TNA adaptation team.

Table I-3.1 Results of prioritization of TNA sectors for adaptation

#	Economy sectors and ecosystems considered for TNA process	Vulnerability to climate change (20)	Contribution to regional development (10)	Government priority (60)			Contribution to sustainable development (10)	Total Score (max score 100)
				National level (30)	Regional level (10)	Community level (20)		
1	Agriculture	15	10	30	10	10	10	85
2	The Black Sea coastal zone	20	10	30			10	70
3	Extreme events	20	10		10	20	10	70
4	Forest sector	10	10	20	5	10	10	65
5	Tourism	5	10	30	10		10	65
6	Energy sector (Hydro)	5	5	30	5	10	10	65
7	Infrastructure development	10	7	30			10	57
8	Water resources	5	5	5	5	20	10	50
9	Health	5	5	10		5	10	35

Nine (9) sectors important for the economy of Georgia have been considered in total: the Black Sea coastal zone; agriculture (land degradation); water resources (agriculture); health; forest sector; energy sector (hydro potential); extreme events; infrastructure development and tourism. Not all of these sectors are relevantly studied within the various projects and programmes already implemented in Georgia. Most of them are studied fragmentary only for some regions. The level of current knowledge about the climate change impact on the sector has been also taken into consideration when prioritizing the sectors as far as this project was mainly focused on the technologies assessment.

The result of the table I.3.1 is selection of three priorities for this project/study sectors. Technology needs assessment process will be limited only by these three sectors. However, the selected sectors sometimes covered at some extend other sectors as well. Good example for this is tourism sector which is priority for the country but was not selected as priority for this assessment as far as its vulnerability is not yet well assessed against vulnerability but from the other hand the extreme events sector and the Black sea coastal zone sectors indirectly consider tourism as well.

3.3 Inventory/Current status of technologies in selected sectors (The Black Sea Coastal Zone, Agriculture and Extreme Events)

Black Sea coastal zone

Georgia's Black Sea coastal zone has always had special importance for country's economy: it is the main foreign cargo turnover locale along this route. Special loading comes to the ports of Batumi, and especially Poti. In addition the recreation potential of Georgia's Black Sea coastal zone increases its significance for country. Along the whole length (330 km), coastal zone is characterized by dense population, great number of industrial enterprises, and accordingly, by developed infrastructure. Any variation of marine ecosystem parameters caused by climate change or negative anthropogenic activities seriously affects the coastal zone and its infrastructure.

The cities of Batumi, Poti and Sokhumi are located here with their ports, as well as the Supsa and Kulevi sea oil terminals, the Batumi Airport, and many other settlements, comprising a core area of economic and tourist recreational activities in the country. A highly developed coastal infrastructure exists here, with a dense network of railways and highways, about 60% of which are stretched along the sea coast. Such a great number of settlements, and multisectoral infrastructure from the old times, created a high population density (about 30 persons / km^2), which will grow even more in future (2030-2050). Coastal ecosystems are highly productive but at the same time extremely sensitive to such development, and are valuable both ecologically and economically.

Georgia

Geological conditions in Georgia's sea coastal zone are exceptionally complex. One of the reasons for this is the different directions and rates of section movements for its separate segments.

Due to intensive development of coastal zone infrastructure in XX century and increasing use of the Black Sea recreation potential, the protection of coastal zone infrastructure became serious problem for the Government. Various coastal zone protection measures have been implemented for most vulnerable different segments of the coastal zone since 1960s. Coast protective measures undertaken in Poti having most developed infrastructure and being most vulnerable segment in the coastal segment of Georgia are analyzed below.

Due to acute emergency situation developed in Poti coastal zone, it become urgent to conduct the relevant coast protective measures. It can be stated that in the second half of XX century, the island 'Didi' turned into a testing area for conducting coast protection experiments. The chronometric list of activities and their effectiveness is given bellow:

- In 1941 an attempt to arrange a 200 m line of piles was undertaken along northern coast of isle 'Didi'. 15,5 m long spurs were constructed perpendicularly to the line in every 16 m. During the construction period some insignificant amount of sand has been accumulated. Washing out processes activated to the south of it. Construction was not finished, because a very strong storm has completely destroyed it;
- In 1950-1951 a stone dike dam was arranged along the coastal line of isle 'Didi' with 25 through piers (70 m long). These piers were constructed with two lines of rails and large stones between them. This construction had a temporary, but positive effect on decreasing the washing speed. 5-7 years later, due to deepening of underwater slope, it started continuously destroying and sinking. The shorter piers constructed within the same frameworks did not work, because the stones were washed out and buried in the ground, while the rails just came to lie in the sea (Photo 3).
- In 1959 a watershed junction, unique by its nature, was constructed at distance of 7 km. The watershed was designed with the aim to regulate hydrological regime of river Rioni. New riverbed was constructed (Nabada) in order to reduce water discharge in old (original) riverbed crossing the city of Poti. In particular, the aim was to introduce management of distribution of water and solid sediments between old (town) and new (Nabada) riverbeds. The older (town) riverbed must have passed through it the expenditure with speed of 400 m^3/sec that would ensure supply of beach forming material in the coastal zone of isle 'Didi' and, accordingly, filling up of the existing deficit. During the period of floods and freshets, the watershed junction would direct the surplus water flow to new (Nabada) bed, thus avoiding floods in the town. However, while passing only 200 m^3/sec it became clear that the older riverbed could not ensure the project task – the adjacent living districts were flooded and the lateral erosion of river banks started developing. After that the riverbed was placed into iron-concrete channel. At its left side one water collector and two water pumping stations were constructed. Despite of these measures, the discharge of 400 m^3/sec defined by the project has not been reached. The maximum limit was 300-320 m^3/sec. It happened because of: from one hand – tilt of the channel was low and consequently, it was easily silted that has lowered its carrying capacity. From the other hand, the sea static and dynamic levels had certain influence, in particular – the sea static level near Poti fluctuates within -0,3 + 0,6 m. The channel could conduct discharge 300 m^3/sec only in case of sea level -0,2 m. In case of sea level +0,2 m, expenditure does not exceed 250 m^3/sec. If we take into account also a factor of entering of storm waves into the town channel and free entering of sea salt water (halosol) in the channel bottom that decreases even more the channel capacity, it becomes evident, that the protection of Poti coast from washing out processes using only iron-concrete shields will never have the desired effect [25];

Photo 3. Rails for spurs and stone dikes

- It should be noted that only once, during an experiment (G. Rurua, 18-26.05.1984) it became possible to conduct 366 m^3/sec volume of water. This experiment ended by flooding of adjacent areas due to lifting of ground water horizon;
- Additional investigations showed that to fill existing deficiency of sediments in coastal area of island Didi, it is necessary to enlarge the channel conductivity to 550-600 m^3/sec, that cannot be ensured by the channel parameters. For the time being there is no perspective for the channel reconstruction, as it is impossible to deepen it due to low tilts, neither to widen it because of existing bridges and dense population. Despite of many technical shortcomings (improper operation of shields), the hydro-junction partially performed its destination – protection of the town from floods and lowering of washing speed in some of the areas of coastal zone on isle Didi (area adjacent to place where the channel enters the sea);
- Construction in 1967-1979 of 6 iron-concrete piles along the island Didi, 130-150 m long spurs, turned to be ineffective. They could not detain coastal sediment flow and could not influence sediment movement perpendicular to coast. Besides that, the dunes themselves have been destroyed (only 3 of them are left, Photo 4);
- Positive results have been obtained through artificial supply of affected coast with sand: in 1966 the 200 m^3 of material obtained by cleaning up of the channel (photo 5); in 1972-79, sediments removed during deepening of Poti port channel (exact volume is not available; according to Poti port data, it is around 200-250 thousands m^3); in 1974 – 60 000 m^3 from new Rioni delta moved by barges to isle Didi's underwater slope (Photo 5).

Removal of sand in all cases from the bottom was effective in local areas and during a short period. Low effect was caused by non-conditioned introduced material (very fine fractures of sand), insufficient amounts and irregular measures conducted.

In 1969-71, northern branch of older riverbed (south from the port) was placed into a channel. The aim of such measure was to divide the total run-off into two branches and thus to feed the isle Didi coast with sediments from both sides. The channel was not correctly designed and the efforts turned to be quite inefficient. For the time being the northern branch is silted and abandoned;

- In 1982-84 the alongshore obsolete dike built with freely placed stones was strengthened by bigger stones (31 000 m^3) and thus lifted the marks (Photo 5). The washing processes were temporarily ceased, though underwater slope deepening process still was in progress along the dike. According to the 2001 data, the deepening of underwater slope in front of dike reached 1-1,5 m in average, while it was 2 m in separate locations.
- Analysis of coast protective measure undertaken in coastal zone of isle Didi showed that in accumulative, and moreover, in sandy coasts, it is reasonable to conduct the protection and fortification of separate damaged areas within a single litho-dynamic system. According to data of complex investigations, common deficit of beach forming sediments in 15 km long coastal zone between the estuaries of rivers Rioni (old delta) and river

Supsa, was 7,5 million m^3. Deficit was increasing due to alongshore and depth losses (including underwater canyon) by 0,4-0,6 m^3 annually.

- In 1986 it was decided to start sand deposition from the head race of Rioni watershed (coastal zone of isle Didi) by ground pumps and 11 km long pipe. During 7 years the deposited sand volume reached approximately 3,3 million m^3. In emergency areas 30-50 m wide coast protective lines have been arranged earlier (central part of isle Didi – approximately 80 m wide).
- By 1993 total area of artificially created beaches from river Supsa to Poti port was around 12 ha.

Photo 4. Line of grooves (1971) (left photo) and sand deposition (1996) on isle Didi (right photo)

Town Poti, 1973, Dredger

Town Poti, Dike on isle Poti, 1974

Photo 5. Town Poti, Dike on isle Poti, 1974

Remnants of obsolete stone dumps were buried into the beach body. At the same time a passive part of the beaches were rehabilitated. A nice boulevard was constructed. This measure had negative consequences also: high volume deposits concentrated in a limited coastal area caused significant activation of the underwater canyon. Approximation of its upper and coastal parts by 50-70 m was observed in 1989. Center of gravity of the sand deposit has been shifted to the south from the canyon by 300-500 m.

Since 1993 due to lack of financial resources and the known developments in Georgia the coast protective measures have not been undertaken. The whole sector of hydro-transport complex has been destroyed. Since 1994 the washing processes activated with increasing speed. The coast was gradually returning to emergency state which existed before 1986.

- In 2005-2007, for the first time after its construction, the rehabilitation works were conducted for the Rioni watershed reanimation. Tail water of the construction was reinforced and the electro-mechanical systems needed for shield exploitation were rehabilitated. Rehabilitation of the watershed and establishment of the project regime for it had positive influence on town channel carrying capacity. Not very significant, but, anyway, positive changes have been observed in coastal zone of isle Didi: 15-18 m wide beaches have been developed in junction area of the channel. A small external cone was developed on underwater slope.

Agriculture

Water and wind erosion technologies

During centralized economy various measures/technologies were conducted (as far as possible) against water and wind erosion in Georgia.

In areas affected by wind erosion (Shida Kartli, Gare Kakheti, Shiraki Valley) – Cultivator flat-cutter (ploskorez) “КПП-2,3” was used for agitating of agricultural residues and pre-sowing treatment of soil (autumn wheat sowing) without turning up clods at depth of 8-16 cm and remaining 80-90% of wheat stem above the ground. Flat-cutting disintegrator КПГ-250 was used for main treatment of soil, which treated it at depth 30 cm with remaining up to 90% of stems. Rakes of appropriate design (БИГ-3) were used for soil surface loosening; grain-crop sowing facility “СЗС-2,1-М”. Significant areas in the mentioned regions were occupied by different kinds of wind protective belts. Due to energy crisis developed in Georgia in the end of past century, the wind belts have been almost completely cut at the whole territory of the country. Total area of wind belts in Dedoplistskaro district was 1771 ha.

In areas affected by water erosion the following measures were conducted: A catch water drain was constructed at the top of land plots; Soil was mainly treated perpendicularly to slopes or along the contours; 15-20 cm deep furrows were made on land plots. Distance between the furrows was 1,4-1,7 m in West Georgia and varied in East Georgia from 5 to 25 m depending on a slope tilt. Soil loosening was conducted in deep stripes at the slopes, tilt of which was over 7°.

A method of common (wheat, barley, and oats) sowing was used in narrow lines and crosswise. Intermediate crops used to be sown in some cases in West Georgia at very limited areas. In East Georgia at the slopes of 6-7° the crops which needed hoeing (maize, sunflower) and crops which could have been sowed commonly (wheat, barley, and oats) were sowed in alternate lines. Buffer zones of perennial herbs were used at the slopes with a tilt over 10°.

Terraces were arranged mainly in West Georgia (Ajara and Abkhazeti AR) where perennial crops such as tea, mandarin, orange, and lemon, were cultivated.

However, it is very important to highlight that all these technologies were planned and recommended for the specific sites in a centralized system through "Kolmeurneoba". Now, there are not special services providing the similar recommendations.

Irrigation technologies

The construction of irrigation systems in Georgia has a long history. In XII century there were more than 200 km canals irrigating up to 50 ha territories in the East Georgia. By the end of soviet era (till 1988) irrigation canals in this region were functioning and watering more than 271 thousand ha of arable land.

At present the majority of irrigation systems in Kakheti are outdated – there is no strict control on water take-off collector-draining systems and watering process is not automated; all irrigation systems require cleaning. Most canals are not faced and have ground bed, many canals and water wells are abandoned. There are no new mapping data for the selection of optimal configuration of canals. As a result, this brings inequity in water distribution and excessive consumption of water, causing soil erosion, salination and creation of marshes. The efficiency of majority of existing irrigation systems vary in the range of 0,4 – 0,6. 65-70% of total water losses are caused by filtration and other factors. Almost all irrigation systems require complex reconstruction, capital planning, increase in water provision, putting in order of inner distribution networks, etc. For the development of irrigation systems there is an urgent necessity to prepare highly skilled experts and specialists in watering, which will keep strictly to the irrigation technologies, specified norms and dates of watering in each concrete region according to each crop demand.

The reconstruction and improvement of irrigation systems in Kakheti must be accompanied by the introduction of modern progressive (not traditional for Georgia) methods of watering: inner soil, under-root, drip and high-dispersion methods that brings significant decrease in specific water consumption per unit of produce. In case of drip irrigation the consumption of water is decreasing 7-8 times, and in case of high-dispersion method – 3 times.

Technologies for extreme geological events

In early 1980s general mapping of anti-erosion, landslide and mudflow measures was elaborated for whole country. Planning of these measures was basing on the assessment study and forecast of potential risky sites for the year of 2000. According to this scheme almost all anti-erosion technologies well-known in the world have been implemented in this period in Georgia. In case of large landslides activated by an abnormal amount of precipitation regulation of surface waters (arranging of water channels; preventing of infiltration of waters into the ground) and phyto-melioration are accepted as first priorities in Georgia. In case of river-side landslides caused by erosion due to activation of rivers, priority is given to construction of river-side protecting gabions and resistance increasing big stone walls. Bio-engineering measures have been also widely used against the river-side landslides.

Regional mapping of anti-erosion, landslides and mudflow measures for Ajara region was first developed in the beginning of 80s of past century, where 65 million USD has been allocated for the protection of area of 1440 km^2. One million USD was allocated for the development of the regional scheme and three millions – for conducting of the relevant measures. The rest of the sum was allocated for the relevant prophylactic measures. However, this scheme is 30 years old and the actual situation is significantly changed accelerated by ongoing climate change. Now it is necessary to conduct the relevant large-scale complex measures to mitigate negative consequences of the elemental geological processes first in three main directions – washing related erosion, landslides, and mudflows. Description of technologies for conducting adaptation measures is given below. All measures considered below and in technology database have been using in Georgia since last century, except of "teramishi" technology.

Chapter 4

Technology prioritization for the sea coastal zone sector

4.1 Overview of possible adaptation technology options in the Black Sea coastal zone sector

Combination of five different coastal zone protection technologies are recommended by the TNA project to prevent the significant damage of Anaklia's territory caused by the Black Sea level raise and increase in intensity of storms. These technologies are:

Artificial filling with inert material and creation of gravel-pebble beaches

The method of dumping inert material for the protection of coastline is widely applied in many countries. It has been adopted at the operational scale in 1980-es in Georgia during the conduction of coast-protection works by the specialized organization "Saknapirdatsva" at the Adjara and Abkhazia seashore. Later on this method has been used in Russia, USA, the Netherlands, Australia and many other countries.

Resulting from the wave dynamical impact the piles of inert material are being redistributed and the complete profile of underwater and land parts of the beach is being restored. Hence, the natural beach is being created, providing the fading of aggressive waves and stabilization of the coast.

Photo 6. Beach filling process between jetties (in the given case between the capes)

Creation of artificial capes

The artificial cape creation method for the protection of coastline is widely applied in many countries. It is successfully used in Georgia as well. One of the outstanding and succeeded examples of artificial cape is the artificial prolongation of the Buruntabie promontory, which contributed to the formation, increase and stabilization of contemporary Batumi beach.

In general, the Georgian coastline is notable with the variety of natural capes, created by the solid sediment of rivers. For the last 5 thousand years the alluvion of large rivers (Mzimta, Psow, Bzipi, Gumista, Kodori, Enguri, Rioni, Chorokhi) has formed geomorphological incrustations (capes), most prominent of which (Bichvinta, Sokhumi, Buruntabie) had protected coastal areas at some kilometers from the dominant westerly rough sea. At the same time, the weaker easterly roughness created so called diffusion zones. The configuration of capes depends on many factors, most important of which are the exposition of the coast and the coarseness of solid material forming the promontory.

With the formation of artificial capes in the coastal zone the same processes are stimulated, that are typical for natural promontories. Therefore it represents one of effective technologies in combination with the arrangement of underwater wave-breakers, coastal swells and dikes for the adaptation of coastal zone to climate change.

In Georgia's conditions the construction of artificial capes could be performed in most cases right to the river outflow by two ways:

1. Artificial cape can be constructed using both concrete and broken stones, or other proper material;

2. Cape can be built with so called “by-passing” method, using the transport of sand by pipeline, hydraulic dredger and hopper-barges.
   The artificially created cape holds up as much as possible inert material transported form the north by sea currents and promotes the restoration of entire profile of underwater and land parts of the beach. By this way the natural beach is being created between the capes, that provides the shading down of aggressive waves and stabilization of the coast.

Photo 7. Artificial introduction of inert material with intermissions

Artificial growing of coastal knolls in width and in height. In case of rapid increase of sea level (5-7 mm/year) – construction of dams

The coastal swells consisting of sand and shingle created naturally as a result of transport by the sea waves of inert material in perpendicular to the coast direction and of sea-level variation. They carry the two-fold function: 1) Swells represent a barrier between sea and land (same to a dike); 2) Swells and the beach are components of a joint system, in which they interact with each other and vary under the impact of wind and waves, climate and sea-level rise. However, when the coast undergoes intensive erosion resulting from the shortage of inert material the underwater slope is being denudated, the coastal swells begin to degrade and are reduced in size, hence they have to be restored artificially.

The importance of coastal swells is widely recognized in coast protection activities; therefore their rehabilitation is one of effective technologies aiming the adaptation of coastal zone to climate change.

The rehabilitation of coastal swells or their heightening and widening could be implemented in parallel with the artificial formation of beach or dumping of inert material. This operation could be performed in different ways:

1. Forming of swell with the abundant inert material delivered by dump-trucks and leveled using bulldozers, graders or excavators;
2. Formation of swell by the “By-passing” method, using sand pipelines, dredgers and hopper-barges;
3. Planting of vegetation at the surface of swell to preserve its stability.

Photo 8. Artificial growing of knolls in width and height

Creation of artificial reefs

Wave-breakers are widely used for coast protection in many countries. One kind of wave-breakers is the artificial reefs, created at the most active part of underwater slope – in the wave-strike zone. Besides the breaking of waves, artificial submarine reefs have another important purpose – the ecological function. In the offered technology the artificial reefs, so called “reef-balls” promote the reproduction of algae, fish and shellfish, that correspondingly can facilitate the development of diving for tourists, playing an important role in the Anaklia free tourist zone. The proposed method is used very successfully in the Ukraine.

By the formation of artificial underwater reef the same processes are stimulated, as in case of wave-breakers. However, they have some preferences, as it represents the through construction and does not impede the transfer of sediment along the coast. Therefore reef-balls, combined with coastal swell and dikes are one of effective technologies for adopting the coastal zone to climate change.

In Georgia’s conditions the construction of submarine reefs could be conducted along the coastline in the wave-strike zone. The artificial underwater reef could be created of concrete construction, produced at the land-disposed concrete manufacturing plant and mounted at the bottom of the sea using special technology. The artificially created submarine reef promotes the breaking of the wave and preserves the beach from washing off.

Photo 9. Reef-balls in wave breaking areas

Decentralized early warning systems

Taking into account the morphology and dynamical structure of Georgia's Black Sea coastal zone, the first four measures aimed at reinforcement of beaches and minimization of sea-level rise adverse effect, should be carried out separately in 3 parts of shore line: from the mouth of R. Enguri to the mouth of R. Tikori, between the mouths of rivers Tikori and Churia, and to the mouth of R. Khobistskali.

At the first section it would be advisable to accomplish artificial piling of inert material and to create a shingly beach, as well as to construct an artificial peninsula north to the mouth of R. Tikori for consolidating the newly formed shingly beach.

At the same time it would be expedient to create underwater reefs along the beach, which will serve as wave-breakers to dissipate the storm energy and as shelter for fish and shellfish. On the shore these measures have to be accompanied by the artificial heightening and widening of the row of shore line knolls.

The same measures should be undertaken at the second section of the shore line, while at the third section main attention should be paid to knolls, focusing on the heightening and widening of knolls, and on the heaping of inert material along the shore line.

The piling of inert material could be performed in different ways, mainly along the coastline in the form of washable piles, or in a broken way in the form of interrupted bermas in the sea, at the depth down to 2m. The sections of the berma could be 30m wide and 150m long with the interval between them of 80m. The total length of this part of shore line south to the mouth of R. Enguri, to be filled by shingly inert material is about 4 km.

To the north of mouths of rivers Tikori and Churia the heaping should be carried out perpendicularly to the shore line, in the form of broken stone boons, with the length of more than 120m. Eventually this measure will result in origination of a small artificial peninsula, which will serve as a barrier, detaining the sub-water sediments moving from the north and thus providing the coastline with new beach forming material.

After undertaking the above mentioned measures it would be necessary to create a through underwater wave-breaker along the shore line to guarantee the protection of the coast. It will consist of 3 rows of concrete figures (reef-balls), mounted at the depth of 3-5m in the form of broken reefs. The length of reefs must be 150m, and the interval between them – 70-80m. The height of the reef-ball itself is 1,52m and the width – 1,83m.

In case of accelerating sea-level rise, reaching 5-7mm/yr, before the coastal knolls had time to move into the depth of the coast, it would become necessary to increase artificially the parameters of shoreline rows of knolls, and in the exceptional case to construct the artificial dam. For the high rates of sea-level rise the height of the knolls must be increased up to 4m, their width – up to 300m, and the regular heaping of coarse-fraction inert material is to be undertaken to stabilize the coastline.

In addition to these measures early warning system is recommended to be organized in Anaklia segment. Optimal location of this system is not assessed yet and is planned to be done in the detailed feasibility study.

More detailed technical description of these technologies are provided in TFS attached to this report and included in the http://tnageorgia.wikispaces.com.

4.2 Criteria and process of coastal zone technology prioritization

As it was mentioned above some additional information is provided in this chapter regarding the basic principles of technology prioritization criteria for Anaklia segment as far as this segment was assessed in the TNA preparation process. However, these principles are common and are valid for all other segments as well.

For the protection of Anaklia coast from sea invasion it is necessary to conduct certain coast protective measures. The world experience in this field, as well as specificity of local coasts should be taken into consideration. The world experience in the field of sea coast protection shows that its efficiency can be ensured by keeping of the following conceptual principles: 1) Coast protection must be active; 2) Coast protection must be multifunctional; 3) Coast protection technology must be ecologically friendly; 4) Coast protective facilities must be relevant to the given coastal landscape and architecting aesthetics; 5) Coast protection must be implemented both locally, and within the whole litho-dynamic system. All mentioned above mean that:

1. Coast protective activities on Anaklia coastal slope and the beach zone should be considered as main measures and must regulate solid sediment movement to ensure proper distribution of sediments along the shore with the aim of maintaining and rehabilitating.
2. Constructions of coast protective facilities should combine main coast protective functions with the possibilities to use recreational, transport, biotechnology resources, with necessary separation of public beach zone.
3. Coast protective measures should ensure the protection and improve ecological state of sea coastal zone and the adjacent land areas.
4. Coast protective facilities should harmonically fit the coastal landscape, while the architecture and design should be of esthetic value. These requirements can be met by using of modern hydro-technique technologies, constructions, materials, and surfaces.
5. Coast protective measures should be undertaken within the limits of litho-dynamic system, though taking into account different social-economic parameters and development levels of different segments within one litho-dynamic system, as well as negative ecological and economical consequences of possible destroying of recreational facilities and settlements and the limited capacity of building organizations, and whole possible damage caused, the coast protective measures may be undertaken locally in the selected areas.

Coast protective facilities used for coast protective purposes can be conditionally divided into two groups:

- Coast protective facilities, such as breakwater walls, plain and stepped facilities, beach, and piers.
- Beach protective facilities, such as jetties, water-breakers of different constructions, including interrupting breakwaters.

Selection of an appropriate measure or coast protective constructions should be based on a wave regime, data on sea level changes, as well as on data on flow, sediment movement, and above- water and underwater relief of a coastal slope, beach grain size composition, etc.

All these requirements and conditions should be transferred into the criteria for prioritization of technologies. Criteria applied in the current TNA process mainly are sample criteria provided by the project executing agency (Riso center, Denmark). These general criteria were relevantly adapted to the relevant sectors (adaptation and mitigation). All three pillars of sustainable development are covered by these criteria: economy development (growth, ownership), social benefits (employment, health, learning) and environmental (water, air, land). Complete list of these criteria is provided as Annex V-list and definitions of criteria. In the table below are provided the criteria for prioritization of technologies. Normalization of weights approach is used when applying these criteria. Detailed weights for each criterion are provided in Annex V. Initial sample weights have been provided by the Riso center together with the guidelines. During the stakeholder consultations the weights have been revised and approved by the PSC.

The same criteria have been applied for prioritization of other two adaptation sectors taking into consideration the specifics of each.

4.3 Results of technology prioritization

Prioritization of adaptation technologies significantly depends on the site selected for adaptation. As it was mentioned in general overview of the Black Sea coastal zone there are five most vulnerable to the climate change segments identified at this stage through the Georgia's Second National Communication and the current process of technology needs assessment. Prioritization of these segments is presented through table 3.1.3.

Different technologies are prioritized for different vulnerable segments. As an example the Anaklia and the Rioni delta segments could be compared. If early warning system is vital for Rioni Delta where population density and economical infrastructure is highly developed, then for the Anaklia segment - artificial reefs is the first priority because of tourism development. Therefore priority of technology for each these segments are assessed separately and concluded for all segments as a whole. It should be highlighted from the beginning that this prioritization process is considered from the country's perspective while for each region/segments (these segments are located in different administrative regions) it might be different and this is reflected in tables I-4.1- I- 4.5.

In total 10 technical experts having experience in coastal zone protection and flood prevention have participated in the prioritization process (for details see Annex V-I).

Results of technology prioritization by segments are provided in Tables I-4.1- I-4.5.

Table I-4.1 Prioritization of technologies for the Rioni Delta segment of the Black Sea coastal zone

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Reduction of vulnerability	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Early warning system	10.2	22.1	19.7	8.7	60.7	**1**
2	**Beach nourishment** (Piling of inert material from the Nabada delta in the area of "Didi" Island and the mouth of the Supsa River (soft measure))	6.3	20.9	15.6	5.9	48.7	**5**
3	**Beach nourishment** (Heaping up of inert material from the bed of the Rioni River in the area of "Didi" Island and the mouth of the Supsa River)	5.1	20.9	15.6	5.9	47.6	6
4	Increase of Poti City Canal capacity (soft measures)	21.7	14.0	14.7	6.4	56.7	**2**
5	Construction of sediment-retaining pier at the Poti Canyon and of boons to the south of "Didi" Island (Hard technology)	20.5	16.3	12.6	5.9	55.2	3
6	Construction of piled rock and stone along the coast of "Didi" Island and of boons south of the island	20.5	16.3	12.6	5.9	55.2	4

Early warning systems are the highest priority for Rioni Delta which is the most vulnerable and economically most developed segment of the Black Sea coastal zone with highly developed infrastructure. Next is the increasing of Poti-city canal capacity which is very effective and not expensive technology

Table I-4.2 Prioritization of technologies for the Chorokhi Delta (Adlia) segment of the Black Sea coastal zone

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Early warning system	10.2	14.0	11.0	1.2	36.4	5
2	**Beach nourishment** (Refilling of beach-forming material at the Adlia emergency section Piling of 150-200,000 m^3 of material at the coastal zone (soft measure))	12.8	20.9	14.0	5.7	53.4	1
3	Construction of sediment retainers in front of Batumi underwater canyon and refilling of beach-forming material at the Adlia emergency section (combined method) Permanent filling up of the sediment stock)	7.7	16.3	12.2	4.5	40.7	4
4	Construction of the boon system in the Batumi-Adlia coastal zone Piling up of 750,000 m^3 of inert material over 25 years For the optional creation of recreational beaches amid boons, filling up of 2 million m^3 of beach-forming material in the same period	15.6	16.3	12.4	4.5	48.8	2
5	Creation of stone piles at the emergency strip (about 2 km) in Adlia Heaping of 50,000 m^3 of beach-forming material annually	15.6	15.1	9.5	2.8	43.0	3

Beach nourishment is number one priority for Batumi-Adlia segment which is touristic zone. Impact of the sea on this segment is slow and permanent resulting in erosion and washing away of coastal zone.

Table I-4.3 Prioritization of technologies for Anaklia segment of the Black Sea coastal zone

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Decentralized early warning system	10.2	16.3	12.3	3.4	42.2	2
2	Beach nourishment (Artificial piling of inert material)	14.0	16.3	7.7	3.4	41.3	3
3	Creation of artificial cape	12.8	16.3	7.4	3.4	39.9	4
4	Dunes (Artificial growing of coastal knolls in width and in height)	10.2	18.6	5.2	3.5	37.6	5
5	Creation of artificial underwater reef	20.5	22.1	25.0	5.7	73.3	1

Only these technologies are considered in prioritization process. This segment was considered as priority for the TNA process. However, information about other/similar technologies required to increase resilience of other vulnerable segments are provided for presentation of broader picture.

Creation of artificial underwater reefs is recommended for this touristic segment of the coastal zone. These artificial reefs are successfully used in many countries where coastal tourism is well developed and the purpose of these reef-balls is breaking of waves and development of diving industry. Next technologies recommended are the decentralized early warning systems and beach nourishment. However, several experts have strong opinion that rehabilitation of deteriorated coastal knolls is most important technology in conditions of the sea level rise.

Table I-4.4 Prioritization of technologies for the Rioni River lower reaches*

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Floodplain development policy introduced to improve long term resilience to flood / flash flood risks	20.5	16.3	17.0	2.3	56.0	3
2	Early warning system	10.2	20.9	18.3	4.3	53.7	4
3	Community-based adaptation measures, such as bank terracing, vegetative buffers, bundles and tree revetments	16.7	18.6	19.1	8.4	62.8	2
4	Flood plain seasonal productive systems (e.g. short season annual cropping, cattle rearing plots or seasonal pastures, agro-forestry)	19.3	18.6	19.1	8.4	65.3	1

** Rioni River lower reaches is considered in the Black Sea coastal zone section because the impact from sea side reaches this segment of Rioni river. However, the measures considered for this segment are mainly river floods risk management measures.*

Measures considered in table 4.3.4 are not fully taken into the final prioritization process as far as these technologies/activities will be implemented through the adaptation project supported financially by the CDM adaptation fund.

Table I-4.5 Prioritization of sea coastal zone management technologies

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Further mapping of flood risk areas on the Black Sea coastal zone	21.9	16.3	13.9	1.2	53.2	2
2	Models for monitoring and forecast climate change impact on a sea coastal zone	13.0	16.3	14.4	1.2	44.8	3
3	Development of national and local infrastructures and policy to improve long term resilience to flood and sea level rise risks	20.5	18.6	21.9	8.8	69.8	1

Broad spectrum of stakeholders has been involved in the process of prioritization: PSC, representatives of local municipalities, climate change experts, coastal zone protection experts, representatives of the State University, NGOs. Involvement of private sector was not successful at this stage of the project implementation. Main barrier in this process is low awareness on the potential risks and lack of attractive economically feasible mechanisms for the risks avoidance.

River Rioni Delta and Anaklia segments of the Black Sea coastal zone in Georgia have been identified as the most vulnerable segments as far as these two segments are particularly focused by the government as economy and tourism development priorities. Establishment of early warning system for the river Rioni segment was identified as the first priority and creation of artificial underwater reefs for Anaklia segment is the second followed again by the river Rioni Delta and in particular increase the capacity of Poti-city canal (former river bed of Rioni). Within this project a project proposal/TAP has been developed only for Anaklia segment. Further mapping of flood risk areas at the Black Sea coastal zone and application of models for monitoring and forecast climate change impact on the sea coastal zone are recommended as general needs for implementation of adaptation measures and risk mitigation. It would be almost impossible to prepare, implement and monitor adaptation measures without the relevant local infrastructure on site and national/regional adaptation policies.

Chapter 5

Technology prioritization for Agriculture Sector (land erosion and irrigation systems)

5.1 An overview of possible adaptation technology options in Agriculture sector

Georgia is a mountainous country: 54% of its territory is located at the altitude of 1000 m above sea level. Soil erosion processes are greatly influencing the development patterns of many sectors of economy, among which the agriculture is most vulnerable branch. A 23,2% of total arable land in Georgia is located at the slopes with the inclination of more than 5^0, that creates suitable conditions for the development of water erosion processes. As a result of this, more than 30% of arable lands in Georgia are registered as eroded by the different degree of erosion.

In West Georgia, due to predominantly mountain relief and abundant precipitation, soil water erosion processes are main cause of land degradation. The hydrological (water) erosion processes are mainly determined by the inclination of crop covered slopes (^{0}) and kinetic energy of rain, conditioned by its intensity (mm/min). Total area of arable land in this region makes 186,8 thousand ha, 33,7% of which are recognized as eroded lands.

In East Georgia, where arable lands occupy mainly plains and foothill areas, wind erosion of soil takes a leading role. From total area of 486,4, thousand ha of arable land in this region 21% (102,5 thousand ha) are classified as eroded lands.

Water erosion of soil is a long-standing problem in West Georgia, so local population here has developed a variety of technologies to protect soil from washing down and subsequent degradation. Most of them are based on plough of the land perpendicularly to the liquid runoff on the surface of a slope in order to minimize the washing out of the soil.

Measures to protect the soil from wind erosion include: covering of soil with crop residues after harvesting and cultivation using special types of ploughs, combined agro-technical measures (sowing of crops in rows, covering with crop residues, sowing of interim crops, planting of wind-breakers, sowing of grass, etc.).

Three types of land management technologies are recommended by the TNA process for agriculture sector. One is for protection of arable lands from water erosion, second is for protection of lands from wind erosion and third is irrigation technologies. All of these technologies are very important for Georgia's economy considering agriculture among the priority economic sectors. In addition the damage of mountainous ecosystems and lands, eco-migrants in addition to political migrants and human casualties made by the different type of erosions cause very high expenses for the country.

Water erosion protective measures

Two technologies are considered against soil water erosion: USLE method and terrace.

Technology recommended against water erosion is the USLE (Universal Soil Loss Equation) method, which increases the resistance of specific type of soil to erosion. Significant factor, playing major role in the development of soil water erosion processes is the "erodibility" factor K (amount of soil annually lost from the unit of area (t/ha)) being basis for USLE method. Erodibility factor K much depends on the granulometric composition of soil, as well as on the content of organic substance (humus), water-proof aggregates, stones and on the permeability of soil to water. Energy basis for the development of water erosion is the kinetic energy of rain. The amount of washed down soil particles from the slope is directly proportional to the index called "Erosion potential of Rain (EPR)". In Georgia the mean multi-year value of EPR varies in the range of 3-120 units. Its maximum values (40-120) characterize the humid subtropical zone of West Georgia, while in arid zone of East Georgia the EPR value varies from 10 to 30 units, and in high-mountain regions of the Great Caucasus and the Javakheti volcanic Plateau the EPR drastically decreases down to 3-5 units.

To assess the impact of current change of Climate on the EPR, mean values of this index have been calculated for the warm period of the year (April-October) in two climatic periods: 1936-1963 and 1963-1990. Calculations were performed for 12 meteorological stations, representing Georgia's different climatic zones. Obtained results show that in the major part of stations in West Georgia the decrease of EPR has been observed between the chosen two climate periods. At the same time, the significant increase of the index took place in East Georgia, indicating intensification of erosion processes here. Despite some reduction of EPR value in West Georgia, its absolute values in this region remain significant, reflecting high intensity of water erosion processes in this region.

Based on amount of soil losses caused by water erosion and assessed through the special equation **USLE** (introduced by Wischmeier,Smith, 1978) different combinations of protective measures could be recommended to the local households and farmers. Measures usually are the combination of plough and sowing. The main barrier identified for implementation of this technology is practical application of the technology (formula) consisting of seven (7) different parameters which can't be assessed without special knowledge and access to the operational information (weather/precipitation forecast). For the development of qualified recommendations on measures special education and trainings are required. The TNA team has been preparing a pilot project proposal/TAP to adapt and implement this technology in Georgia. Adjara (West Georgia) is already recommended by the PSC as a pilot region for this technology. Particular territories/villages have been selected together with local authorities, communities and households during the site visit to Adjara in the end of September. Some other details of this technology is described in the relevant TFS (**www.tnageorgia.wikispaces.com**) and in proposal developed for this sector.

Wind erosion

For the assessment of occurrence of wind erosion and selection of erosion protection measures the correlation between winds and following parameter should be established: annual loss of soil from the unit of area (t/ha); soil deflation, determined by soil granularity and its crustiness (t/ha); inclination of soil surface; coefficient of roughness resulted from cultivation; climatic index of wind erosion depended on the average wind speed and soil moisture content; length of unprotected part of field, perpendicular to wind direction. It is known that the transport of soil particles is proportional at the third power of wind speed and inversely proportional to the squared water content of the soil. This formula is the basis for assessment of wind erosion.

In this particular study a climate index *C* in East Georgia has been assessed. It was not significantly high in the past that could explain the real course of events, because the climatic recurrence of high winds in this region was low (Dedoplistskaro region is exception characterized with high winds). However, in rare cases, usually in winter and early spring, violent winds (30-40m/s) blowing for 2-3 days, are causing heavy erosion of soil greatly damaging agriculture sector.

Special survey has indicated that in East Georgia the wind velocity threshold, exceeding of which cause sweeping of soil particles, varies in the range of 10-15 m/s.

The projected further warming of climate eventually will cause the subsequent rise of soil temperature, especially in Dedoplistskaro region of Eastern Georgia. This will bring to decrease of soil moisture content, its impoverishment of organic matter, thus increasing the mobility of soil particles. Hence, the anticipated climate change in East Georgia should result in dangerous augmentation of soil wind erosion processes even without high winds. However, the future forecast shows the increase in intensity and occurrence of winds in East Georgia.

Three types of technologies have been assessed and prioritized as wind erosion protected measures: low-till technology, no till technology and windbreakers.

No till technology is the number of cultivation procedures which could be reduced to one – the sowing. In many cases it is limited only by direct sowing in furrow, tray or on the turf, that makes it possible to decrease operational expenses and soil loss by wind erosion. Farming virtually without land cultivation (at the background of "Zero cultivation") is possible only under some preconditions. First of all, the application of mentioned technologies is most of all acceptable in the raising of fodder cereals. Besides, and most important, the application of these technologies is entirely dependent on the use of herbicides.

Low till technology is very similar to no till technology but it allows limited number of cultivation activities.

The decisive measure (technology) to combat against the wind erosion is the arrangement of windbreaks. The rising of their effectiveness could be achieved in two ways: 1) By increasing the efficiency of separate belts (optimization of wind conductivity and increase of the belt high) and 2) By drawing nearer the belts in the system, providing the limitation of wind speed above the critical level. The height of windbreak, which is restricted by natural conditions, comes out as a limiting factor as well. In case of optimal height and wind conductivity of the shelter belt, the critical wind velocity could be achieved at the soil surface and in the open field. The effective protection of soil from wind erosion could be attained for any velocity of wind by bringing nearer the windbreaks.

Salination

Another type of land degradation, widespread in East Georgia, includes saline and alkali soils. The saline soils mainly occupy arid zone of this past of the country – the Kakheti and Kvemo Kartli regions and the Kareli district of Shida kartli region.

Total area of saline soils in Georgia makes 202,77 thousand ha, and that of alkali soils – 156,79 thousand ha. Major part of saline soils is occupied by perennials (77% of all saline soils).

All types of alkali soils are spread in East Georgia over 156,79 thousand ha, among them alkali and heavily alkali soils make 50,08 thousand ha. Alkali soils are mainly taken up by ploughed fields (47,9%) and hayfields and pastures (43,8%). The area of slightly alkali soils in total is equal to 60,34 thousand ha, and that of medium alkali soils – 39,71 thousand ha.

Following technologies are considered within the TNA process against salination: liming of alkaline soils; desalination by washing salts into deep layers of the soil and biological melioration.

Liming or gypsum melioration of alkali soils implies the application of gypsum during meliorative tillage, the overdosing application of organic and mineral fertilizers, sowing of perennial grasses and systematic seederation of the plot.

Desalination technology implies the melioration of meadows salinized soils through their capital washing off at the background of horizontal draining. Before the capital washing down, the soil cultivation technology includes ordinary ploughing and plaining of plot surface. After the deep (1m) moulding of soil must be carried out and the chemical meliorates-gypsum, ferrous sulphate and other compounds must be applied. Further the meliorative tillage of soils should be undertaken with the ПТН-40 plough and systematic deep tillage between the washing off procedures.

Biological melioration

Biological melioration is well known technology considering the sowing of perennial grasses and periodical sideration. Perennial grasses used in this case are nitrogen fixate plants such as Lucerne and Perennial Ryegrass. Green biomass of these plants should be deeply ploughed under soil in order to improve the physical, chemical and biological features of soil. As a result the productivity of land is increasing. To ensure the high efficiency of this technology it should be applied in combination with other melioration measures for example such as capital washing off at the background of horizontal draining. This technology is additional measure to other salination technology increasing the cost of the former. Therefore it’s not considered in TAP.

Irrigation systems

From 1925 to 1990 the area of irrigated lands in Georgia has increased from 100 to 450 thousand ha. Due to the lack of precipitation and presence of relatively vast areas of arable land, most part of irrigation systems are concentrated in East Georgia, where 43 irrigation canals were functioning in 1988, watering more than 271 thousand ha of arable land. From this number about 120 thousand ha were irrigated in the Kakheti Region on the basis of 15 irrigation systems and canals. The sources for them are 2 main rivers of the region – Alazani and Iori, as well as 10 small tributaries to R. Alazani.

The reconstruction and improvement of irrigation systems in Kakheti must be accompanied by the introduction of modern progressive methods of watering: inner soil, under-root, drip and high-dispersion methods that brings to significant decrease in specific water consumption per unit of produce. In case of drip irrigation the consumption of water will decrease 7-8 times, and in case of high-dispersion method – 3 times.

In Kakheti conditions the most rational methods of irrigation should be: watering of territory by self-flow using irrigation canals, mechanical water-lifting and artificial raining.

At present only gravity-flow surface watering technology is in use in Kakheti. Due to the overall natural inclination of plains in Kakheti from north-west to south-east, the watering of territories by self-flow using irrigation canals (including that to be rehabilitated) is provided almost everywhere. However, considering local conditions the best method featured with highest economic efficiency is artificial raining.

For optimization of irrigation process the four different technologies are recommended by the TNA team for rehabilitation of irrigation systems: surface self-flow (traditionally used in past), surface self-flow with mechanical uplifting of water (used in past), artificial raining (used in past only in West Georgia for irrigation of tea plantation) and drip irrigation.

Surface self-flow is the most widely used method when the flow of water is conditioned by natural inclination of relief. The command mark is located above the irrigated territory. Any irrigation system must have the headwork – hydro-technical construction allowing distribution and water take-off from a system. It is built at the head of derivation or main canals. The headwork provides the constant supply and regulation of water flow in the system. The technology is mostly used in case of relatively soft and uniform relief, with inclination in the range of 0,001 – 0,03; with large (>800-1000m^3/ha) norms of irrigation; to wash down salts from saline and alkali soils; in areas with strong winds. There are 3 types of irrigation technologies: by rows, by free flows and by filling to overflow. The row irrigation is used for hoeing crops (e.g. maize). According to the inclination of slope and properties of soil the rows could be through or shut-off, short (60-80m) or long (450-500m). One row can pass through 0,1-3,0 l/min and more amount of water. When designing the ground canals, it is important to select flow velocities preventing washing out of the canal bed or, on the contrary, sedimentation of suspended particles.

Surface self-flow with mechanical uplifting of water is the same to the surface self-flow technology, differing only in the necessity to create the flow of water by its uplifting at certain elevation using pumping devices.

The irrigation by **artificial raining** method has a number of advantages against the self-flow method – the watering is possible in complex relief conditions; The labor expenses are decreased by 80%, watering norms using raining device are less by 200-300m^3 per 1 ha; The water erosion of soil/soil salination is decreasing and the soil structure is being improved, the filtration and evaporation losses of water are decreasing, etc. At the same time the surface of crops is cleaned by droplets, improving their biological properties and the photosynthesis conditions. During the drought and foehns the evaporation of droplets at the surface of crops and in nearby air brings eventual cooling of the environment, serving to ameliorate local micro climate. This technology is also useful for washing down into deeper layers salts from saline and alkali soils.

Watering with gravity flow is used in areas, where the inclination does not exceed 0,02-0,03. In case of mountain relief, with inclination more than 0,03 the irrigation by **artificial raining** is more convenient. The raining devices are mobile, stationary and semi-stationary. The water pressure in systems usually is created by pumps, consuming large amount of electric energy. This is an expansive way and is not applicable everywhere. If the difference of elevations between the command and watered territories is significant, it is possible to use the natural (gravity) pressure of water. In case of artificial raining the main problem is to determine the mean intensity of artificial rain and to regulate it. Rain intensity must be relevant to the soil permeability to water. Watering of slopes in foothill conditions is opportune by natural pressure using long-range spraying devices. In this case relatively efficient is the stationary water-supply network. In case of long-range spray raining devices different raining methods are applied according to topography, soil properties and characteristics of device. Arrangement of terraces is recommended on slopes that prevents soil erosion and decrease water losses. This technology also promotes the washing down of salts from saline and alkali soils. Taking into account further global warming this technology is anticipated to be widely used in plains, and especially in foothill and mountain areas up to altitudes of 1300-1500 m a.s.l.

The artificial raining is complicated by high winds, hence in the area of its operation the presence of wind-breakers is of urgent necessary.

In future, the anticipated changes in climate of Kakheti Region will stipulate the increase of irrigated land areas on hilly and foothill territories at the slopes with significant inclination. This eventually will require the arrangement of terraces and creation of dense network of stationary and mobile raining devices.

Drip irrigation technology represents one of the options of sub-soil irrigation, in which the active layer of soil is being watered. Drip irrigation provides the root system of every plant with definite amount of water in the unit of time. Applying this technology makes possible to keep the irrigation norms, as well as to regulate irrigation network placed at the surface of the ground, or at some depth in the soil. Considering global warming impact, this technology will become of great demand in the arid regions of Kakheti (basically in the Dedoplistskaro region).

More details about these technologies are available at www.tnageorgia.wikispaces.com

5.2 Criteria and process of technology prioritization

Criteria for the prioritization of agricultural technologies are the same as recommended by the TNA guidelines and tools and described in Annex V. However, specifications of agriculture sector in Georgia and local environment have also been taken into consideration in the assessment process. Different impact of climate change has been revealed in West and East Georgia and relevantly different types of technologies have been recommended for each of them. Specific circumstances have been considered for selection of a pilot region and a pilot project in addition to the criteria given in Annex V.

5.3 Results of technology prioritization

Table I-5.1 Prioritization of land degradation protective measures for West Georgia (water erosion)

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Soil water erosion protective technology USLE (pilot proposal)	15.1	18.6	18.6	6.5	58.8	1
2	Terrace	5.3	22.1	19.8	8.3	55.5	2

It was recognized by all experts that construction of terraces is the most effective measure against water erosion. However, high investment costs make this technology second in the prioritization process. In addition USLE method is an innovation for Georgia and therefore it was prioritized as the first for recommendation.

Table I-5.2 Prioritization of land degradation protective measures for Kakheti region (wind erosion)

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Agro-forestry-Wind breakers	14.4	20.9	18.5	13.5	67.3	1
2	Low till with synchronized soil processing options (Agro-technical measures ….)	11.9	18.6	14.7	6.9	52.0	3
3	No till	17.2	18.6	14.7	7.4	57.9	2

Assessment shows that agro-forestry and particularly wind-breakers is considered by the experts as the first priority against the soil wind erosion. It should be highlighted that this technology is not new for Georgia, and that it has over 50 years tradition, but after the dismantling of the Soviet Union new types of barriers have been emerged to wind breakers maintenance and expansion process. These are energy crisis, lack of awareness on the function of wind belts, capacities of farmers and households to rehabilitate and maintain wind belts. As regards the low till and no till technologies, they are new technologies not having been used so far.

Table I-5.3 Prioritization of technologies against salination

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Liming of alkaline soils	7.0	20.9	17.7	9.1	54.7	2
2	Desalination by washing salts into deep layers of the soil	10.5	14.0	14.5	5.3	44.3	3
3	Biological melioration	21.9	20.9	22.8	9.1	74.7	1

Mainly these three technologies are recommended against salination in the East Georgia. Liming is traditional technology and was broadly applied in the soviet time while washing down of saline and alkali soils have not been used because of high economical burden and availability of water resources for washing in the semiarid areas. In addition some negative consequences when use this technology should be also taken into consideration. Biological melioration has been assessed as first priority (as the cheapest method) among the anti-salination technologies.

Table I-5.4 Prioritization of irrigation technologies for Kakheti region

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Surface self-flow	14.0	20.9	17.3	6.0	58.3	3
2	Surface self-flow with mechanical uplifting of water	9.4	20.9	17.3	6.0	53.7	4
3	Artificial raining	7.7	23.3	22.9	9.5	63.4	2
4	Drip irrigation	8.8	23.3	22.9	9.5	64.5	1
5	Optimization of irrigation systems considering the climate change impact on water resources and precipitation	15.1	11.6	16.5	8.9	52.1	5

Stakeholder consultations and multi-criteria analysis show that the priority at this stage is given to the new technologies such as artificial raining and drip irrigation. However rehabilitation of traditional irrigation systems facing new type of barriers after breaking the Soviet Union is also quite important for the country. Artificial raining technology was used in the past but it was limited only for large team plantations.

After intensive stakeholder consultations it was decided to exclude from the prioritization process biological melioration having less barriers and being more or less traditional for Georgia. The next technology with highest priority is wind-breakers. This technology was broadly introduces in 1960-ties (during soviet time) but is facing currently new types of barriers. The second priority after wind-breakers for agriculture sector is given to irrigation systems and in particular, to the drip irrigation following by artificial raining. Finally it was decided by the PSC to prepare TAP for USLE technology which was the fourth in the list taken into consideration that this is the innovation for Georgia. In addition, basis for this decision was that the problem is acute for West Georgia where mainly small household farms are being developed which are less protected against climate change risk. In addition, this problem of soil water erosion is less tackled by other projects comparing with rehabilitation of irrigation systems (the WB is active in this sector but climate change issue is not seriously considered in the rehabilitation process) and wind erosion problem (raised and partially covered in the SNC of Georgia).

Chapter 6

Technology Prioritization for Extreme Geological Events Sector (Landslides, Mudflows)

6.1 An overview of possible adaptation technology options for natural disaster sector

As a result of intensification of landslides and floods, population in the mountainous regions has decreased by 40% since 1986, and it is believed that this process will continue until decisive adaptation measures are taken to mitigate the adverse impact of climate change in the region. Three main problems: landslides, mudflows and floods have been identified as the most urgent climate change related risks in the mountainous areas of Georgia. Relevantly three groups of technologies have been offered, considered and prioritized by the experts (Annex IV) and other stakeholders including local population and municipalities in Adjara region. These are technologies for abatement of landslide and mudflow impacts, one technology against the river flooding and extreme geological phenomena management technologies. It should be highlighted that new approach has been recommended by the stakeholders, which imply maximum involvement of local communities in extreme geological phenomena monitoring and management process. During the Soviet time this field was fully monitored and controlled by the government and therefore significant training and awareness raising are needed for changing the former approach.

Detailed description of technologies considered in the process is available in www.tnageorgia.wikispaces.com

6.2 Criteria and process of technology prioritization

More than 10 national experts and other stakeholders have participated in the technology prioritization process. Criteria for the prioritization of technologies against extreme geological phenomena are the same as recommended by the TNA guidelines and tools and described in Annexes V and V-I. However, specifications of this sector in Georgia and local geological conditions have been taken into consideration in the assessment and prioritization process. Different impact of climate change has revealed in the West and East Georgia and relevantly different types of technologies have been recommended for each of them. Landslides and river floods are more typical for West Georgia characterized with high humidity and relevant technologies are recommended for mitigation of landslides and floods risks. Mudflows are more typical and intensive in the East Georgia and relevant technologies are recommended for mitigation of mudflows damages.

6.3 Results of technology prioritization

Table I-6.1 Prioritization of technologies for the management of extreme geological events

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Mapping of climate related extreme geological processes (current state)	16.7	16.3	17.6	0.8	51.3	1
2	Long-term forecast of landslides	4.7	14.0	15.0	0.8	34.4	4
3	Regime-monitoring on large-scale landslides, early warning systems	7.7	18.6	21.9	0.8	48.9	2
4	Response-training	12.8	16.3	18.6	0.0	47.7	3

Result of prioritization of risk management technologies is that identification of recently most vulnerable to extreme geological phenomena areas has the highest priority. Early warning systems for the large scale landslides and mudflows are second following by response-training of local communities. Highest weight in this prioritization process has been given to the costs of implementation and that's why long-term forecast technology has got the lower priority. However, based on long discussion and advice given by the PSC a long-term forecast technology has been finally included in the final set of technologies and proposal has been prepared for donor submission.

Table I-6.2 Prioritization of technologies for protection from landslides in West Georgia (Adjara region)

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Regulation of surface waters and arranging of water channels; preventing of infiltration of waters into the ground	15.3	9.3	9.9	5.9	40.4	6
2	Regulation of ground waters (keeping of ground waters or lowering levels)	7.7	14.0	14.3	5.6	41.5	5
3	Changing of topography landslide relief for the purpose of improvement of slope stability	10.2	11.6	11.6	1.0	34.5	7
4	Phyto-melioration	21.9	16.3	16.2	7.8	62.1	1
5	Increasing of slope stability by supporting constructions (counter-banquet, counter-force; anchor; piles)	4.4	18.6	18.4	6.5	48.0	2
6	Artificial improvement of rock features (resistance to shifting and improving stability; cementation of landslide and other kinds of splits, applying of clay, silicate, electro-osmotic draining, electro-chemical reclamation, burning out, covering with concrete spray, gunned material, etc.)	4.4	18.6	18.7	0.8	42.4	4
7	Changing of landslide ground – arranging of so called 'terramesh'	1.2	20.9	20.9	0.8	43.7	3

7 different types of anti-landslide technologies have been offered by the project expert group. Phyto-reclamation technology is considered as cheapest and most effective technologies according to the multi-criteria analysis. Increasing of slope stability through supporting constructions is the second in the range following by very expensive "terramesh" technology aiming at changing of landslide ground.

Table I-6.3 Prioritization of technologies for mud flow risk reduction in East Georgia (Kakheti region)

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Protruding dyke and cleaning up the riverbeds	12.8	18.6	22.0	1.0	54.4	2
2	Iron-concrete through construction (Kherkheulidze design);	2.0	16.3	18.6	0.9	37.7	4
3	cleaning and leveling of riverbeds;	19.1	18.6	22.0	1.0	60.7	1
4	arranging of basins in the riverbed transit-accumulation zone	19.1	11.6	15.1	2.8	48.6	3

Cleaning and leveling of riverbeds in the segments which are threatening the population and objects has been chosen as priority technology for mud flows. Due to these measures, water will not overflow the banks and the transit will be improved. Basins arranged in transit accumulation beds could fully receive the water-flows and attenuate the energy. At the same time, the released water-flows transform into so called 'under-bed flows' that in its turn will promote the replenishment of ground water supply.

Table I-6.4 Prioritization of technologies for protection of riverbanks from erosion processes

#	Technology Options/ Criteria	Economic Feasibility	Benefits			Total Score	Priority
			Risk reduction	Economic development and Social benefits	Environment protection		
	Weights for normalization	**25.6**	**23.3**	**36**	**15.1**	**100**	
1	Bioengineering measures – construction of gabions or big stones and fortification of the riverbanks by planting of deep-rooted trees.	13.3	11.6	19.7	8.1	52.7	

Bioengineering measures has been offered by the group as a technology against the floods. As far as Georgia has initiated 5 million USD adaptation project against the floods and flash-floods this technology was not included in assessment.

As a result of prioritization of three groups of technologies three technologies were selected: complex of technologies which are palliative measures against landslides (regulation of surface waters and arranging of water channels; preventing of infiltration of waters into the ground, Regulation of ground waters, Changing of topography landslide relief for the purpose of improvement of slope stability and phyto – melioration); cleaning and leveling of riverbeds (mudflows) and forecast and mapping of climate related landslides (future).

Chapter 7

Summary/Conclusions

Three priority ecosystems and relevant economy sectors have been selected through broad stakeholder consultation process and approved by the PSC for adaptation needs assessment. These are: the Black Sea coastal zone for which the tourism development is considered as priority area, agriculture for which two directions land degradation and irrigation systems are assessed within the project, and extreme geological phenomena which is considered from the perspective of infrastructure development.

Expert groups established for each sector have conducted intensive consultations with stakeholders and made significant effort to prioritize technologies for each individual segments or regions as well as in general for the country. Multi Criteria D Analysis (MCDA) has been conducted in accordance with the recommendation provided by the TNA process implementation guideline. Details of assessments are provided in Annex V and final scores are incorporated in chapters 4,5 and 6 above.

Main conclusion of the TNA and technology prioritization process for adaptation sector is that the adaptation technologies and adaptation needs are very much determined by local conditions and couldn't be always assessed country-wise which might be the case for mitigation technologies. Therefore it's very difficult to say which technologies aimed at coastal zone risk reduction are priorities for the country. As it is shown above, if early warning system has a highest priority in the river Rioni Delta, the artificial underwater reefs have highest priority in touristic areas. If water erosion mitigation technologies are recommended as a priority for the west Georgia, wind erosion technologies are recommended as priorities for East Georgia.

As a result of TNA and technology prioritization process for the approved by the PSC priority sectors 9 technologies (3 per sector) have been identified for further barrier assessment and development of proposals. One proposal has been prepared per sector.

Table I-7.1 Technology prioritization results

#	Technology	Sector	Score	Comment
1	Creation of artificial underwater reef	Black Sea coastal zone (Anaklia)	73.3	Proposal is developed
2	Decentralised early warning systems	Black Sea coastal zone (Anaklia)	42.2	
3	Beach nourishment (Artificial piling of inert material)	Black Sea coastal zone (Anaklia)	41.3	
4	Wind-breakers	Agriculture (wind erosion)	67.3	
5	Drip irrigation and artificial raining	Agriculture (irrigation)	64.5 and 64.5	
6	USLE methodology	Agriculture (Soil water erosion)	58.8	Proposal is developed
7	Protective measures against extreme events - phyto- melioration	Natural disasters (Landslides)	62.1	Proposal is developed for all protective measures (regulation of surface and underground water-streams, improvement resistance of slopes against the landslides, phyto-melioration)
8	Cleaning and levelling of riverbeds	Natural disasters (Mudflow)	60.7	
9	Mapping of climate change related extreme geological processes and providing long-term forecast of their development	Natural disasters (management)	51.3	Proposal is developed

Innovative character of some technologies has been particularly taken into consideration by the PSC, experts and other stakeholders when choosing the project proposal. Such examples are: ULSE technology for hydrological/water erosion, mapping of climate change related extreme geological processes and providing long-term forecast of their development.

Part II

Technology Action Plans

Executive Summary

The Technology Action Plan (TAP) has been developed for all technologies identified within the TNA process as priority for the Country and presented in the table 7.1. It should be highlighted that not all of these technologies are new for the country but some of them such as: beach nourishment (for the Black Sea coastal zone), wind-breakers (in East Georgia) and protective measures against landslides, mudflows and floods were successfully practiced in the past (during Soviet period). However, they need improvement taking into consideration some disadvantages demonstrated by these measures in past and what is most important, the new circumstances (decentralization and market approach) emerged after the breaking of Soviet Impair, where everything have been planned, organized and implemented in a centralized way, require new approach for improvement and implementations the same technologies. This new approach is being considered in the TAP as a new technology which should be sometimes transfer from most developed countries or develop locally and implement taking into consideration the local condition which is particularly important for adaptation technologies.

TAP has not been equally comprehensive for all technologies identified as priority in the TNA process. The technologies recommended by the TNA process and reaching the stage of project concept/proposal have more detailed TAPs while others are more limited and general. The reason for such approach is nature of adaptation technologies for which the action plans very much depends on local circumstances and the best example of this locallity is the different segments of the Black Sea coastal zone which have different infrastructure, functionality, density of population and priority for Government. However, there are common elements of TAPs which are concluded in summary section of a sector.

In the Black Sea coastal zone TAP has been developed only for the Anaklia segment. After the identification and thorough analysis of barriers which could hamper the adoption of recommended technologies in the Black Sea coastal zone (artificial underwater reefs, decentralized early warning systems and beach nourishment), the (TAP) is presented, containing activities for the introduction of reef-balls technology, the decentralized early warning system and the beach nourishment in Anaklia segment. The technology market survey has been conducted for the reef-balls technology and capacity building problems are analyzed for the early warning system including the establishment of meteorological and oceanological monitoring systems, strengthening capacity to forecast the location and scale of anticipated threats, producing participatory emergency and contingency plan and the perfection of existing communication system. Several actions are recommended in the framework of beach nourishment TAP, among them the detailed investigation of hydrology and geology of Anaklia segment, assessment of inert material sources, required amount and transportation options, creation of software for monitoring the geological and hydrological processes and for the treatment of observational data, identification of financial sources for implementing the project.

In Agriculture sector, after the detailed analysis of barriers impeding the rehabilitation of wind-breakers, the transfer and diffusion of drip irrigation systems and of soil water erosion technology, the TAP for drip irrigation technology is presented for the introduction in Kakheti region, East Georgia. It contains several measures, including training of highly skilled irrigators to ensure optimal regime of irrigation, the development of plan based upon the division of irrigated territory into parcels to be treated with different watering regime and technologies, the assessment of cost-effectiveness of utilization of new water sources, preliminary survey of Alazani-Agrichai artesian basin underground water resources and conduction of their inventory, selection of plants having high marketing value to compensate adoption of costly drip irrigation technology. The TAP for soil erosion technology is presented as well, based on the idea of piloting the process in Adjara region and assessing the current demand on this technology and feasibility of the idea. It contains such actions as assessing the current status of erodibility of soils in the pilot villages, assessing the current climate change impact on the intensification of arable land water erosion, assessing the economical losses caused by this kind of soil erosion, preparation of recommendations on water erosion prevention measures, training the most vulnerable local communities for the implementation of pilot measures, evaluation of the demand on consultancy and elaboration of options of demanded services.

Measures considered for the extreme geological events sector were well known and successfully practiced in Soviet time. These are palliative measures periodically implemented by the central government in a centralized manner against the landslides and mudflows. However, after the breaking of this centralized system new approach is required to implement these measures at community level with the full participation and responsibility of local communities. New technology recommended by the project is a software for forecasting considered extreme geological events (in particular landslides). Training of local staff and rehabilitation of monitoring process on geological changes are identified as the principle actions for operationalization of computer models.

As a result of this study it could be concluded that there are two types of barriers to the reduction of climate change risks and successful implementation of adaptation measures: community level implementation of measures, which doesn't yet successfully work in the country yet and lack of knowledge and experience in advanced technologies. Relevantly these two barriers are focused in the TAP.

Chapter 1

The Black Sea Coastal Zone Sector

1.1 Preliminary targets for technology transfer and diffusion for coastal zone

Georgia's Black Sea coastal zone is considered as an ecosystem most vulnerable to climate change in Georgia, having at the same time serious anthropogenic press particularly in the Deltas of rivers Rioni, Chorokhi, Enguri and Gumista.

As it is already explained above the current TNA process has been focused on one of vulnerable segments of the Bblack Sea coastal zone being intensively developed as touristic area.

Set of technologies developed and recommended by the various projects have been identified during the stocktaking and stakeholder consultations. All these technologies have been assessed through multi-criteria analysis, but prioritization has been done only for technologies recommended for Anaklia segment. Technologies recommended for Anaklia are provided on www.tnageorgia.wikispaces.com

Technologies in general recommended for the coastal zone are: mapping of flood risk areas on the Black Sea coastal zone and computer models for monitoring and forecast climate change impact on a sea coastal zone, decentralized early warning systems, artificial piling of inert material (beach nourishment), creation of artificial cape, creation of artificial underwater reefs.

Preliminary targets for considered and prioritized technologies for the Black Sea coastal zone protection are: to reduce the risks anticipated from the sea side, to protect the beaches, infrastructure, local population and to contribute to the development of tourism sector (in this particular case and for this particular segment). Transfer and implementation of beach and population protection advanced technologies (such as artificial reef-balls and decentralized early warning systems) bring into the country new knowledge and latest developments. Concerning the beach nourishment technologies they are not new for Georgia's coastal zone but they not always have been successfully implemented and therefore to transfer the latest updates of this technology and management of the coastal zone having real picture of climate change impact on interaction between the sea and coastal zone is very important for risks reduction.

1.2 Barrier analysis and enabling activities for overcoming the barriers

Technologies considered in this sector are mainly non-market technologies, in most cases - public goods. However some of them, such as reef-balls or decentralized early warning system, could be considered also as market technology depending on ownership. Reef-balls technology could be considered as an example. This technology is available at the international market and could be imported by the central/local government or by touristic agency interested in development of diving. In the second option the technology could be considered as a market technology. Both of these options are considered in the market mapping (Annex II).

1.2.1 Barrier identification and analysis for artificial underwater reefs (reef-balls) and enabling framework/incentives for overcoming the barriers

This is comparably new technology for the country recommended by the TNA for implementation in Anaklia segment. Artificial reefs have been used during the soviet time, but not for this particular segment. They were not directed to the tourism development, but mainly were used as wave-breakers not taking care of visual side of artificial reefs. In this case the recommended technology is reef-balls which have additional attractiveness such as development of submarine environment making it very attractive for diving and consequently for tourism development which is priority functions of this Anaklia segment. Following barriers are identified for the implementation of this technology.

- Environmental impact which should be minimized

- The use of toxic materials is a common mistake when building an artificial coral reef. This greatly pollutes the habitat and nullifies any benefit artificial reefs have to wildlife.

- Artificial reefs often do not meet the weight requirement necessary to keep them in one place. They are known to float along the sea floor, damaging wildlife and often disturbing or destroying nests.
- Many times, artificial reefs will be chained to light buoys or not be sufficiently chained at all. In addition, some of these reefs are poorly constructed. Both of these factors greatly increase the amount of ocean dumping each year.
- There are a number of artificial reefs being placed and mounted without any sort of marker on the surface of the water. This prevents boats and fishing vessels from avoiding them and they can do certain damage to the vessels and the surrounding real reefs.
- All these technological deficiencies listed above related to the lack of knowledge of know-how and lead to increase of transaction costs required for additional technical assistance, transfer of knowledge and skills, establishment of local capacity.

These types of barriers are linked to the experience and skills which do not exist currently in Georgia. One of the ways to remove these barriers is to use an outside expertise for development of local capacities. TNA process has identified that there is a reef-ball foundation which is very experienced non-profit organization (www.reefballs.org) having implemented more than 1000 projects in more than 50 tourism developing countries worldwide. This foundation has also small grant program helping coastal zone countries to initiate the dissemination of this technology with the lowest technical risk.

Other barriers

- Technology is not available at the local market. This know-how should be transferred from outside and technology should be adapted to the local environment
- Availability of construction materials could also be serious barrier when recommended this technology

In case of Anaklia construction material is not a barrier. Concrete plant is situated near the site but to get the know-how might be a problem. Reef-balls foundation offers only ready constructions. Location of this foundation increases shipping costs. Further investigations on a technology/know-how provider should be conducted by the country.

- Perspective for the development of diving tourism in this area is not yet fully proved. There are not enough materials and assessment results on sea water transparency and periods of transparency required for development of diving sport.

Additional assessments of water transparency should be conducted.

1.2.2 Barrier identification and analysis for decentralized early warning systems in coastal zone and enabling framework/incentives for overcoming the barriers

Early warning system technologies for the coastal zone are not yet introduced to Georgia. However, the intensive development of infrastructure and tourism requires increasing the safety measures and reducing potential risks. This information about decentralized early warning system is obtained from www.climatetechwiki.org. It is a TNA team opinion that a decentralized system would be more convenient in touristic areas in case of high organization of local municipalities and touristic infrastructure. Description of technology is provided in www.tnageorgia.wikispaces.org, similar to the option provided in “climateteckwiki”.

The obstacles that could prevent the successful implementation and use of the technology are related to a number of factors:

- Lack of confidence in a new and unfamiliar system from local government and touristic services.

A comprehensive awareness-raising and education plan should be developed and undertaken amongst the participating institutions (local government and touristic services). Ensure participation of the population and local institutions in the planning and implementation processes

-Problems with the timely dissemination of information among the responsible structures

Methods for disseminating information should be accurately prepared and incorporated into the communication strategy. A network of local promoters linked to grassroots organizations for dissemination of information should be stabled and well organized.

- Financial and management sustainability of the system

Sustainability and maintenance mechanisms, linking the EWS with local government and private sector involved in tourism should be developed through active participation of these stakeholders.

1.2.3 Barrier identification and analysis for beach nourishment (artificial piling of inert material) and enabling framework/incentives for overcoming the barriers

Beach nourishment/artificial piling of inert material is not a new technology in Georgia. It has been intensively applying since 1960-ties. However, because of high cost maintenance beach nourishment practice was terminated in 1990-ies. Success and failure of this technology in the past is analyzed in details in section 3.3 – inventory of technologies.

Following barriers have been identified to this technology:

- **Availability and transportation costs of inert material**. Beach nourishment requires a suitable source of sediments to be identified in enough close proximity to the nourishment site. This ensures that costs are kept at a reasonable level. Depending from the segment location the sediments are still available in most cases in Georgia. However, sources are not always close to the beach which is a serious barrier in this process. This barrier has been taken into consideration when scoring this technology.

  For this particular site of Anaklia the river Engury bed has been identified as the most optimal option among the inert material sources. However, this option is not assessed in long-term perspective taking into account the impact of climate change on beach washing processes. Long-term source of inert materials for piling should be investigated in case if this technology will be practicing in long-term perspective.

- **Availability of local expertise to implement this measure**. Beach nourishment requires highly specialized equipment and knowledge including dredgers and pipelines that will need to be hired from a specialized contractor. Local site characteristics will also influence the type and size of dredger which can be used – this can further limit the availability of dredgers. Limited number of contractors is available around the world.

  Since 1960s coastal zone nourishment (pilling) has been implementing in Georgia. Country has local expertise and experience, but as it is described in chapter 3.3 this past experience for beach nourishment is negative. More contemporary approaches should be investigated from the current practices in other well developed countries with the sea shore line. None of these past approaches have considered climate change features when designing the nourishment plan.

- **Public awareness of how beach nourishment schemes work can also present a barrier**. This is especially the case when using shore-face nourishment or underwater sediment deposition is questionable. Using these techniques, the advantages of nourishment may not be immediately noticeable and unless the public are educated on how the scheme works, they may doubt the benefits of nourishment and oppose such projects. The public should also be made aware that nourishment is not a permanent solution and that re-nourishments will be required. If this is not communicated, the public may again believe the scheme has failed and resent further spending on re-nourishment. This will be especially the case if public funding is used to cover nourishment costs.

The TNA team opinion is that more long-term measures should be implemented in Anaklia segment such as rehabilitation and upraising the natural knolls (dunes). However, this technology is not yet supported by the policy makers and some of experts. This approach never has been used in Georgia. Opinion of local population is not also very positive regarding this technology, in particular for the Anaklia segment aimed at sea tourism development.

- Once nourishment has been carried out, the ongoing beach monitoring is needed in order to evaluate nourishment success and to determine when re-nourishment will be required. Given appropriate training and technology, monitoring should be possible at a local/community level. Nourishment schemes should be evaluated as a whole, however, they may require the participation of multiple communities if nourishment is undertaken on a large scale. Monitoring was terminated because of financial problems caused by the breaking of Soviet Union.

  Tourism and economy development in the coastal zone area should be serious incentive for the government and for private sector having business near the vulnerable segments to rehabilitate and maintain high efficiency monitoring system.

1.2.4 Linkages of the barriers identified

Since 1980s, after breaking the Soviet Union and starting transitional period, the country's priorities have been significantly changed. Optimization of structures financed from the state budget has resulted in abolishment of the most of observation and monitoring systems, including statistics. In this period oceanographic and hydro-meteorological observation network has practically stopped its operation except of a few cases supported from time to time by different projects implemented through grants. Old infrastructure was destroyed, but new one is not still built. Some improvements are observed in the rehabilitation of oceanographic and hydro-meteorological observations during the last decade. However, the scale and speed of this process are far from the country's economy development planned and ongoing in the Black Sea coastal area. Absence of observed data trends and firm scientific background to demonstrate to the local government and private sector the anticipated risks imposed by climate change is serious impediment to the adaptation technologies. Country still has not rehabilitated regulatory, institutional and financial capacity to deal with this issue. Role of and contribution from private sector having business in the coastal zone should be significantly increased along with the contribution (in particular, in scientific studies and in establishment of regulatory mechanisms) from the local governments. Almost all types of barriers (regulatory, infrastructure, local capacity, financial) exist in this sector to the identification, preparation and implementation of coastal zone adaptation measures. Main barriers to this adaptation process are:

- **Lack of observations** of oceanographic and hydro-meteorological data for assessment of vulnerability of the Black Sea and its coastal zone vulnerability to climate change (weak monitoring infrastructure)

  Monitoring system should be rehabilitated and strengthened particularly in targeted areas by the TNA process. This is mainly Government's responsibility. Government offers different incentives (exemption from taxes, development of infrastructure for free for investors, free licences, etc) to the business and in particular in the Anaklia area. Rising of awareness among the decision makers and in particular in local government on the potential risks of climate change could improve the current status of monitoring systems.

- **Lack of scientific studies** dedicated to the assessment of climate change impact on this ecosystem and adjacent areas. Contemporary software tools for monitoring and forecasting of changes in interaction between the land (coastal zone) and ocean are not available for Georgian scientists. The results of these studies are very important to convince the relevant decision making structures in urgency of adaptation measures (lack of local capacities).

  To support such scientific studies is the direct responsibility of the Government. However, the costs of such studies could be partially shared by the private sector having business in these risky areas. Importance of impact assessment studies in a risk reduction process should be clearly communicated to the private sector as well as to the government.

- **Lack of knowledge and experience in new coast protective technologies**. Georgian coastal zone protection service has very long and rich experience in technologies traditionally applied for the protection. Not all of them have been successful in implementation and none of them have been designed taking into consideration the phenomena of climate change (lack of knowledge in technology achievements and availability).

This is the most important barrier. Current situation: donors assisting the country in risks assessments and in recommendation on measures mainly provide ready products to the country using international experts. Such process is a crucial barrier for the development of local capacities. Recommendation from TNA process: to facilitate joint involvement in feasibility studies and exchange of experience and software used for assessments. Climate Technology Centers Network (CTCN) adopted in Durban (at CoP 17) should be main provider of such knowledge and experience to the non-Annex I Parties involved in technology transfer process. CTCN should be used for establishment/strengthening/increasing of local capacities. In case of Georgia the Institute of Technologies, which the Government of Georgia plans to establish, should be a national counterpart of CTCN disseminating knowledge and skills further in the regions through innovation centers also planned by the government to be established in regions.

- Coastal zone protection/adaptation measures being implemented currently (protection of river banks or coastal beaches) against the recent extreme phenomena are designed based on past experience. In most cases these measures are **post rehabilitation measures** rather than protective. Climate change future scenarios and relevant risks in different fields of business (tourism, free economic zones, development of different elements of infrastructure in the vulnerable regions) is not yet regularly taken into consideration in national policy (awareness and regulatory barrier).

  Responsible structures at national and regional levels for monitoring of climate risks, preparation of adaptation measures and implementation of these measures should be established by the government along with the relevant regulations. Involvement of business structures in decision making process is of crucial importance, in particular in case of coastal zone protection.

- Absence of **responsible structures for climate change adaptation** at the central and regional levels (lack of regulatory framework and infrastructure). There is no clearness in a mechanism for continous monitoring of climate related risks, preparation of adaptation projects and implementation. Climate related risks are being currently assessed trough different ongoing in country projects (national communications, TNA, etc) and adaptation measures are also recommended by these projects. There are different agencies responsible for different stages of the process. E.g. Ministry of Infrastructure and Regional Development is responsible for implementation of flood resistance measures, Emergency Situation Management Department (of the Ministry of Internal Affairs) is responsible for post emergency reaction and recovery process. However, interaction and coordination between different agencies is not regulated and climate change problem is not relevantly considered in the activities of these structures.

  Coordination mechanism between the structures (Ministry of Environment, Emergency Situation Management Department, Ministry of Infrastructure and Regional Development, etc) responsible for different processes should be very strong and continuous. Currently such coordination happens only in case of emergency situation directed to the post extreme phenomena reaction. Similar cooperation should be established on the permanent basis and should be directed to the adaptation, risk reduction and prevention.

Besides of these common barriers to the implementation of different types of technologies in any of considered vulnerable segments of the Black Sea coastal zone, there are barriers or disadvantages typical for each technology which should be very carefully analyzed at the stage of feasibility studies taking into consideration local environment, conditions, traditions and existing regulatory framework and infrastructure in order to avoid the unsuccessful recommendations to the government and moreover unsuccessful results of implementation. Intensive consultations with the local stakeholders are crucial for success in general technology transfer process.

1.3 Recommended solutions for the Black Sea Anaklia segment

Market Mapping for technologies recommended for the Black Sea coastal zone Anaklia segment is provided in Annex II and recommended actions for transfer and implementation are given in TAPs. Common recommendation for ensuring the successful implementation of new technologies and reduction of climate change risks are to establish the responsible body (a board or any other type of structure) at the regional level for permanent monitoring of climate change impact on the coastal zone, identification and implementation of adaptation measures and general risk prevention.

1.4 Technology action plan, project ideas, and other issues in the Black Sea coastal zone sector

1.4.1 TAP for the introduction of the reef-balls technology

Following actions have been identified as core actions for transfer and implementation of underwater artificial reef-ball technology:

- **Technology market survey**. Country's priority is to get know-how of the reef-ball technology along with training and to produce it locally. This reduces the shipping expenses and increases the local capacity. To establish joint venture with producer is the next acceptable option. The option less attractive for the country is to purchase a ready product and to import it to the country. However, the last option is not excluded as an initial step (pilot project) for Anaklia segment. In this regard all possibilities existing at the international market should be well investigated to get technically and commercially most appropriate for the country option.
- As far as a technology is new, the **ownership** should be established. There are three options under consideration. The first one considers this technology as a public good (owner is central or most likely local government) for coastal zone protection imported and maintained by the government and offered as an incentive (similar to other incentives already offered by the government to the private sector for development of this segment) to the private sector for developing of diving tourism. Another option is intensive raising of awareness on the perspectives of this technology among private sector operating in tourism development section. Combination of these two options seems to be most cost-effective and less business risk comprising option if Public Private Partnership approach will be applied as far as both partners have interest and profit from this technology. For the government (central or local) this is a coastal zone protection technology which is the direct responsibility of government while for tourism business it could be an additional income and perspective.
- **Capacity building**. The diving tourism elements already are familiar in the country. However, capacity of this type of tourism should be increased and strengthened. Particular elements for training are: marketing, safety measures, code of international standards.

1.4.2 TAP for the decentralized early warning system

Following actions have been identified as core actions for implementation of decentralized early warning systems at the community level:

- Establishing meteorological monitoring system;
- Establishing tidal and sea level raise detecting system;
- Establish capacity (software models and trained people) to forecast the location and scale of threats;
- Establishing an organizing committee (leaders of the community and civil society, NGOs, representatives of local authorities and the private sector);
- Producing a participatory emergency and contingency plan;
- Implementing or strengthening of the existing communication system: early warnings, dissemination of prevention, mitigation and adaptation measures.

It should be highlighted that early warning system is very important instrument reducing damages, but not so effective without other protective measures such as: beach nourishment, artificial/natural knolls/dunes adjusted to the sea level raise, wave breakers, etc. Therefore, combination of different options is recommended in case of Anaklia.

1.4.3 TAP for the beach nourishment in Anaklia segment

Beach nourishment technology is not a new technology for Georgia and it has been using since 1960s. Technology has very high maintenance costs, depends on availability of inert materials and accurate investigation of underwater geology. Because of high costs, the technology has not been used almost for 15 years. Sea coastal zone protection service renewed this process in 2004 and was used in two sites (Kobuleti and Adlia). This technology is recommended by the TNA expert group for Adlia segment as well. Following actions should be taken for implementation of this technology:

- Detailed investigation of hydrology and geology of Anaklia segment. Some preliminary assessments have been already done.
- Inert material is planned to be transported from river Engury bed. Preliminary amount of initially required piling inert materials and amount for annual maintenance are also assessed.
- Transportation options and costs are assessed.
- Software for monitoring of development of geological and hydrological process in future and for monitoring of the results of measures is not available. Local capacity for operation of such monitoring system is not satisfactory. Additional training of local researchers and strengthening of other capacities along with the software is necessary. This part of TAP is particularly related to the climate change impact assessment and is incremental cost for the project.
- Financial sources for implementation of this project are not yet identified.

1.4.4 Brief summary of project ideas for international support (Details in Annex III)

Implementation of community level decentralized early warning systems, reef balls and software (computer model) for monitoring the relevant hydrological and geological processes impacted by climate change are main technologies identified as priorities in this sector. One project proposal has been developed for Anaklia segment of the Black Sea coastal zone for submission to the donor community. This is combination of four (Artificial piling of inert material, Creation of artificial cape, artificial growing of coastal dunes in width and in height and Creation of artificial underwater reef) technologies described in Annex III and included in www.tnageorgia.wikispaces.org.

1.5 Summary

Despite the long term experience and history of implementation of preventive measures in order to protect the Black Sea coastal zone, after the breaking of Soviet Union the situation in coastal zone management has radically changed as well as priorities in its different segments. Government's current policy and structures already existing are mainly oriented to the implementation of post disaster rehabilitation measures. There is no clearly appointed body/structure (which should be at the regional level) responsible for continuous monitoring of processes, considering the future trends and integrating the risks reduction policy in the development strategies and plans. Establishment of such responsible body could be considered as key policy level recommendation issued by the TNA project in order to facilitate the import of advanced technologies and development of local know-how.

Chapter 2

Agriculture Sector

2.1 Preliminary targets for technology transfer and diffusion in agriculture sector

Traditionally, **agriculture** has been a leading sector in Georgia. The fertile soil of the country has provided favorable conditions for land cultivation, as well as animal husbandry. The agricultural area covers 43.4% of the territory. Traditional agricultural crops include grape vines, wheat, maize, many species of fruits, citrus plants, and tea plantations. Traditional types of animal husbandry include cattle-breeding and sheep-breeding.

Georgia is a mountainous country: 54% of its territory is located at an altitude of 1000m above sea level. Soil erosion processes are greatly influencing the development patterns of many sectors of economy, among which agriculture is the most vulnerable branch.

Based on the diversity of climatic zones and climate change related problems four main directions have been considered in agricultural technologies prioritization process: soil water erosion protective technologies, soil wind erosion protective technologies, anti-salinity technologies and irrigation technologies intensively used in past in Inner and East Georgia for compensation of dry weather conditions (in particular in South-East of Georgia).

Preliminary target for technology transfer in agriculture sector is the protection of arable lands and pastures from erosion intensified by changes in climatic parameters such as heavy precipitation, high speed winds and increase in temperature. Demonstration of advanced technologies, best practices in land management and rising of awareness on climate change and agriculture issues among farmers, decision makers and agriculture service centers accompany the transfer of technology or new approach. Some of these technologies considered in the TNA process are technologies (wind breakers, self-flow irrigation systems, terrace, etc) well-known in Georgia in the past and having been applied in agriculture for a long time while others are new technologies facing barriers typical for the transfer of innovations. However, these technologies successfully used in the past are recently facing new barriers related to the transition to market economy and privatization process.

2.2 Barrier analysis and enabling activities for overcoming the barriers

All these technologies considered in the agriculture as well as in other sectors considered in adaptation section in general belong to non-market technologies and are assessed against the barrier and incentives. However, there are some elements of whole technological process which are not directly fall under the non-market technology and could be analyzed through market mapping process. One of the examples of such case is wind breakers analyzed below.

2.2.1 Barrier identification and analysis for the rehabilitation of wind-breakers and enabling framework/incentives for overcoming the barriers

Wind breakers have been traditionally used in agriculture sector for protection of arable lands and pastures. Broad dissemination of this technology started in 1960-ties during the soviet economy and this dissemination process was led by well-known community type, state owned organization called “kolmeurneoba/kolxoz”. Process of dissemination was organized by the central government and was completely centralized (including methodology, planning, providing of saplings, maintenance, and protection from different dangers). Wind breakers were established mainly in East Georgia as well as in West Georgia. However, majority of experts confirms that optimization was not taken into consideration at that time (the same as in irrigation sector). Methodology for designing of wind breakers was based on climatic parameters and in particular, on direction and speed of winds for specific sites, but the climate change phenomena was not known in 1960s and consequently it was not taken into consideration while designing the technology.

- Based on the above mentioned information, one of the barriers to the rehabilitation of former wind breakers (non-market technology) or to the establishment of new ones is the **updated methodologies and approaches** for assessment of optimal design of wind-breakers taking into consideration the climate change patterns.

  For the removal of this barrier methodologies on designing of wind-breakers should be updated taking into consideration the current status of local lands and local climate change patterns. Demand on such updated *methodologies and statistical data for application of these methodologies should be created. Demand is the product of understanding of the benefits (increase in productivity, protecting soil, etc) and urgency of something which in this particular case is technology (wind-breaker). Awareness of local households, farmers and in particular municipalities should be updated on the climate change issues and strengthened. Former approach of planning research works and development of methodologies should be altered taking into consideration the requirements of market economy. In particular, research works should be decentralized and directed on practical needs. It is very important in capacity building process to clearly differentiate national and regional/local priorities. Wind breakers have mainly local significance even if agriculture as a sector is priority for the government. Recently this process of awareness rising among the local society/stakeholders is supported by international donors. For establishment of real demand on wind-breakers and relevant methodologies for the introduction of this technology should be priority and should be supported by local municipalities, farmers associations and communities in the regions where this technology has real priority and urgency for the sustainable development of agriculture.*

- Next important barrier identified is **ownership** of this technology/good. As it was mentioned above, in past, these windbreakers and territories belonged to “Kolmeurneoba/Kolxoz”. These already degraded/logged windbreakers belong now (after privatization) to the farmers having arable or other type of agricultural lands adjacent to the wind-breakers areas. Farmers don’t have enough understanding of the role of windbreakers in agriculture and not have enough income for rehabilitation/establishment of this very important technology in the climate change environment. Moreover, some of these farmers consider wind-breakers as impediment to increasing of land productivity.

  In case of non-market technologies this barrier is most difficult one for overcoming. Step by step the government has been improving situation and gives more attention to up-to-date technologies and innovations but such efforts are mainly directed to the very high priority areas such as tourism development and even in such areas not always state-of-the-art technologies are imported based on cost-effectiveness principle. Ownership should be clarified and decided and decentralization of regions should be intensified. Such, regional priority technologies are competitive at the regional level but are not always competitive at the national level.

- **Services** for implementation and maintenance of this technology don’t exist, need updating or are not available at the regional level.

  Required services (nursery, protection, methodology, design, etc) should be created locally/should be available locally and involvement of local stakeholders in establishment of such services is decisive factor for successful implementation of updated technology. One of the most important services to be established is protection of windbreakers from fires, animals/grazing and cutting. Role of local communities and farmers are crucial in this process. Interest of local households and farmers for participation in protective service could be increased if some fruit trees will be mixed in the shelters. Harvest could be used by farmers.

Two types of windbreakers were planted in East Georgia (in Dedoplistskaro region) with the width of 60 meters making the central shelters protecting the large areas and with the width of 10 meters intervened in the smaller parcels of arable lands of pastures. All these territories were that time common good and belonged to the “kolmeurneoba”. Wider windbreakers are very expensive to rehabilitate, protect and maintain and would be almost impossible to support even by prosperous farmers. 10 m wide windbreakers could be rehabilitated and maintained by one farmer or small communities and therefore it has been considered as a market technology and mapping has been done (see Annex II).

- Barriers identified for this technology are:

  -Local **environment** for technology transfer is not sufficiently developed yet. There is no special enabling environment including regulations for import of innovative technologies and no standards against which an imported technology would be accredited. Prices of technologies are quite high but recently mostly initial investments (more than 60 %) are mainly covered by grants.

  Institute of technologies and innovations should be established as a main basis for effective participation in the technology transfer process. Government of Georgia has already claimed that Institute of Innovative Technologies will be established in 2012 in Batumi-city. In many cases technology could be developed locally but to have the understanding of modern technological requirements and developments the country should be involved in the international network of Centeres of Excellences.

- most of ***services*** required (design of windbreakers, standard setting entities, nurseries for sapling, laboratories, monitoring of climatic features and future forecast, etc) are in place since the Soviet time but all of them need reconstruction to the market environment, information and methodologies used by these services are outdated, there capacities are not satisfactory for contemporary requirements, banks have not targeted concessional loans for renovation/reconstruction of existing technologies or for transfer of new technologies;

Recently, most of these services are formally in place (except of standard setting entity) but tendency is such that reconstruction of existing services has more barriers than establishment of new ones replacing the existing services. New structures are mainly established either by NGOs or private sector still supported from outside. In long-term perspective the targeted state/regional programmes (depending from the level and intensity of decentralization process) should be introduced in support of local private initiatives providing relevant services to the agriculture sector. Meanwhile, local municipalities should be strengthened and involved in the service at least as information centers.

-***market actors***, traders/importers item does not exist at all. Technology and methodology provider at the time being are still international donors through specific targeted projects and programmes mainly from environment protection funds.

Market actors are to be created or some relevant enterprises/trading agencies, specialized in agriculture might be modified. Most likely, initially joint ventures should be established for importing know/how or market based services.

2.2.2 Barrier identification and analysis for the transfer and diffusion of drip irrigation systems and enabling framework/incentives for overcoming the barriers

Drip irrigation is selected for assessment of barriers to the transfer of state-of-the-art irrigation systems. The rest of technologies considered within the TNA process have been more or less distributed in past in Georgia. Drip irrigation could be considered as market technology for big farms and therefore market mapping have been conducted in this case (see Annex II). The technology is spread worldwide and is demonstrating high efficiency, especially, when used for arid and semi-arid lands but it isn't in practice in Georgia, partly, due to its cost. As Dedoplistskaro district is considered as one of the vulnerable areas to CC, and, at the same time, very important from economical point of view, and also issuing from large scale of the area, this technology was selected as the most suitable for this region. Besides Kakheti, the technology can be suitable for other regions in the East Georgia as well, where the landscape is semi-arid too. Total area for irrigation involves almost all southern and south-east Kakheti (Ole-Naomari, Taribana, Eldari, Shiraki, Jeirani Valleys etc) and Kartli region too).

Following barriers have been identified through market mapping.

- **Information about market availability and technology standards**. Technical appliances for drip irrigation – water distributing and regulatory systems should be bought at the international market. Good technical knowledge and practical experience in operationalization of such systems is necessary for selection optimal for the specific site system. Such knowledge and service is not in country and therefore consultant from outside should be invited each time increasing with this the transaction costs of the project.

  Institute of the innovative technologies' is planned by the government to be established in Georgia (in Batumi). One of the functions of this institute should be collecting and dissemination of information about available state-of-the-art technologies. One institute might be not enough to cover all regions and priorities and needs of all regions. Regional network of innovation centers should be also established. This idea partially coincides with the government's plans adopted through the document of "Regional Development Strategy". The strategy envisaged to establish innovation centers in each of 10 administrative regions of Georgia. Institute of technology could be center and leader of these innovation regional centers. One of the functions of the Institute and Regional Innovation Centers should be establishment of standards for the required technologies and it should be provider of information to the private services and NGOs for further dissemination.

- **Operationalization of modern technologies**. Modern drip irrigation systems has irrigation process auto-regulatory functions as well which is very important in case of Georgia due to the negative attitude from stakeholders having in mind the negative (soil salination) past experience caused because of improper operationalization of systems.

Initial (in short-term perspective) technical support or transfer of knowledge should be provided by a technology provider to an end-user. End-users need special training and awareness raising process in making agreements with technology providers. Practice show that in many cases there are serious gaps in the contracts less considering the interests of end-users or technology receivers. Again the precision and quality of the contracts (equally protecting the interests of all partners) much depends on knowledge and information existing in the country. Development of such services is crucial in technology transfer process. according to the recent decision in Durban on TT the CTCN(Climate Technology Centers Network) will be established. This network should be main provider of worldwide available technologies along with other types of supports to the non-Annex I Parties. In long-term perspective whole system of services should be created locally ensuring the maintenance and dissemination of drip irrigation systems. Diffusions of a technology fully depends on successful implementation and exploitation of pilot (first) technologies. Local capacities at the level of regions should be created and strengthened for the maintenance and proper exploitation of drip irrigation technology.

- **Energy supply**. Irrigation systems using energy are not economically feasible in Georgia yet. Energy consumption in irrigation increases the production cost which affects the price and makes product uncompetitive at the market.

  Cheap energy source should be acquired. For East Georgia this could be solar energy in long term perspective. Meanwhile the sites for use of drip irrigation system should be selected carefully based on the optimization of water resources, energy resources, cost-effectiveness and urgency. There is no enough in home capacities to make such assessments. Therefore feasibility study should be supported by the donors (grant) in order to reduce the transaction costs.

- **Ownership**. This is expensive technology and has high financial risk for one farmer.

  Irrigation systems could be shared and managed by farmers associations or households communities decreasing with that the financial risk for each individual farmer.

▪ Barrier identification and analysis for the transfer and diffusion of soil water erosion technology and enabling framework/incentives for overcoming the barriers

Technology has not high costs related to new hardware (only for few exceptional recommendations). Main financial burden comes on the part of software including monitoring and assessment of particular meteorological and environmental data. Following barriers have been identified to the technology preventing soil water erosion process:

- The **legislation** does not exist on the protection of agricultural lands and on retaining of their fertility, which determines the rights and obligations of land owner in respect of soil protection.

  Obligations of land owners (farmers, households) regarding the maintenance of land quality should be regulated by the state along with the governmen's responsibility to support the land owners in fulfillment their obligations through different programmes and subsidies. Serious awareness raising compaign on the future danger and risks in case of land degradation should be conducted by the national and international environmental institutions possessing enough evidences on the possible results.

- The **monitoring** is not being conducted of parameters, which are necessary for the assessment of soil erodibility and other quantities required by the technology. Hence, the implementation of this technology has start-up transaction costs, which could not be burden for the land owners/end-users of technologies.

  Initially such type of investigations should be done by the state programmes by grants but for future sustainability of the process special service should be established which is reasonable when demand on such assessments are proved.

- The application of offered technology requires the determination of **historical and projected trends of climate parameters** (precipitation, temperature), the reliable forecasting of which using regional climate models is so far not possible. The resolution of regional models is higher than that of global models, but is still insufficient to assess the local trends, especially in high-mountainous regions. Models often produce contradictory results, that complicates to convince the decision makers of problem's urgency.

  This is global problem and barrier for all climate change related technologies is being tackled by whole international society of scientists. Regional models for climate change forecast are available in Georgia and assessment of future trends of water erosion in each particular case could be obtained within the interval of some acceptable uncertainty. However, such assessments require additional expenses. This barrier is similar to the previous one by its nature but has longer lifetime. Monitoring of climatic parameters and updating the recommendations is the substance of this technology. These transactional expenses should be shared by the governmental programmes and donors. Currently there are ongoing projects (among them the Third National Communication of Georgia) which are doing the similar assessments and the results of these projects could be used.

- The adoption of this technology requires to create additional **local services**, which will elaborate recommendations for each particular plot according to climate conditions and soil parameters. The climate change trends should be considered as well.

  Second and third barriers above are most expensive parts of technology. This particular barrier depends from successful removal of barriers two and three. Services considered in this barrier could be initially supported by the regional governments or donors engaged in ecosystem based environmental activities. NGO service seems more realistic until the feasibility of/demand on technology is proven. NGO service later could be substituted by private sector.

- The awareness rising of population, farmers and local officials on the economic efficiency of this technology and on the possible aggravation of climate change adverse impact is of paramount importance for the introduction of this technology and provision of its further sustainability.

  As far as technology is new and the results of its application are not probated in Georgia the implementation of pilot project is recommended by the TNA adaptation team. Results of pilot project will be used for awareness raising of local governments who has to facilitate process and end-users of technology. It would be easier to convince private sector in the perspective of this business based on the evidences produced by the pilot project. Proposal for pilot project is attached as Annex III.

▪ Linkages of the barriers identified

Main problem identified in agriculture sector is change in sector management process from centralized governance to the private management of all processes at the medium or small farmers' level. In past even households living in villages were involved in the centralized process of land processing/melioration and management. This means that all type of services (land cultivation measures, seeds, saplings, plants, fertilizers, chemicals and all other types of recommendations) have been planned and provided through "kolmeurneoba/Kolxoz", which was community type organization established and acting during the soviet time. After the dismantling of this centralized system most of elements of whole chain disappeared and farmers and households engaged in agriculture have founded themselves face to face to their own private lands but without any help and service. Meanwhile new types of barriers have emerged related to the market economy and privatization process and even technologies (irrigation systems, wind breakers, terrace construction against water erosion, etc) well disseminated and utilized under the centralized management now need modern schemes of rehabilitation taking into consideration the elements of market economy and sustainable management including the resource management optimization process. Following barriers are common for agriculture technologies:

- Lack of local technical capacities (knowledge of innovative technologies and up-to-date approaches applied in agriculture). This doesn't mean that there are not individual farmers or initiative persons having such knowledge about innovations but they don't have vision of whole implementation process and barriers to such process and ways to remove the barriers. There is not system and infrastructure in country having necessary knowledge and skills to apply the knowledge in agricultural practice; (local capacity)

- Former structural elements serving the agriculture sector are either abolished or restructured in a way that doesn't always functioning properly; (institutional)
- Lack of scientific studies dedicating to the assessment of climate change impact on land degradation and agriculture. Not availability of contemporary software tools for monitor and forecast anticipated in future problems; (lack of local capacities)

2.3 Recommended solutions for Agriculture

Transforming an agricultural production system into a system that is more resilient to climate change such as integrated farming is a longer term adaptation strategy which may be supported by public good subsidies. This, for example, could include subsidies for the TTD (Technology Transfer and Deployment) of insurance, irrigation or new crop varieties. Transfer of advanced agricultural technologies and revival of traditional technologies/measures having in consideration the climate change impact and new political and economical circumstances is principle recommendation given by the project which should be accompanied by facilitation of the community based agriculture management.

2.4 Technology action plan, project ideas, and other issues in Agriculture

2.4.1 TAP for implementation of new approach for wind-breakers development

Wind breaker is not a new technology for agriculture sector of Georgia and it has been intensively using since 1960s. However, most of windbreakers are destroyed during the energy crisis years. Technology has very high initial costs, depends on local biodiversity, availability of water resources for irrigation (at list from the beginning) and accurate investigation of territory and wind directions. Maintain costs are not very high but problem is protection from fires (population has practice to burn the agricultural residues and pastures when fire easily spreads to adjacent windbreakers) and cutting. Population still has not enough understanding of the function of wind-breakers for productivity of their own lands. In past all these problems have been avoided by centralized political system. The owner of this technology was "Kolmeurneoba/Kolkhiz". Newly emerged problem after the decentralization of the system is ownership. New approach in the process of rehabilitation of wind-breakers should be implemented. Following actions should be taken for full operationalization of this technology:

- Replenishment of damaged wind breakers taking into consideration of new circumstances (changes in wind directions and speeds caused by climate change, selection of variety of plants, etc.);
- Sharing experience (best practices) of other countries in the planning of rehabilitation of damaged wind-breakers;
- Mapping of new sites for establishment of new windbreakers and optimization of rehabilitation process;
- Establishment of enabling environment (ownership, wind breakers protection and soil protection) considering the new political and economical relities;
- Awareness raising among the farmers on the role of wind-breakers in the protection of soils from wind erosion.
- Establishment of service centers for agriculture sector;
- Strengthening the cooperation between agriculture and climate change services.

2.4.2 TAP for drip irrigation technology

Following additional actions, to the establishment of enabling environment considered in the barrier section, are identified for operationalization of drip irrigation systems in Kakheti region, Georgia.

- Highly skilled irrigators should be trained to ensure optimal regime of irrigation (taking into consideration the soil humidity, vegetation and sowing dates) and the maintenance of the system;
- Irrigation plan should be developed based on assessments made for division of total irrigated territory into parcels to be irrigated by different watering regime and technologies.

- Cost-effectiveness of utilization of new water sources should be assessed. In particular, Alazani-Agrichai artesian basin underground water resources should be assessed for inclusion into the southern section of Alazani basin irrigation network. These resources are abundant and are featured by high quality;
- Inventory of these resources along with the temporarily closed down wells should be conducted.
- High cost of technology is one of the barriers to dissemination of drip irrigation technology. This barrier should be neutralized by using this irrigation system for watering of sufficiently expensive plants which have high marketing value.

2.4.3 TAP for soil erosion technology (USLE method)

This TAP is based on the idea of piloting of the process and assessing the current demand on such technology and feasibility of the idea. These actions listed below are for assessment of feasibility of the technology in this most vulnerable region.

- Assess the current status of erodibility of soils in the pilot villages
- Assess the current climate change impact on the intensification of water erosion of arable lands and pastures in the pilot villages
- Assess the economical losses per ha caused by the aggressive water erosion of arable lands
- Prepare recommendations for each household and each plot on water erosion preventive measures
- Mobilize and train (awareness raising) the most vulnerable local communities for implementation of pilot measures and implement recommended measures
- Evaluate the demand on consultancy in agriculture and elaborate options of demanded service.

In case the feasibility of technology is not proved the main barriers should be identified to the idea and new action plan should be developed or technology should be denied.

2.4.4 Brief summary of project ideas for international support (Details in Annex III)

Several technologies advanced and well practiced in the past have been considered in agriculture sector for two main directions- land degradation and irrigation. Three types of technologies are finally recommended by the TNA project based on stakeholder consultations and technology prioritization processes. Wind-breakers are recommended against the wind erosion in East Georgia, USLE method is recommended against the water erosion in West Georgia and drip irrigation is recommended as an advanced technology not disseminated yet in Georgia. Two project proposals have been prepared as a result of TNA process: proposal for rehabilitation of irrigation systems and proposal for the piloting of soil water erosion technology. Proposals are provided in Annex III.

2.5 Summary

Agriculture sector is declared by the Government as first priority in the nearest several years. Introduction of advanced technologies and latest best practices in the management of the sector are fundamental principles in this process supported by the Government. First step has been already done and service centers for agriculture sector have been established in each region. However, without solid knowledge of technologies and relevant capacities these centers couldn't be sufficiently effective. These service centers are considered by the TNA stakeholders as main target group /recipients. All results and proposals obtained by the project will be communicated to the beneficiaries (farmers and local population) through the service centers. Special training programmes and capacity building activities should be provided to these centers. Existence of such centers will increase the feasibility of proposals recommended by the TNA.

Chapter 3

Extreme Geological Phenomena (landslides, mudflows) Sector

3.1 Preliminary targets for technology transfer and diffusion in extreme geological phenomena sector

Technologies reducing the landslides and mudflows risks well-known in the country and broadly applied in the past are considered in this sector. Similarly to agriculture sector in the past, whole responsibility on implementation and maintenance of technologies mitigating the landslides, mudflows and flash-floods risks has been taken by the government. Government, through the Ministry of Infrastructure and Regional Development still takes responsibility for the most urgent and emergency cases but is not in the position to cover all vulnerable sites due to the lack of public money. Participation of local communities not only in decision making process but also in implementation of protective measures and further monitoring process is a new approach not practiced in the past and therefore requiring intensive community mobilization, training and awareness rising. In this process the advanced technologies along with the relevant knowledge should be provided to the vulnerable communities. It's clear that this approach could be used for villages, sites which are not under a very high risk and are not urgent, but where the processes are being intensified under the impact of climate change.

Technologies recommended in this section should be considered as non-market technologies with limited barriers as it is recommended by the guidance for market mapping. Role of the government in import/maintaining and dissemination of such technologies is crucial. Government can play a decisive role in supporting people and businesses to overcome some of the barriers to the implementation of non-market technologies.

Preliminary target for transfer of technologies and approaches recommended in this section is to demonstrate the benefit and effectiveness of decentralization of risk management process at the level of regions and local communities when only strategic objects are under the monitoring and full control from the Government side.

3.2 Barrier analysis and enabling activities for overcoming the barriers

3.2.1 Barrier identification and analysis for the dissemination of preventive measures against the landslides

Organizing of local population and communities, being under the landslides hazard, for implementation the recommended preventive measures is one of the prioritized technologies identified by the project. Four protective measures among 7 have been chosen as more appropriate and feasible for community level implementation: regulation of surface waters and arrangement of water pipes, preventing penetration of water into the ground; regulation of ground waters (catching of ground waters or lowering of levels); change of relief topography with the aim of improving of slope state and phyto-melioration.

There are two types of barriers impeding broad dissemination of this technology. These are technical barriers and general barriers considered in sections 3.1 and 3.2.4 below.

Technical barriers or disadvantages of this set of technologies are:

- Most of them have some negative impact on local environment (removing some slopes)

Neutralization of this barrier is important taking into account needs of population and the State (in case of big projects). If certain impact on the environment is inevitable, the relevant compensation as well as rehabilitation measures for neutralization of the caused damage should be provided. Principles of sustainability should be maximally taken into consideration while planning the relevant measures (to avoid other damages), implementation of which requires very good knowledge of modern technologies.

- Population in densely populated areas have concerns regarding the losing of useful territories as a result of removing the part of lands and vegetation;

  An approach proposed by the project should presumably remove this barrier. In particular, when the state plans and implements something (notwithstanding serious consultations with stakeholders) the population quite often expresses resistance and dissatisfaction. If local population recognize the mentioned activities as their own task and responsibility, than there is a chance to achieve the implementation of concerted and effective measures. Their awareness must be raised to the level when they would understand that by giving up something they would be able to achieve final success.

- These measures are not always easily accepted by local population recognizing that they could have significant impact on local water resources (underground and surface);

  Sufficient knowledge of modern technologies is required for removing of this barrier. Information on the modern technologies is not available within the country. This problem cannot be solved only at national level. In this context it is very important to establish regional consulting centers (Centers of Exellences) within the global process of 'technology transfer', where national experts would work together with international or more experienced foreign experts on technologies significant for each individual country. This will be especially important for adaptation technologies which are mostly very local and require taking into account a complex of local factors.

- Availability of mining ballast and excessive costs in case of necessity of transportation

  This barrier should be considered and discussed separately for each particular case. The measures should be selected taking into account conditions of each single case.

  Among the barriers emerged during implementation of this kind of projects the most significant are: awareness rising among population and shifting of management of the processes to the regional level. Main goal of this project is the removal of these barriers, or at least their minimization.

Other barriers of this set of technologies are:

- Risk assessment and risk management processes are still centralized even in those cases when the state does not take financial responsibilities for risk minimization.

  Actually, the mentioned risks often have local character and represent a priority for local authorities and local people. The mentioned barrier should be removed through decentralization of decision making processes and mechanisms. The mentioned pilot project is aimed at discussing of ways of decentralization and solving the local priority issues at local level.

- Some of these technologies are quite difficult for implementation and require involvement of highly experienced specialists; lack of relevant specialists who have knowledge in modern technologies is one of the serious barriers.

  Since transiting to market economy, many specialties which were considered as very prestigious and valuable during Soviet time, including geology and hydro-geology are not prestigious anymore because there is not relevant demand on them. During the Soviet period the State itself ensured demand on geologists. The State was economically strong (the last period is not taken into account) and took financial responsibilities for different geological works. For the time being the State provides finances only for large strategic objects (mainly roads), while the private sector is still quite weak and is involved rather in relatively easy businesses, than in businesses which require prefeasibility studies of geological situation and businesses requiring continuous geological monitoring. Such monitoring and prevention are necessary for business safety and risk minimization, but private business representatives do not still comprehend it. There is still no demand on such specialties in population as well, because people do not still have appropriate awareness and information on possibility of doing something independently on the ground of consultations with proper experts, as these issues were subject to state management and the local population did not have any experience in taking part in these processes.

To improve this situation there should appear a demand on geologists and hydro-geologists at local, regional, and municipal levels, who would serve the local population. Actually, the decentralization of management process and relevant specialists must be conducted.

- Measures to be implemented are expensive.

  Measures to be undertaken to avoid risks of landslides, mudflows and floods are quite expensive, though they are highly needed at the regional, municipal, and village levels. Locations where acute problems reveal must be addressed by permanent mobilization of particular funds using as the state finances, as private (population) resources. These local funds will mobilize, manage and provide target use of the financial resources to cover expenses for preventive measures.

3.2.2 Barrier identification and analysis for the dissemination of cleaning and leveling of riverbeds against the mudflows

Barriers for this technology are the same as for technologies considered in section 3.2.1.

3.2.3 Barrier identification and analysis for transfer of technology (software) for mapping of climate change related extreme geological processes and providing long-term forecast of their development

- Contemporary methods for the development of long-term forecast in Georgia have not been used yet. Hence the first barrier might be defined as absence of appropriate specialists.

Specialists should be educated through different programs and by the suppliers of particular methodologies. As a rule, such educational seminars are conducted and financed by different international donors on the ground of a country request. Such request can be done during the process of preparation of Third National Notification.

- A long-term forecast computer model can be so expensive that it will be impossible to purchase it.

Some primary investigations have been conducted within the frame of this project and supposedly there should exist some low price (or even free of charge) soft ware for the risk assessment, though their adaptability to the conditions in Georgia is still a question and needs some additional studies and time.

- Older statistics may not meet the requirements of a selected model, needed for calibration and validation of the model. Monitoring of the current processes is not conducted which is very important for determination of the actual changes and for the assessment of correlation with climate change.

It is quite difficult to define in advance the ways of removal of these barriers. The optimal ways of removal of the barriers should be discusses separately for each parameter, for which there does not exist previous statistic data, or the monitoring was ceased, or has not been ever conducted.

Alongside with acquainting with a model and developing forecasts, the ways and means of delivering of the obtained results to the customers should be studied and best of them selected together with the relevant stakeholders. Involvement of the private sector in this process is very important.

3.2.4 Linkages of the barriers identified

Technologies considered in this section are mainly the first group technologies (guideline) provided by institutions and main a barrier for them is a financial barrier. Implementation of these preventive measures almost completely depends on the government's policy. In case of Georgia the government's policy is mainly directed to the post-factum reaction and recovering the damages. Decentralization of extreme geological processes monitoring and protective measures implementation is principle conclusion of this barrier analysis. This decentralization process should be accompanied by intensification of communities' mobilization.

3.3 Recommended solutions for extreme events sector

Extreme geological events could happen in any place in a country and in the world but this doesn't mean that the hazard and high risk are typical features and are vital for the country or the region within the country. Having relatively young mountain the South Caucasus region is featured by high sensitivity to extreme events such as landslides and mudflows but there are sites particularly sensitive to these hazards. In previous political system even local problems have been solved by centralized approach but changes happened in Georgia show that most of problems should be and can be solved locally by local governments and communities. Raising awareness among the local decision makers to consider extreme geological events in the list of local priorities and organize community based approach for the implementation of protective measures against landslides and mudflows, whenever such approach is feasible, could be considered as the principle recommendation from the project. Local services, similar to agriculture service centers (described in agriculture section), should be organized by the central or local governments. In the regions with high vulnerability to landslides and mudflows, existing agriculture service centers could be extended and used for providing recommendation to the local governments and communities on preventive measures against extreme events as well. This approach doesn't mean that the central government has no responsibility in this process. The central government responsibility still should be large landslides creating threat for strategic objects of the country's infrastructure and setting up of enabling environment for the development and transfer of new technologies and services.

3.4 Technology action plan, project ideas, and other issues in Extreme events Sector Technology action plan

3.4.1 TAP for landslides protective (palliative) measures

Lack of capacity and awareness to involve local population in implementation process of preventive measures is the main barrier in using of this technology.

- Investigation of engineering-geological conditions of the pilot territories and selection of effective measures for each area under particular risks.
- Intensive consultations with population on possible risks and the ways to avoid them for the awareness raising purposes
- Opening of local Service Centers (regional and municipal) or using the existing ones (for the time being such centers are established by the governmental initiative for the purposes of servicing the Agricultural Sector). Supplying of such centers with a package of effective measures for risk minimization of the dangerous processes.
- Mobilization of village population/communities around the mentioned problem and ensuring of their maximum involvement into the monitoring of the dangerous processes and to the implementation of preventive measures.
- Landslide area of village Shurmuli. Regulation of surface waters through arrangement of drainage pipes and berms.
- Large landslide area in active dynamics at the territory of village Vashlovani. Regulation of surface waters in combination with arrangement of drainage system.
- Washing out of right bank of river Ajaristskali in Shuakhevi municipality (so called 'Lentorgi district'). Full solution of the problem is possible by construction of a 120 m coastal gabion. It is significant that the material needed for the construction of the gabion is available in the riverbed.
- Almost whole territory of village Jalabashvilebi is under risk of landslide processes. For the recovery purposes and for slowing down the process the following measures have been considered – regulation of surface waters, drying up of the wetland area located at the border of landslide, and directing of waters to the neighboring natural water bodies through drainage pipes.
- Left side bank of river Chakvistskali in village Chaisubani of Kobuleti municipality endures intensive erosive washing. To neutralize fully this process it is necessary to construct a 300 m cost protective gabion.

3.4.2 TAP for mudflow protective technology (cleaning and leveling of riverbeds)

Barriers to implementation of this measure are from the group of palliative measures/technologies and practically are the same as for landslide protective measures. Relevantly the TAP for this technology considered the same actions.

3.4.3 TAP for transfer and implementation of advanced technology (software) for mapping of climate change related extreme geological processes and providing long-term forecast of their development

- Preparation of input data for model

1. Statistic analysis of the main factors provoking hazardous geological phenomena is the main activity for the implementation of mapping and forecast system. This analysis itself involves the following actions to be implemented:
2. Re-qualification and updating of data on constant factors, such as geological constitution, lithologic and tectonic data. Assessment of geo-morphological features in connection with climate change. Composition of relevant GIS maps (1: 50 000).
3. Defining of regimes of slowly changeable factors – contemporary tectonic movements – taking into account changes of climatic parameters; assessment of hydro-geological conditions for the purposes of defining the Black Sea iso-static and eco-static changes; inventory of changes taken place in the plant cover.
4. Analysis of rapidly changeable factors – meteorological elements (precipitation, humidity, temperature, sun activity stages, etc.). Analysis and correlation of within-year, seasonal and daily data with regard to mean multi-annual data for the whole observation period for 6 meteorological stations of Ajara.
5. Determination of trends of earthquakes according to years; assessment of the released energy and negative results of earthquakes
6. Changes hydrological regime during the years.
7. Anthropogenic changes in geological environment and activation level of the connected elemental geological processes.
8. Statistical analysis of hazardous geological processes activated by climate change in different years and the damage caused in Ajara pilot region.
9. GIS processing of geo-dynamic map of damages caused by hazardous geological processes provoked and activated by climate changes in Ajara pilot region.

- Acquiring and transfer of suitable for Georgia's condition software(adaptation to the conditions in Georgia) for development of long-term forecasting of hazardous processes.
- Training of local personal and establishment of service centers for consultations on the relevant protective measures.

3.4.4 Brief summary of project ideas for international support (Details in Annex III)

Two project proposals have been developed within the TNA process for this sector: preventive (palliative) measures against landslides and transfer and implementation of hazardous geological events long-term forecasting system. Proposals are presented in Annex III to this report. Objective of the first proposal is to demonstrate the new, community level approach to the implementation of preventive measures against the extreme events and the second proposal should increase the local capacity in monitoring and forecast of landslides and contribute to the effective decision making process.

3.5 Summary

From the three types of frequent extreme events- landslides, mudflows and floods typical for Georgia and considered in the TNA process only two were finally assessed for further recommendations. Floods are not assessed in this TNA process, because the phenomena of climate change impact on floods and adaptation measures are covered by other ongoing in the country projects. Two technologies: palliative measures implementation at the community level and long-term forecast have been identified as priority for landslide phenomena more frequent in West Georgia and relevant project proposals have been developed. Cleaning and leveling of riverbeds as a protective measures against mudflows which are more frequent and intensive in East Georgia has been prioritized for that region. A proposal is not developed at this stage.

Part III

Cross-cutting issues for the National TNA and TAPs

This section gives an overview of processes currently ongoing in Georgia and facilitating the Technology Transfer (TT). A TNA process established by the UNFCCC is a main tool significantly contributing to the transfer of climate change mitigation and adaptation technologies. Three types of technologies are being considered in this process: new technologies not yet piloted in the country, traditional technologies not being in operation because of the barriers emerging in the process of economy transition and local know-how which needs further development, diffusion and marketing. Two of these types of technologies are considered and assessed in the report. Brief descriptions of indigenous know-how which should be further developed and tested are included in the www.tnageorgia.wikispaces.com.

TNA in Georgia is a nationally driven process aimed at identification and development of new technologies based on local know-how and supplemented with the establishment of local capacities for the transfer of advanced technologies from outside the country in case the technology is not locally available. Government's strategic vision of technology transfer facilitation process is considered in the document "State Strategy on Regional Development of Georgia for 2010-2017" approved under the resolution (#172) of the Government of Georgia on 25 June 2010 [5]. The resolution implies the establishment of the Governmental Commission on Regional Development as well. Until full operating of the TT process this commission could be responsible for coordination, facilitation and monitoring of the TT process through creating the enabling environment, in particular, regulatory framework, infrastructure and regional as well as national capacities. Basis for this is that Georgia considers regional development as one of the priorities of the country. Stakeholder consultation process has revealed that technology needs assessment process should be mainly regionally oriented excluding a few exceptional cases when technology has strategic importance for the country.

Two main activities considered in the Regional Development Strategy should be highlighted in the context of technology transfer process. These are: development of local and regional statistics (article 2.5) and support to the development of innovations, new technologies and entrepreneurship (chapter IV of the Strategy) [5].

Government's vision on the TT process stated in this strategic document is that "Comprehensive technological progress entails the growth of competition with its scale and speed amongst nations with competitive knowledge and innovation capacity playing a determining role in this process. The growing competition in the world makes it clear that Georgia's economic development and security require the creation of a regional economic strategy which is oriented towards knowledge in economy, innovations and new technologies."

One of the tasks on the way to implement this strategy is to support the creation of regional innovation centers aimed at supporting the establishment of connections between small- and medium-size businesses and foreign investors; assessing technological capacities of enterprises functioning in the region and information and knowledge dissemination on SME (Small and Medium size Entrepreneur) needs; studying new technology commercialization opportunities; encouraging the implementation of joint research and projects by different entrepreneur groups; organizing consultations and training in new technology fields; initiating direct inter-regional co-operation in the spheres of innovation and entrepreneurship; promoting scientific and technological breakthrough of regions. The current TNA consultation process has concluded that the role of these centers in climate change technology transfer process should be more explicit which could be improved in the strategy implementation and innovation centers operation process.

The climate change issues considered in chapter V of NEAP (Development of Agriculture, Tourism and Ensuring Environmental Protection) are further elaborated in this report in relation with particular sectors.

Results of all ongoing and planned projects facilitating the transfer of climate change adaptation and mitigation technologies are sources for TNA, barrier assessment and recommendations on actions for creating of TT enabling environment. However, among these projects and programs, main sources are Georgia's National Communications

(Initial (1997-1999) and Second (2006-2009)), first phase of TNA (2000-2002) and this current TNA process as well. New technologies needed for adaptation and mitigation have been identified when conducting this TNA process.

On the other hand the TNA process and report contribute to development of country's different strategies and will contribute to the establishment of innovation centers which is one of the priority recommendations from this process.

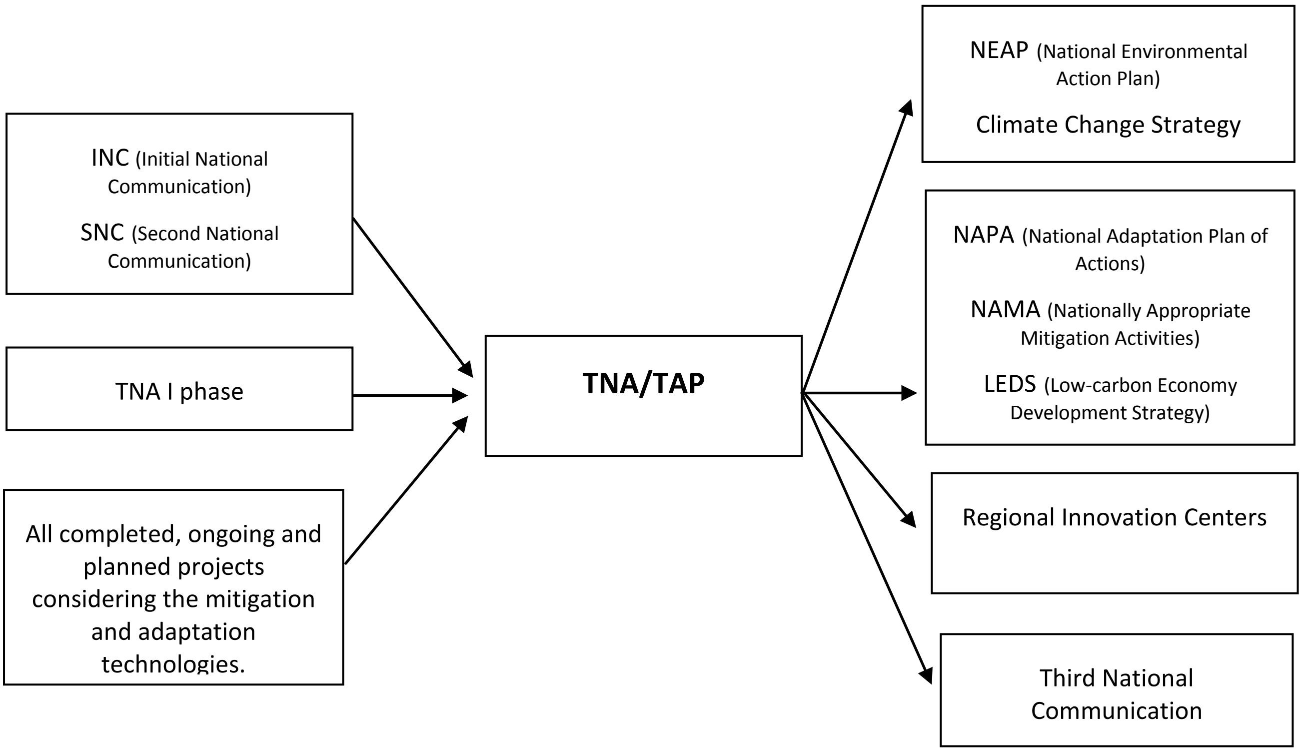

Fig. III-1 Links of TNA process with other activities

FigureIII-1 demonstrates the main links of TNA with other activities already implemented or ongoing in Georgia.

Common barrier for entire TT process is **absence a coordinating body** (board, commission, commitee, etc) having political responsibility to create the enabling environment (legislation, innovative centers, university for advance technology development, etc) for technology development and transfer process including the climate change friendly technologies.

As far as climate change impact on different sectors of Georgia's economy is already obvious and proved the project makes recommendation to re-establish the Climate Change Committee (the first such committee was established in 1996, but was abolished later in 2005) with the responsibility of coordination of all climate change related projects and programmes implemented in country and technology transfer process among them.

Next very important barrier to the implementation of advanced technologies in the country is **lack of local expertise in latest development** in this field. Practically the country totally depends on outside expertise which is not efficient practically in the process of operationalization and maintenance of these advanced technologies. Technologies recommended based on outside expertise not always suitable to the country's geographical, climatic, economical, political circumstances and traditions.

Establishment of University of Advanced Technologies in Batumi, Adjara region is already planned by the Government. This initiative should give a chance to local engineers and researchers to get the contemporary knowledge, latest developments in technology field and conduct the joint research programmes with experienced invited experts. However, it's very important that still demand on technologies should be defined by a decision making body at the central or preferably regional levels. The current TNA project will significantly contribute to the University's and Innovative Centers' activities planned to be organized in each region. Another good opportunity for country to develop endogenous know-how and expertise in advance technologies is the Regional Centers of Excellences planned to be organized by the international TT process. The Government of Georgia has to facilitate the close cooperation between the University and the Regional Centers of Excellences.

New political and economical circumstances emerged in Georgia (transitional period) should be relevantly reflected in the TT process. **Decentralization of technology implementation process** should be in parallel with regional development process and should become one of the priorities for each region.

Political process should be initiated by the government and intensive awareness raising among the decision makers should be ensure through different projects and programmes implemented by broad spectrum of stakeholders (NGO, private sector, etc).

Strengthening the process of community participation in some climate change adaptation measures which could be implemented at the community level has already initiated by different NGO projects but it's very important that this process should be actively supported by the local governments.

These are four main direction considered by the TNA project as crucial for success of technology transfer process in Georgia.

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Annexes

Annex I

Technology related information (in the format of Technology Fact Sheets (provided by the guidance) for all adaptation technologies considered in TNA process is located in climate change techwiki established by the project.

Electronic address of this wiki is: www.tnageorgia.wikispaces.com

Georgia techwiki is designed for two languages (Georgian, English) and know-how identified within the different climate change project are also available there along with the adaptation and mitigation technologies.

Annex II

Market maps for Technologies

Introduction

Market mapping is a useful technique that is particularly relevant to technology transfer. It allows an exploration of the chain of market actors for the technology and the surrounding enabling business environment (in terms of policies and regulations, etc.) and the activities which support the market (e.g., professional consultancies, information exchanges, quality control standards, R&D, etc.). Market mapping helps to identify problems on the way of TT and its integration into the country system. Market mapping is recommended to be conducted on each priority technologies, mostly long-term and large scale.

Generally market mapping includes following steps to be made:

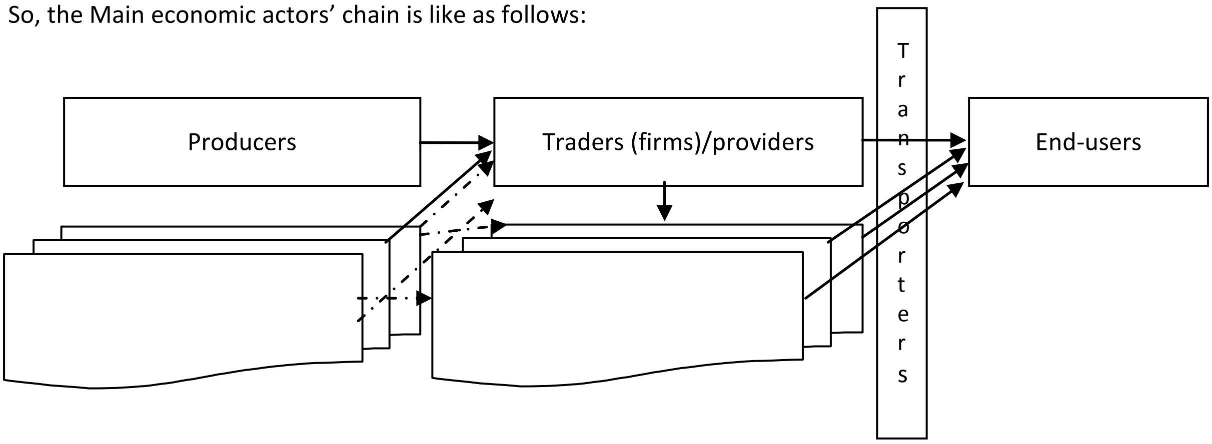
I component: Market chain

Consists of main steps the technology should pass through from producer to end-user.

First, **Market actors** should be identified. It means main actors in the market and their linkages. The chain of economic actors shows who owns the product as it moves from primary producers to final consumers.

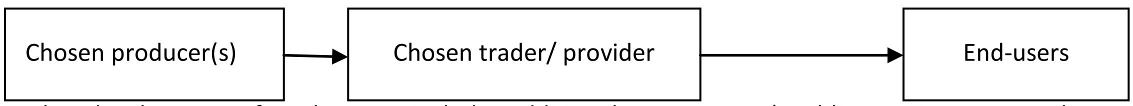
Second, type of transfer should be identified: e.g. import and installation of a ready (fully functioning) technology or conversion of existing in-country technologies, or construction by in-country manufacturers and suppliers through intellectual property rights (IPR) agreement. The decision on the technology transfer type should be formulated as recommendations from stakeholders to the government and/or other funding bodies. Incentives for investors should also be considered by stakeholders so that they could be harmonized with the country's national policies/priorities.

So, the Main economic actors' chain is like as follows:



Next step is to identify which markets and channels offer the best prospect – this is done through the overview of the prospects and relationships between competing channels, analyzing product volumes and values. This task is most challenging in Georgia and in most non-Annex I Parties. The decision in favor for one of the channels is a base for further market-chain development.

So, chosen market chain looks like following:



Further development of market map includes additional components (Enabling environment and Supporting services) in detail possible.

II component: Business enabling environment (or simply enabling environment)

This implies charting of critical factors and trends that are shaping the market-chain environment and operating conditions, but may be amenable to change. These "enabling business environment' factors are generated by structures (national and local authorities, research agencies etc.) and institutions (policies, regulations and practices) that are beyond the immediate direct control of economic actors in the market-chain. In other words, *business enabling environment* implies legal and other instruments enabling technical viability/feasibility of the measure/technology. This involves permits to do works, to settle possible controversies between different stakeholders on ownership and other issues, mechanism of searching sponsors/funds, agreement between local and central authorities, implementing entity, standards, QA, etc. So legal, financial, scientific-technical entities and infrastructure that are needed to do business but are beyond the dependence of market actors, are involved.

Charting EE aims not at simply recording the status quo but to understand the trends affecting the entire market-chain, and examine the power and interests that are driving change. This knowledge can help determine opportunities for realistic action, lobbying and policy entrepreneurship.

III component: Supporting services

Enterprises and organizations that support market chain's efficiency are forming so called *support services.* They are of different kind: financial, insurance institutions, informational (market info), technical (spare parts suppliers, maintainers), transporters. Services can be delivered in different ways: fee-free (governmental extension services), fee-based (private services) and non-formally delivered (information or advice, through e.g. social networks or personal relationships).

Mapping 'services' enable, at the first stage, to identify particular service needs and their locations within the market-chain in order to get an overall picture of the opportunities for using services to improve market-chain efficiency or equity; and then, subsequently, at the further stage, assess the most appropriate mechanisms for delivery of services, including outreach, sustainability and cost-effectiveness.

In Georgia's case, mainly 'new' technologies that are to be transferred from outside and only few technologies practiced in Georgia but facing recently new types of barriers were mapped. Mapping of adaptation technologies is not similar to the market mapping of mitigation technologies. Most of them are not market technologies and final ownership is not always easy to be identified. Particularly, the last one is serious barrier in Georgia's reality. However, the TNA adaptation team has made effort to show market mapping process for some of the new technologies to be transferred from international market. Only large-scale, long- or medium-term priority technologies were mapped as recommended. The selected for mapping technologies for each priority areas are: for agriculture – drip irrigation/ artificial raining, water-caused erosion and wind-breakers; for coastal zone – coast protecting underwater artificial reefs, early warning system and beach nourishment (artificial filling with inert materials), and for natural disasters – phyto-melioration, cleaning and leveling of riverbeds and mapping of climate-change-related extreme geological processes. The selection was made basing on the criteria of importance, urgency and effectiveness of the technologies. Most of the technologies consist of both - hard part (technique, machinery, devices) and soft part (know-how), that should, likely, be introduced together, having thus the same market chain, though further they need different maintenance. In some particular cases, however, e.g. for coastal reefs, only know-how is to be introduced. Transfer type mostly implies import and installation of a ready (fully functioning) technology; though in some cases the technologies imply conversion of existing in-country technology or construction by in-country manufacturers and suppliers on the base of the transferred new know-how.

1. Mapping the market for technologies in Georgia

Having analyzed Georgia's specifics, common for all technologies to be transferred is that:

In Market Actors' line: Producers are implied as reliable firms in developed countries as 'inner' producers, e.g. in former SU space, are not preferable because of the quality of their production, mostly unsatisfactory for Georgia's fast economic growth course, and also due to possible problems in maintenance and outreach related with political and economical instability of those countries. Owners/sellers may be the producers themselves or other entities/enterprises owning, using or selling the technology. They may be in the same country where it was produced or outside it. Traders/sellers are meant as trading firms importing technologies and machinery in the country. This is that doesn't exist in Georgia. Big barrier for country is the capacity to relevantly assess available market information and not having full access to the existing information.

In Enabling Environment line: regulations and policy, financial, legal and material incentives require substantial enhancement/strengthening, while maintenance conditions (spare parts supply line and regulations, technical assistance/expertise, standards, QA, staff skills) should be built on an almost empty base.

In **Supporting Service line**: Almost all needed services - informational (market info), financial, technical, consultancy, transportation/supply of spare materials - require creation or/and enhancement/ transformation to market economy and principles.

2. **Market mapping for selected technologies for priority areas**

A. **Agriculture**

Agriculture is a priority sector for Georgia Technologies to be transferred for the priority area of agriculture in Georgia are those for irrigation of arable lands in Dedoplistskaro district (Kakheti region in South-East Georgia) that falls in semi-arid zone, prone to desertification. Nevertheless, this district was called 'barn of Georgia' supplying the country with cereals and fully covering its needs. Since 1990s after the break down of the Soviet Union the irrigation system operating in this region 'of cereals' was ruined and the windbreaks, providing moisture maintenance in the soil, was exposed to uncontrolled felling during energy crisis in 1990s. Traditional water scarcity, windy, dry and hot climate together with increased temperature due to global CC and with no human support contributed to desertification processes in this region. Rehabilitation of windbreaks, ongoing there for recent years can be useless without proper irrigation. However, rehabilitation of traditional irrigation system may be insufficient in nowadays conditions: optimal resolution seems to be - elaboration of a proper net of irrigation systems of different kind according to the specific soils, climate and agricultural purposes. The net should involve modern systems as well as rehabilitated traditional irrigation canals. Two irrigation technologies selected for transfer for the vulnerable Dedoplistskaro region are drip irrigation and artificial raining and methodology for abatement of water-caused erosion.

1. ***Drip irrigation and Artificial raining***

Drip irrigation

This technology is relatively new for Georgia, first used last year in Kartli region. In this case, the technology to be transferred is envisaged for use in Kakheti region too (especially, large croplands in Shiraki valley) for irrigation of arable lands there. The technology is spread worldwide and is demonstrating high efficiency, especially, when used for arid and semi-arid lands but it isn't in practice in Georgia, partly, due to its cost. As Shiraki valley is considered as one of the vulnerable areas to CC, and, at the same time, very important from economical point of view, and also taking into consideration the scale of the area, this technology was selected as the most suitable for this region. Besides Kakheti, the technology can be suitable for other regions in the East Georgia as well, where the soil is semi-arid too. Total area for irrigation involves almost all southern and south-east Kakheti (Ole-Naomari, Taribana, Eldari, Shiraki, Jeirani Valleys etc) and Kartli region too).

The knowledge for operation and maintenance of the system should be transferred together with hardware for long-term use in this region in order to assist this water-scarce soil to adapt to CC and rehabilitate large arable lands of this region to the extent of its former fertility in late 1980s. So, this technology should be transferred and installed ready (fully functioning). What about its producers, as the local market doesn't have the technology and it should be imported from the experienced producer/exporter-countries (Europe or Israel) experienced in producing them.

Market mapping for drip irrigation technology

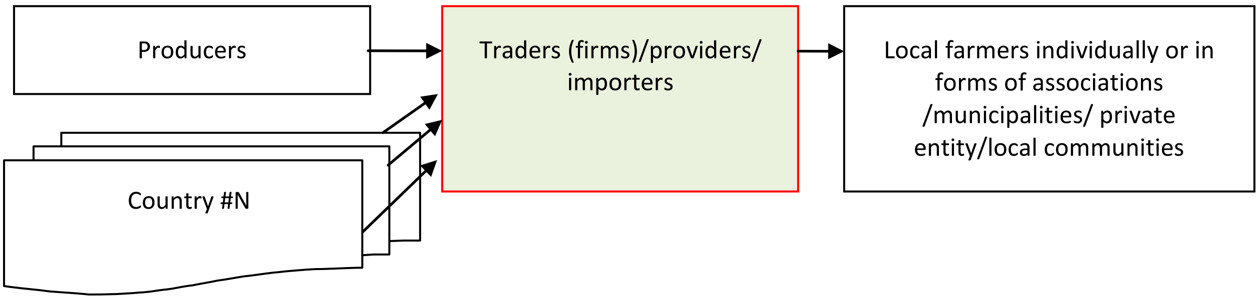
Main actors chain includes: initial actor-producers (Israel or Spain firms, tentatively, as most experienced and qualified), final actor – local farmers, owning the territory to be irrigated /municipalities/ technique owners, mediate actors may be traders – providers of such kind of techniques, importers. Municipalities can be major stakeholders if the system is not private. Otherwise, they won't be included among actors. The system may be under state ownership as well to belong to farmers associations or local communities.

As the drip irrigation system has never been implemented in this area, the type of transfer should be import and installation of a ready (fully functioning) technology, including both – knowledge and hard parts.

In case of Georgia, producers should be chosen based on the appropriateness of the technology and taking into consideration effectiveness and similarity of working conditions, as well as price and distance. Intermediaries (traders, importers) do not matter in this stage due to their total absence in the market; they should be created later.

So, the following market chain has been identified:

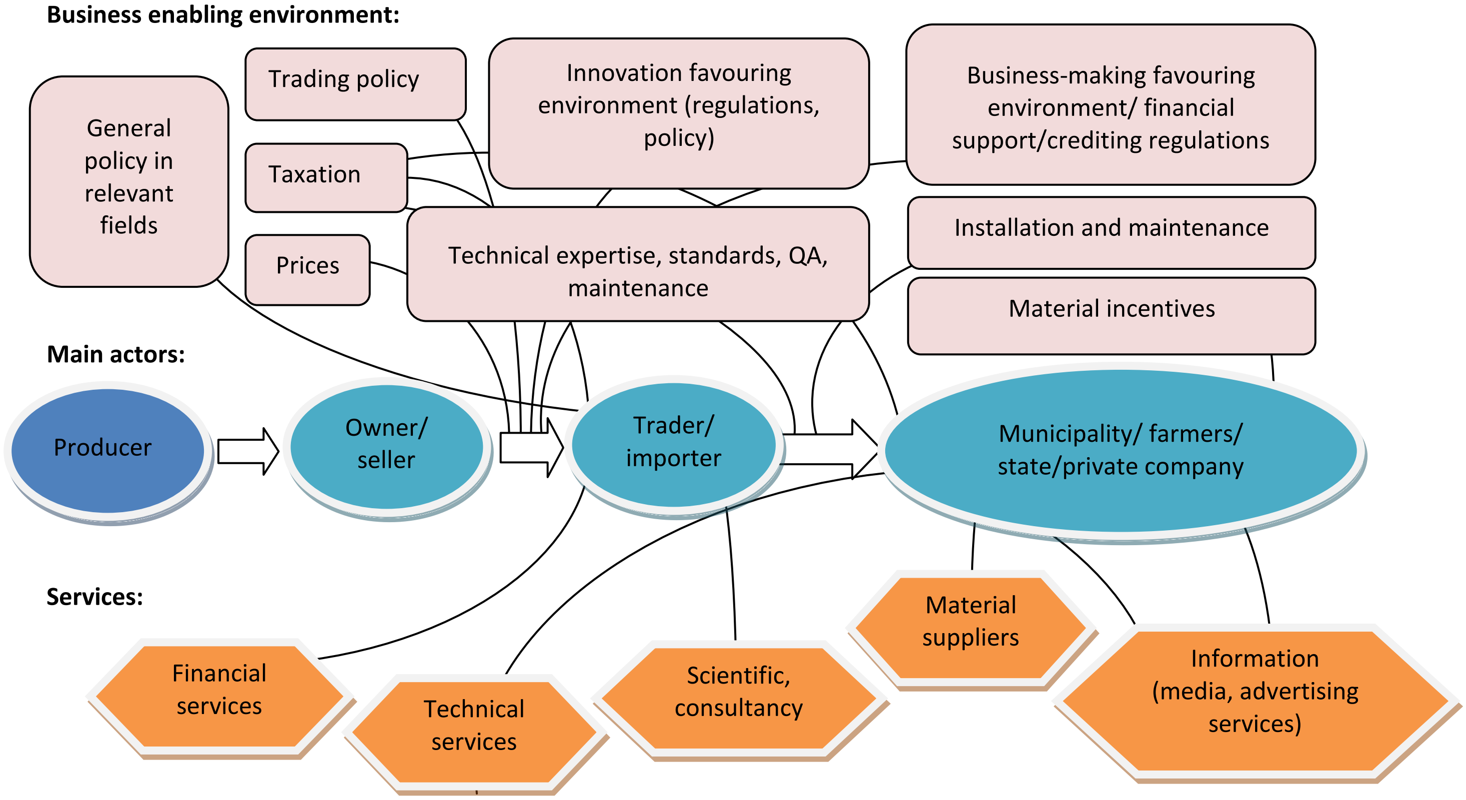
Georgia



Israel as a pioneer of drip irrigation technology and also the country with similar agricultural conditions can be chosen for the exporter, though Spain may be also suitable. The final decision should be made basing on the cost/effectiveness analysis mainly, as there are no established trading links for this kind of goods as another criterion for selection. Here intermediary actors – traders/providers – do not exist at all that impedes import of the technology in the country. Further construction of the market map would be more suitable after selection of technology producer made.

Enabling environment involves: state policy in related fields (agriculture, environment, regional development), general policy/strategy for development, tendencies, legal base for technology introduction in the country, economic incentive (taxation, trade policy, insurance policy, customs, business-making opportunities, crediting regulations, prices, QA/standardization/certification/expertise structure. Some of them are in place, e.g. some incentives (political, financial, legal and material) promoting making business in agriculture though they **may require enhancement to be developed to the extent enabling the technology transfer-use line run in the country.**

Services involve consultancy, both scientific and technical; technical entities (central/local) authorized for accreditation of entities making irrigation, public registry of arable lands and their productivity, entities responsible for installation and maintenance of technology, technical expertise/workshops/agencies, transportation companies (materials /spare parts supply chain infrastructure), informational entities (media, advertising) and financial/crediting institutions for financial support.



Analyzing the map we can see that <u>main barriers</u> are related to trader/importer area, that is, the process of the technology introduction itself, namely, trading policy, taxation, other regulations related to financial support/crediting, general and environmental policies as well as prices are affecting greatly the process of introduction of the technology. But some regulations need improvement and there is no technical expertise/consultancy for imported technologies, neither maintenance/development conditions for it (for long-term run of the technology: spare parts supply line, access to technical assistance for expertise, QA/QC, necessary skills of staff), monitoring agencies that are to be created. **The most important lacking item of this system is consultancy center(s) able to conduct technical expertise and provide advice on agricultural issues and technologies and their technical implementation (**however, in the process of the TNA project implementation the Government of Georgia has already initiated the process of establishing the service centers for farmers/agriculture in each region)**.** Lack of technical standards and expertise is hindering traders to get professional advice when selecting a new technology to be introduced. Installation and maintenance process is also related to technical staff to be trained specifically for new technologies. Lack of financial services is also restricting range of technologies to be transferred. Most of donors' multilateral or bilateral funds they have their own conditions not always acceptable for a Country or private sector or associations. Materials suppliers (supply chain) need to be created in parallel with the technology installation.

<u>Enabling environment is:</u>

<u>General policies:</u> General Policy regarding regions (Regional Development Strategy is in place highlighting importance of regions development) and regarding agriculture sector (agriculture sector is declared as a high priority sector for country since 2012); Such policy is enhancing modernization of the field (agriculture) and there are already some precedents of novelties introduced in the country. Such environment will, likely, assist to accelerate the process of technology transfer, if these general tendencies are properly reflected in relevant regulations and policies (trading, taxation, innovation, customs, crediting and enhancement of lacking services and entities).

<u>Legal (regulations):</u> private ownership of agricultural lands, taxation system in place, low corruption, customs regime established, trading regime (facilitated with many countries); insurance regulation (diversified insurance companies, able to provide proper schemes);

<u>Financial support:</u> concessional crediting system (easy credits option from banks can be used if adjusted for the purposes);

<u>Material incentives</u>: growing demand and consumption of cereals and other agricultural production, growing market;

Among the services, the strongest is *scientific consultancy* potential in the country: experienced and highly-qualified local staff (from Agricultural Institute and other specialists from scientific institutes of biological and agricultural profile and independent experts) is in place in the field of agriculture and hydro-melioration, able to make advisory, consultancy and monitoring work; though the scientists are scattered in various entities and the needed consultancy units should be created on site, they can provide the most efficient work taking into account that local conditions should be taken into consideration. At best, such centre can combine scientific/consultancy and technical assistance functions, solving the problem of technical standards and QA as well. However, additional training package in market economy and in up-to date approaches in agriculture/irrigation is crucial in technology transfer process, taking into consideration the climate change problem.

In Georgia's case, *local municipal entities* (local municipalities and their subordinate entities) can be used in harmonization of the farmers' private interests with municipal planning. Local municipalities can be considered as one of the interim services to be helpful in arranging the system of TT.

Public registry well-established system can provide necessary information about ownership and quantitative figures on lands' area and other characteristics. The registry is easily accessible electronically from any parts of the country.

In general, it is obvious that even in case of having in place most of these structures/units, yet, novelty of the technology would trigger the need of transformation/modification of most of them to be suited to new requirements. This can be done by means of properly elaborated structure of measures in all relevant areas of TT chain. Some of the item can be combined, others should be created, in addition, those outside the country's influence (e.g. price) should be taken into consideration when elaborating the measures.

<u>*Artificial raining*</u>

The same mapping could be used for artificial raining technology regardless more familiarity of this technology to compare with the drip irrigation. The difference involves choice of producer/exporter/outer market only. Regardless the fact that the technology has been used in Georgia for years it is outdate technically and old market supply chain is destroyed and should be re-established. Modernization is needed in whole agriculture sector to proceed from obsolete

Soviet practice to the advanced one. Combined practices of drip irrigation and artificial raining technologies will be used according to the soil specificity, taking into consideration economic purposes, crop species and climatic conditions. All the enabling environment and service tools can be created in parallel for both of the technologies.

The barriers for the artificial raining technology are the same as for drip irrigation. In case they are successfully overcome and the TT/maintenance process is established in the country, general economic development rate and agriculture priority of Georgia are a good indication for further dissemination of the technologies throughout the country.

Arrangement of Wind-breakers

Technology of wind-breakers has been used in Georgia for many years. Wind-breakers are the necessary element of croplands in areas featured by strong wind. Wind-breakers protect croplands from being dried out and eroded, and maintain humidity and humus. They, together with irrigation systems, are necessary tools to ensure long-term productivity of arable lands in windy areas. Sound science-based windbreak plantation practice used to be arranged in Georgia until the energy crisis in 1990s when most of them were destroyed for wood.

Nowadays, there is an ongoing project of rehabilitation of former windbreaks in Dedoplistskaro district in Kakheti region, after revealing high vulnerability to climate change impacts as stated in the Second National Communication of Georgia to the UNFCCC. However, the technology needs updating with modern know-how with soil- and crop-specific plant-selection for windbreaks. Well-developed windbreak planting practice has immense potential to be disseminated or established throughout the country as a complementary measure for irrigation to deal with CC impacts in agricultural cropland areas prone to strong winds.

The *technology transfer type* is conversion of existing technology – a 'know-how' part and 'technical" part (e.g. modern plant/sapling protecting tools) with or without sapling of the selected plant(s). The justification for updating the existing technology is the substantially changed conditions of the soils since 1990s due to CC and other adverse impacts caused by mismanagement, and inability to tackle the problem of croplands productivity decrease with national means. National scientific base for agro-melioration is outdated, while foreign knowledge in agriculture has been raised greatly. The same is true regarding technical tools. Effective equipment and technologies are needed for agriculture to provide its substantial improvement to meet present challenges.

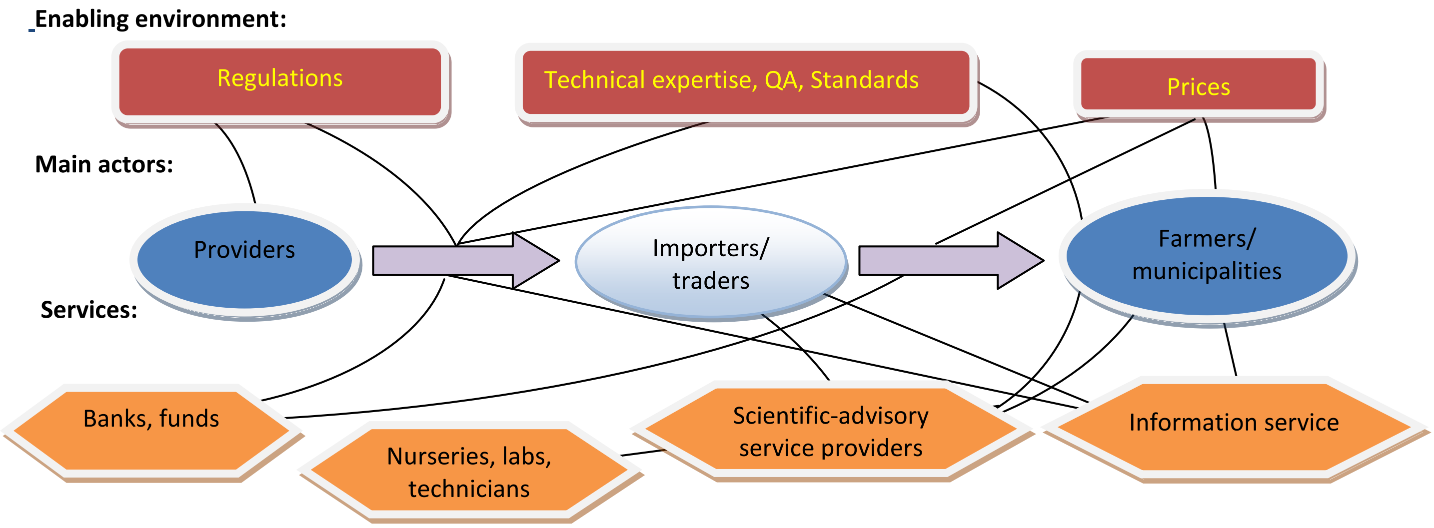
To identify barriers in TT process regarding windbreaks the following market mapping has been developed:

Market actors are the technology providers (outside the country), importers/traders and end-users (farmers and local municipalities).

Services involve entities providing scientific-advisory service: Ministries, consultancy firms, scientific-research institutions of agricultural profile (SRI of Botany, Agriculture University etc.); technical services (plant nurseries, labs, technicians), financial institutions (banks, funds, projects).

Enabling environment involves: regulations (trading, customs, and land ownership, financial/crediting), prices, technical expertise, QA, standards.

So, the market mapping for the technology of arrangement of windbreaks looks as follows:



Analyzing the map, we can see that the most barriers are related to the import of the technology reflecting imperfection of regulations and technical expertise/standards, as well as costliness and fundraising difficulties. Regardless general policy encouraging agriculture sector and novelties, proper trading, customs) regulations are needed to promote new technologies import in the country. Banks also do not have any particular scheme for crediting technology transfer. Lack of technical expertise and technical standards is also hindering technology transfer. Old Soviet standards are to be updated according to modern knowledge.

Services are mostly in place because of former experience in windbreak arrangement: there is a large set of scientific and research institutions able to provide advice on agricultural issues, as well as nurseries for growing saplings and labs at the Agriculture University and other scientific centers, and technical staff to provide technical assistance. However, fundraising for technology transfer meets difficulties regardless well-developed banking sector as there is no crediting scheme facilitating new technology transfer and/or implementation. This financial barrier relates to all new technologies as banks are always cautious about novelties where entrepreneurs have not enough experience. Information service requires substantial enhancement in the part of awareness raising as all the participants of the market are unaware of what and how can be done that greatly hinders implementation of the technology. However, public registry is a well-developed structure in Georgia that can be easily accessed electronically and provide all necessary information about lands and their owners. Though the NR doesn't provide information on the soil types, preferable plants to grow on them or climatic conditions that is the competence of other institutions. This gap is to be filled-in.

As regards the market actors, traders/importers, the item does not exist at all, and is to be created, or some relevant enterprises/trading agencies, specialized in importing of agricultural goods are to be modified or amplified, if this business boosts. Foreign scientific agriculture institutions may be the providers (for the know-how)/firms (for sapling-protecting tools) and/or foreign or national owners of plants (siblings). End-users are local farmers, but municipalities may have a very important role too: in the former SU the windbreakers were arranged by the government, as they were nationalized. Now the lands are privatized, but the scales of windbreak area can exceed individual farm borders and may be arranged on a municipality level. Another option is to tackle the problem on the level of communities. In general, the ownership is the biggest barrier in this wind-breaker practice rehabilitation process.

Creation of local consultancy centers seems to be necessary to push and lead the process of TT. These centers could be completed with specialists of agro-technical profile having the role of mediators between landowners and scientific-research institutions on the one hand and importers on the other. They would coordinate provision of necessary information and services to the end-users and traders. Such centers can raise communities' awareness and, consequently, their incentives to implement the technology that, from its side, enhance market creating potential of the technology.

2. ***Management of water-caused soil erosion (ULSE)***

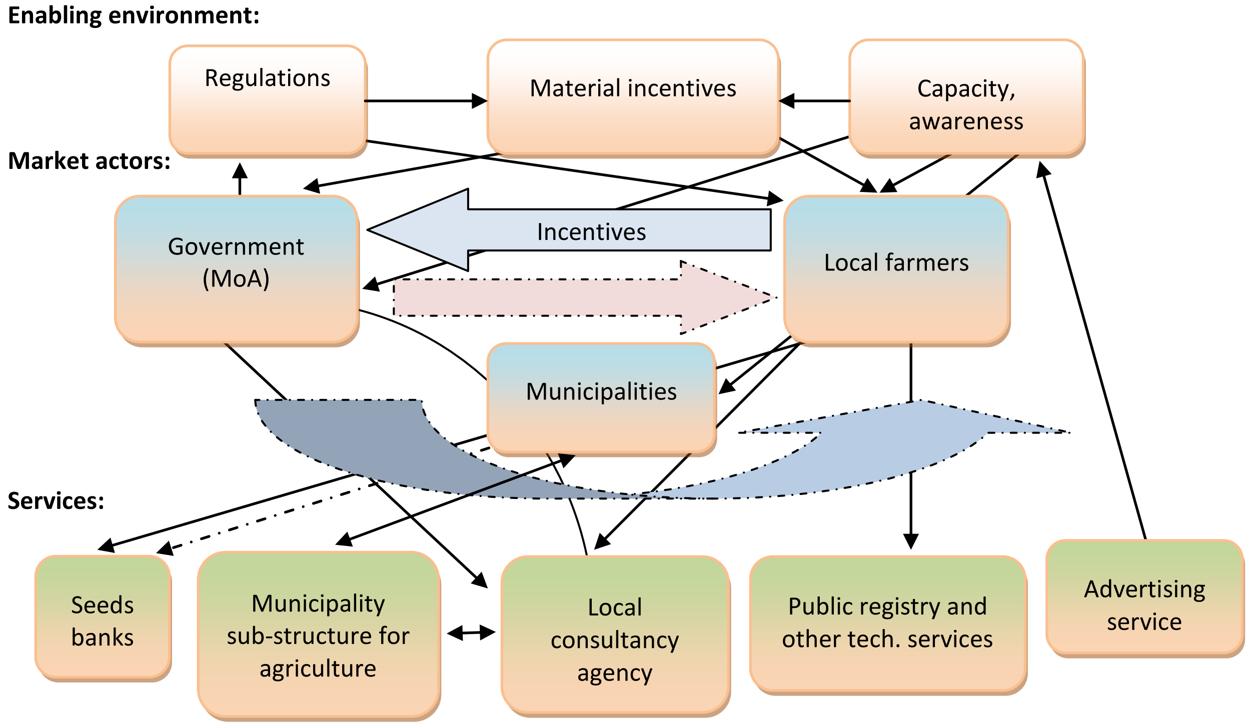
The technology is a software (know-how) type envisaging to tackle the problem of soil erosion in mountainous areas where croplands are mostly located on the slopes and are eroded or prone to be eroded by water. The technology is based on a tool for calculation of soil mass loss for individual plots, reflecting their erodibility level, and consequent selection of proper cultivation methods and plants decreasing the erodibility.

The tool represents a formula for calculation of soil mass loss for individual plots by multiplying 6 factors corresponding to various characteristics of the plot, such as the angle of slope decline, erosion potential of rain, soil erosion factor, slope length factor, plot cultivation factor and a coefficient of crop species' anti-erosion impact. All the factors, except of the last two, are invariant with regard to the individual plot while the last 2 are variables that can be varied and, therefore, selected in order to minimize the product (soil mass loss). Thus, having the invariant values for the characteristics of individual plots, one can select the most suitable cultivation and sowing methods, as well as crop species to minimize one's plot erodibility potential.

The technology is a purely software-type, and is accessible by Internet. The benefit of its use is evident from economical, ecological and social point of view, and properly corresponds to sustainable development goal of the country. The problem is in its implementation in the country.

As the technology belongs to non-market type, market-mapping for this particular case will take the form

of the following chart:



The technology implementation should be government-driven and government-facilitated, based on awareness of the possibility to improve individual plot erosion management by means of simple measures, such as identification of optimal cultivation and sowing methods plus selection of optimal seeds for sowing in accordance with individual characteristics of a plot.

The needs include: creation of incentives for farmers to improve the management by encouraging regulations (e.g. strict requirement for keeping the productivity of lands etc.), awareness raising (by means of advertising service) and capacity building through creation of local consultancy agencies (amid through local municipalities), able to make scientific-technical assistance to the farmers in identification of their individual optimal management practices. Local sub-structures within the municipalities, responsible for agriculture sector at the local level, can be of assistance in establishing such agencies. Seed banks are very limited and oriented on saving of endemic species. Productivity of lands are not inventoried. These services are barriers to the process of implementation of the technology.

Thus, the technology belongs to a software + orgware type and its implementation involves awareness-raising on the existing software and creation of the specific services (local consultancy agency) taking the function of intermediary between the farmers and the methodology provider. Such entities can be formed on the base of local scientists, agricultural firms and/or NGOs of relevant profile. They should grow to the capacity to measure, calculate and identify invariant characteristics of individual plots and give advice on optimal management practices (cultivation, sowing, regimes and species) for them. Organizational coordination can be made by local municipal entities.

Implementation of the technology is cost-effective as there are minimal expenses required for adjusting the method already at hand (of certain national experts) to local conditions for optimal results, and long-term profit from steady increase of productivity of agricultural production, let alone social and environmental benefits. From the CC point of view, the technology contributes also to adaptation of erosion-prone soils (due to slopes) to its adverse impacts from flood and heavy precipitation. The evidence of such cost-effectiveness, together with proper awareness of it, must be an incentive for the government to facilitate the implementation and dissemination of this technology. So, awareness-raising amongst decision-makers should be the first step to be made to push the process of the technology implementation. Creation of the consultancy agencies and their capacity-building to the extent sufficient to give qualified advice to farmers on proper management practices for their individual plots is the task where assistance is needed the most. Individual scientists already aware of the know-how can be used for building the capacity of the agencies. Local agricultural entities under municipality can be of assistance too.

The implementation is meant to be made, first, in mountainous areas of Adjara region as one of the most vulnerable regions of Georgia, and can easily be disseminated further to other mountainous areas of the rest Georgia.

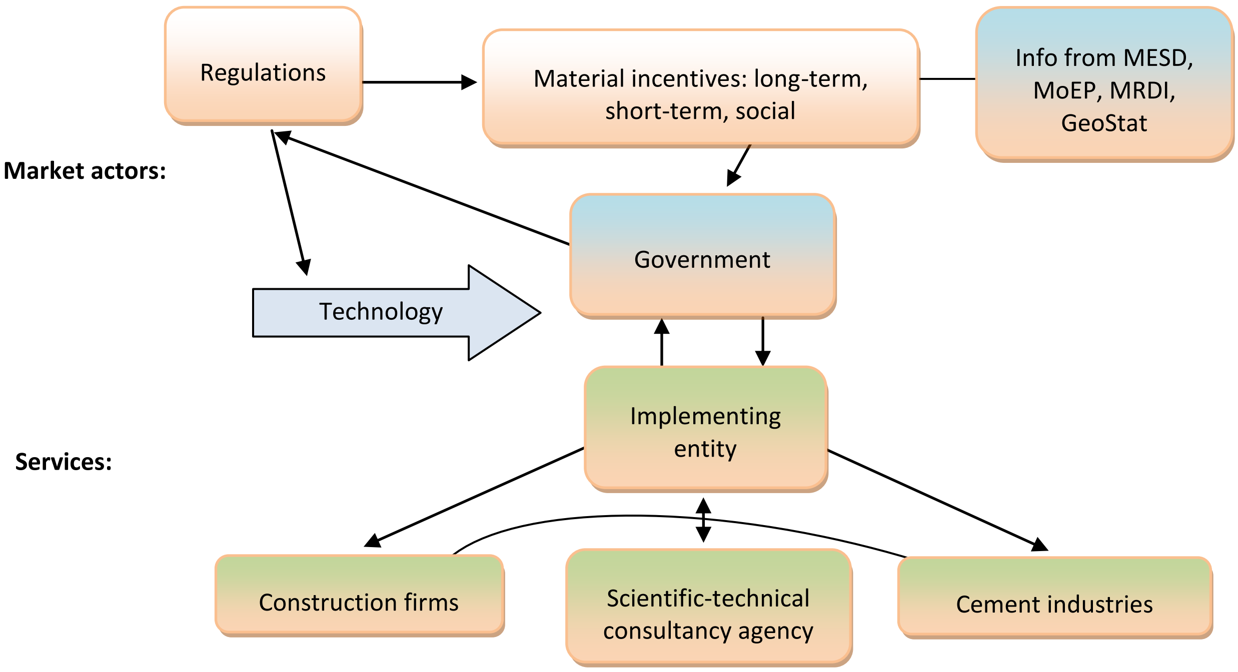
B. The Black Sea Coastal zone

1. Creation of artificial underwater reefs

The technology of constructing underwater reefs consists of the modern know-how (shape, location, size, etc.) and the technical part of the construction of the reefs itself. Transfer is needed only for the software as the hardware part of technology can be constructed locally (well-developed national cement-producing and construction industries in the country). So, the technology to be transferred belongs to a 'software type'. The know-how needs the modern knowledge of identification of optimal parameters of the underwater reefs, such as its length, width, depth, shape etc., according to the site's characteristics (wave height, direction, depth of the sea etc.).

The technology is considered to be implemented in the Black Sea coast where the sea maximally threatens the coast, due to storms strengthened and frequented by CC and where the diving tourism is planned to be developed. Because of its scale, the technology must belong to non-market type of the first group and should be provided at the governmental level. Creation of an entity to coordinate the work is also needed. So, the TT (technology transfer) is of a 'software + orgware' type. The mapping will look as follows:

Enabling environment:

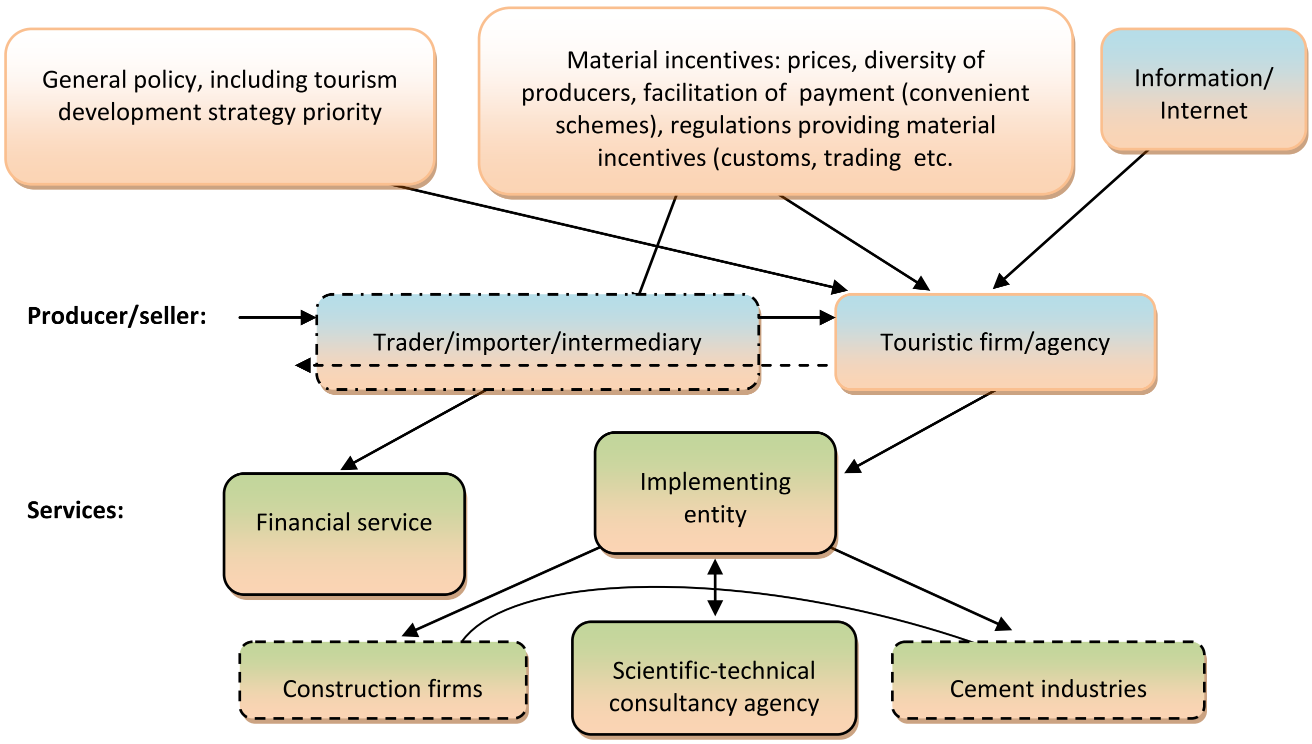


The incentives for introducing and implementing of the technology include the results of cost-effectiveness calculations showing the scale of damages - economic, environmental and social - in case of inactivity. Another serious incentive is the improvement of poor aquatic environment for diving. The incentives are coming from the Ministry of Economy and Sustainable Development (MESD), Ministry of Environment Protection (MEP) and Ministry of Regional Development and Infrastructure (MRDI). Government may need to make appropriate changes in regulations to ensure or facilitate the introduction of the selected technology (e.g. facilitation of the trade with the selected owners, imports, liberation of taxation, customs). Changes shouldn't cause the increase of the cost/effectiveness ratio to the extent that can make the introduction non-profitable. On the contrary, in the long term the benefit of the introduction of the technology should reimburse its costs. Successful scheme of introduction and implementation of the technology should create short-term benefits. Favorable conditions may consequently create incentives for new economic projects along the coast, contributing further economic growth and employment. Changes in regulations can create even additional incentives for construction firms and cement industry. The implementing entity may or may not differ from the Scientific-technical consultancy agency. In case they are the same, the latter should combine scientific and technical function with those of implementation and financial management; or these functions are distributed between the Agency and some multilateral entities (e.g. UNDP) experienced in financial management and project implementation.

Further dissemination of the method/technology is possible for other sites of vulnerability along the coast, augmenting the benefit of it with no more costs for the software.

There is also a possibility of introduction of this technology (fully ready, software + hardware) by national touristic firms. Then this transfer is no more of non-market type, and there are some differences in the chart: the incentives are purely economic, participation of governmental organizations is minimal and the construction part is limited with installation of the ready equipment. Thus, the Market mapping chart will look as follows:

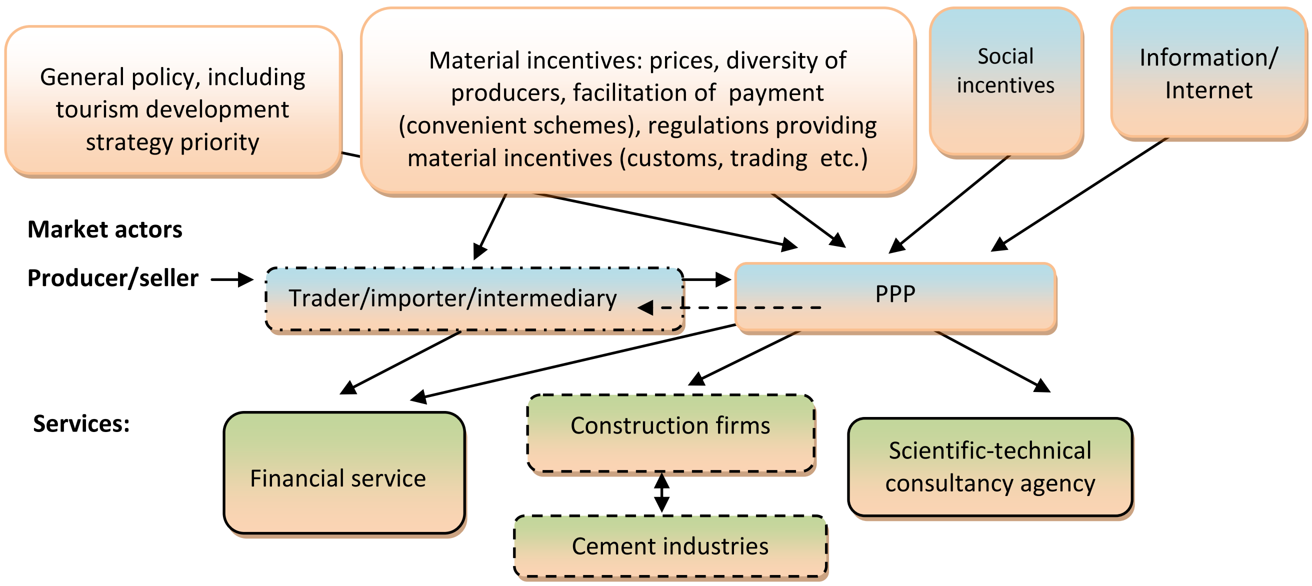
Enabling environment:



Dash-blocks denote that they may not be needed. Regarding Trader, it can be a Touristic agency itself; regarding services, they may or may not be needed if the technology is fully ready (constructed fully and requires just installation). Most likely technology maintenance service should be established.

The third option is a combined participation of touristic firms and local municipality (through local budget and a special regional Development Fund already operating in Georgia since 2010), through a PPP, and the mapping will look as follows:

Enabling environment:



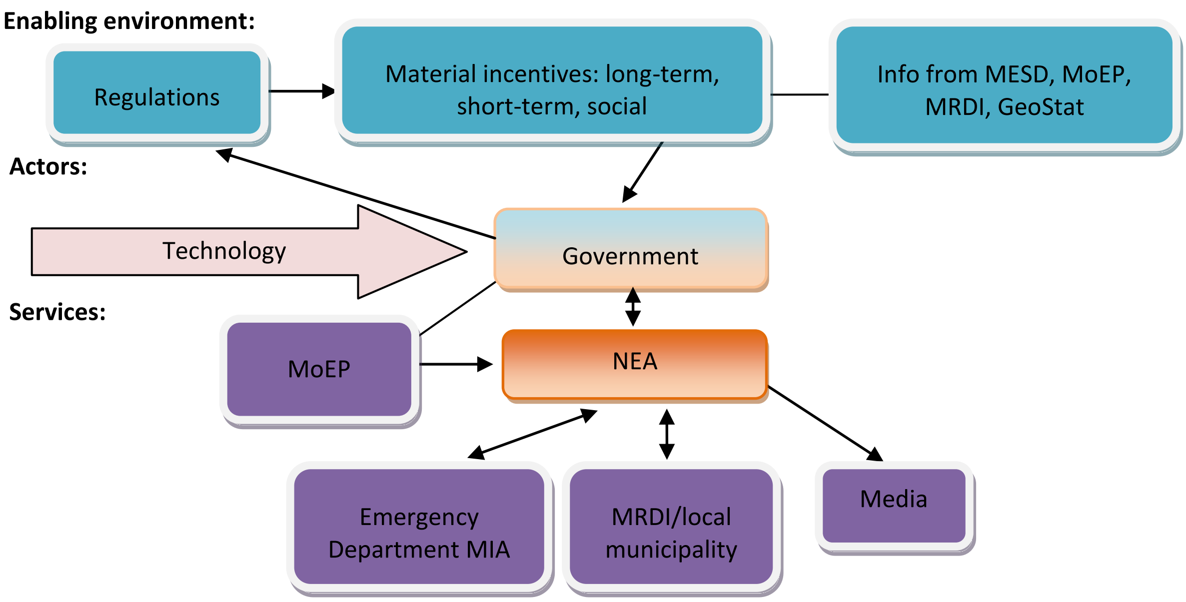
2. Early warning systems

EWS are classical example of non-market technologies. Introduction of the EWS is an essential part for any extreme phenomena management. EWSs vary significantly according to their scale, complexity, costs etc. For the Black Sea case, EWS is needed as a necessary part of the management of the sea level rise and storm-related disasters. As it is detrmined, storms have been becoming more and more frequent causing serious impacts on the coast and beach and threatening human lives and households. The technology to be transferred involves a whole EWS – soft as well as hard parts. The EWS should include monitoring, forecast and warning, and a developed infrastructure enabling the response measures. Due to its large scale, the technology should be introduced by some institution, though under the governmental decision and budget. Cost/effectiveness is based, as in case of the previous technology, on the evidence of damages and consequent economical losses in case of inactivity, and a benefit in long-term perspective in case of proper measures. Concrete C/E analysis may show approximate ranges of the affordable costs for the technology or/and a source for co-financing may be found.

Information and statistics of losses from the relevant ministries (MoEP, MRDI, MESD and others) and the national statistical service (GeoStat) serve as the incentive for introduction of the technology. Other incentives can be formed to overcome possible barriers in technology introduction related field of legislation (trading, customs policy, innovations related facilitation/concession (if any) policy) in the importing and recipient countries, and bilateral economic relations. Short-term economic and social incentives can also be considered as the establishment of the EWS, which will make the area protected and consequently more attractive for tourism, business and employment.

Main actor is the government as the national owner of the EW system, through its subordinate entity – National Environment Agency – that is meant as an implementing entity of the technology establishment and maintenance. This agency, completed with experienced specialists of the relevant fields, may need only some capacity-raising due to the technological novelties. Other institutions involved in the service of implementation and maintenance of the EWS, serve as partners to the NEA: MRDI, as responsible for works in local municipal level, including roads, and the Department of Emergency at the Ministry of Internal Affairs (MIA), responsible for dealing with emergencies including natural disasters.

The mapping chart looks like the following:



The technology is considered to be installed in Anaklia settlement in the Black Sea coastal zone. In addition to vulnerability, the site has important economic growth perspective as it is considered as a future touristic and resort centre and free economic zone, subject to active investments and construction.

For the technology diffusion opportunity, it should be said that this issue is tightly related with the individual EWS characteristics – in case of its strong specifics according to the site, it may not be suitable for other sites: the Black Sea coast is showing considerable specificity from site to site. In case of more flexible model, the dissemination is possible. Decentralized model of EWS is recommended for this segment.

3. Beach nourishment (artificial filling with inert materials)

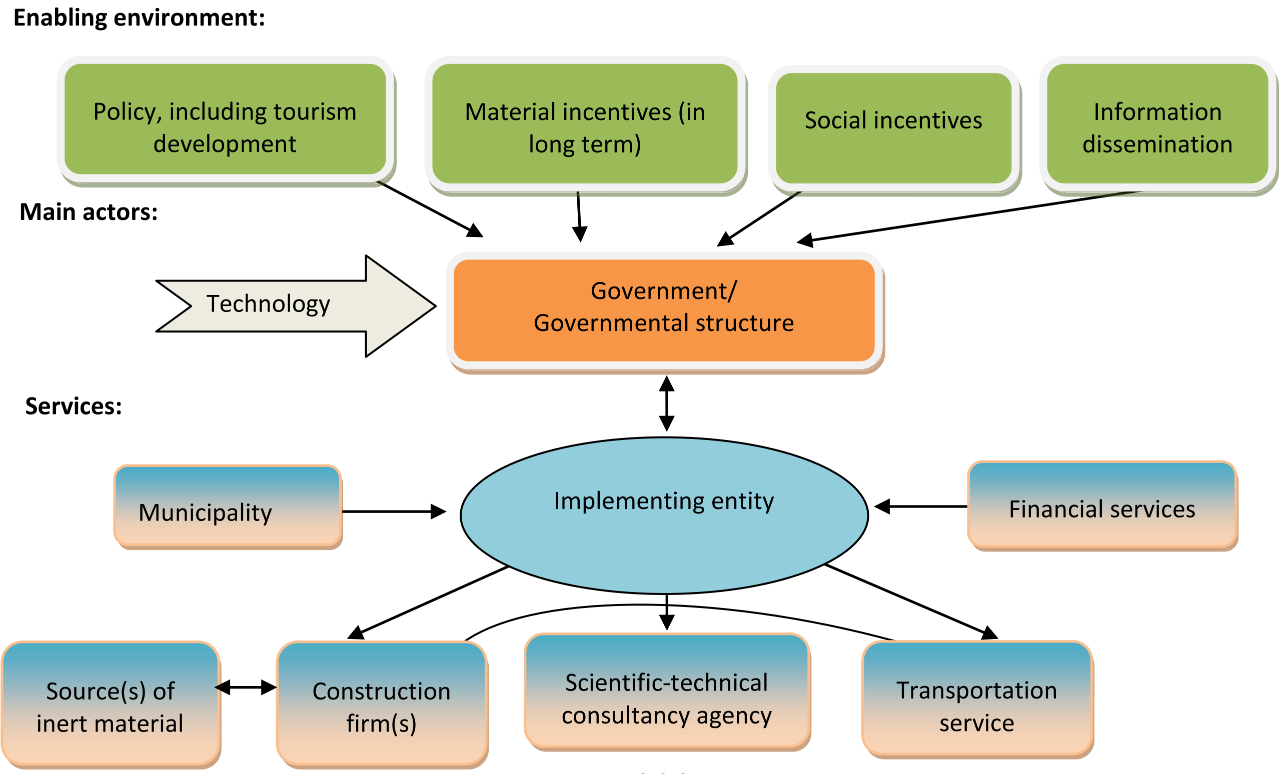
The technology is envisaged to be used in Anaklia village located at the Black Sea coast, in the northernmost part of Kolkheti Lowland, representing a technologically damaged area, where natural development has been disturbed in 1970s by the engineered change of the R. Enguri direction and its transfer into the riverbed of R.Eristskali due to construction of Enguri HPP giant dam. This interference has stipulated intensive washing off of beaches in the Anaklia area, being in progress since 1970s so far.

The technology is relatively cheap and effective in rehabilitating eroded and/or erosion-prone beaches, and was widely used in former Soviet Union. It may be suitable for Anaklia beach as this village falls in the active zone of Georgia's growing tourism economy. In case of inactivity, the ongoing beach degradation and washing out will result in losing of large area of land in this recreation zone. The proposed technology represents a measure for preventing the process of beach land loss, providing the formation of stable natural beaches along Anaklia and preservation of the existing recreational, tourist and other facilities.

Supplying of inert material for piling is envisaged internally, within the country; the river Engury bed is selected preliminary for transportation of inert material. However, the optimal source is still to be selected. Software for permanent monitoring of sea and beach interaction is not available in the country. The segment for nourishment is already identified by local experts. Length, depth and width of segments for nourishment depend on waves/tiding direction and intensity, underwater geology. Volume of initial inert material and amount for further maintenance are also assessed.

The technology requires pushing/promotion because of a few barriers hindering its use regardless its relative cheapness. To identify them, mapping technique was used both for market- and non-market cases: the technology can be non-market if the government itself will take the responsibility to rehabilitate the beach along with other infrastructure for Anaklia, using the budget resources only; non-market version will take place if the touristic firms/agencies or/and other organizations/investors existing in the country implement the technology among the measures for establishing touristic infrastructure in the settlements in order to develop their touristic industry there. In both cases the methodology practiced in the country in the past should be updated taking into consideration the impact of climate change on the sea level raise and the storms. Both market and non-market cases are mapped as follows:

I case: Non-market mapping

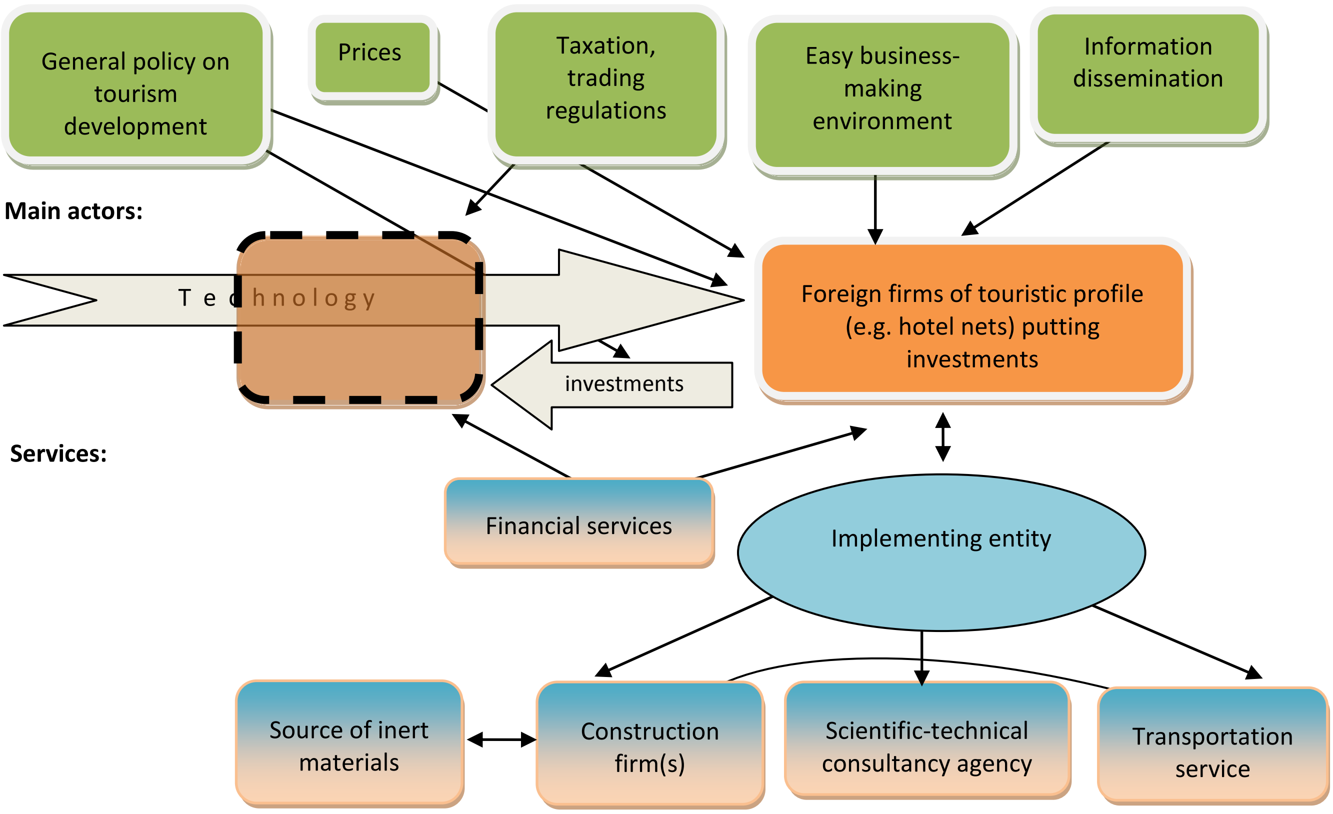


General policy regarding tourism development priority is a strong incentive, including material, as it means having allocated budgetary sources. Other material incentives (though long term) may be the government's expectations regarding further economic development in this area and foreign investments. Social incentives are evident (employment and improvement of social conditions of the population around). Information is playing also an incentive-creating role for the government, e.g. about the climate change possible impact on the infrastructure. The process itself will begin, most likely, from the proper information provided to proper official level. The technology may be sought inside the country or introduced/purchased from abroad. Budgetary sources or/and other financial services (favorable schemes, long state-wide credits, foreign investments etc.) can be used. Implementation agency may be governmental or accountable to the government (or linked with binding agreement) entities able to coordinate and lead the process of implementation. Scientific-technical consultancies, including under-governmental organizations are necessary. Some additional capacity, at least, will be needed for them. Transportation and construction firms can be hired to do the technical works.

The barriers are mostly: financial issues, capacity needs and methodology update.

II case: Market mapping

Enabling environment:



In this case main incentives are material, created by prices and taxation and trading policies; other incentives are facilitating the business-making in the country – environment and tourism development priority policy, creating good conditions for such kind of business. The first-order incentive is created by the proper information to the investors that can launch all the process.

Other participants are the same excepting municipalities, who are excluded from service-making organizations.

In both cases scientific-technical consultancy is meant to include technical info about standards; so, informational and technical services are not put in the chart.

Extreme phenomena (landslides, mudflows and flesh-floods)

Three technologies are considered and recommended by the TNA process for transfer and implementation for the extreme phenomena risk reduction. They are oriented mainly on such hazardous geological phenomena as landslides, mudflows and flesh-floods.

The technologies chosen for management and risk reduction of above three phenomena fall into two categories: centralized and so-called community-level. The former implies adaptation processes organized at national or municipal levels and involves 2 technologies (establishment of monitoring and Early Warning Systems (EWS) for the strategic objects where preventive or other measures are not feasible and a system of long-term projection of activation of hazardous geological processes). The third type of technology is community-level adaptation technology which implies identification and implementation of a system of preventive measures for landslides risk reduction. All three technologies are considered to be implemented in Adjara region as pilot technologies and further to be extended to other regions and sites with similar problems. Adjara region has been chosen based on several criteria: mountainous relief, high-level vulnerability, good set of hydro-meteorological stations and a priority region for touristic and economic development.

Market-mapping for the chosen technologies is aiming at revealing barriers to their implementation.

Identification and implementation of a system of preventive measures for landslide risk reduction for communities in Adjara region

Adjara region belongs to a zone where eco-geological risks are in a critical phase and may transform into irreversible state. Due to scale of the endangered areas comprehensive adaptation measures may be very expensive and, consequently, unaffordable. The only solution of the problem is implementation of small-scale, preventive (palliative) measures in large areas threatened with landslides in order to reduce the risks. Community-level adaptation measures may serve as palliative measures against landslides in inhabited areas. Traditionally state used to practice several technologies during Soviet time when the problem used to be solved at central governmental level. Destroyed system of centralized measures left the population of these risky areas disarmed facing the enhanced threat. Municipal works are mainly done on mending damages after disasters.

Among the appropriate adaptation technologies traditionally used in Georgia for landslide prevention 4 technologies with relatively lower cost have been chosen for implementation.

1) Regulation of surface waters, limiting water to soak into ground;

2) Regulation of underground waters – catching water and/or lowering water level;

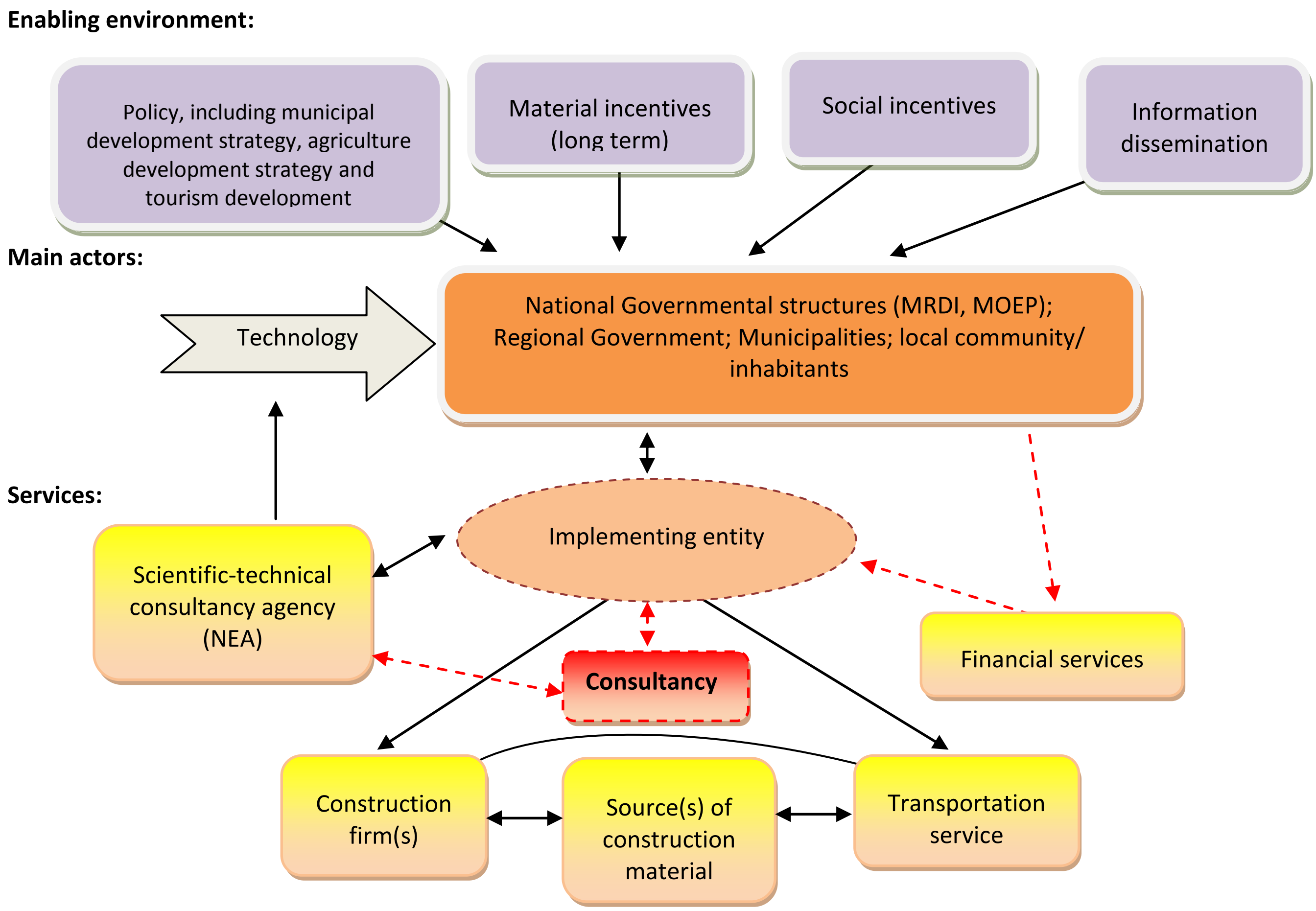
3) Transformation of topography of landslide-prone landscape/relief in order to improve resilience of slopes;

4) Phyto-melioration.

All these technologies are affordable and rather effective. They should be used in combination based on site-specific conditions to ensure maximal effectiveness.

1) <u>Regulation of surface waters, limiting water to soak into ground</u>

This technology is aimed at impeding of surface waters to soak into ground and comprises a few measures that can be used in combination according to the specifics of the landslide-prone/landslide-exposed site. These measures are: arrangement of shallow (in cross-points with underground waters – deeper) drainage canals with or without cemented canal-beds; additional bio-engineering measures to discharge underground waters (arrangement of vegetative buffers, bundles and tree revetments) and/ or discharge of surface waters runoff using fortification of landslide-prone or landslide-exposed slopes. Identification of concrete site-specific measures should be based on preliminary exploration of the landslide-prone or landslide-exposed sites. All the measures are technically viable and can be implemented at community-level. Market-mapping for this technology implies combination of all above-listed measures and considered as non-market cases.



Implementing entity may be chosen by local municipality/community administration and could consist of local inhabitants with appropriate experience in engineering and managing such kind of works. Success of implementation of a technology depends on appropriate preliminary exploration of the site(s), recommendations on optimal combination of measures and close cooperation of appropriate municipal structures with local representatives of NEA and further management of works planned. Financial assistance should be mobilized through municipalities from regional budget (in Adjara's case) and Municipal Development Fund or community fund established by local population. Construction firms are only used in case of need of professional construction works. Creation of centers for training-consulting purposes is also essential. They should provide scientific and technological consultations to local farmers and facilitate their communication with central structures, like so-called extension centers being created just now (next year there will be 14 such centers in total) by the Ministry of Agriculture which are dedicated to do the same in the field of agriculture. Lack of such a consultancy centres is one of the main barriers for implementation of such community level technologies.

2) <u>Regulation of underground waters – catching water and/or lowering water level</u>

This technology implies catching underground water as one of the important preventive technologies from landslides. The measures may involve: "catching horizons " of underground waters, lowering levels, arrangement of "closed" drainage systems, connection of collected quantities of underground waters to a collector, as well as some additional (passive, subsidiary) measures of fortifying the landslide-exposed slopes.

The market-mapping for this technology is similar to the technology of regulation of surface waters with the difference in increased importance of preliminary study and consultancy, as more professional input is needed in this case. Additional measures may also require professional construction firms and special technique in case of large scales.

3) <u>Transformation of topography of landslide-prone landscape/relief in order to improve resilience of slopes</u>

This technology implies several measures that can be used in combination based on the site-specific conditions. Those are: wall-constructing, removing of slid mass of land, loading of landslide-exposed area with a large ground mass; filling-in cracks of landslide-exposed slopes with clay ('claying technique').

Large-scale and technically uneasy works are needed for the implementation of this technology requiring considerable amount of construction material and workers. Market-mapping in this case may be the same with the appropriate distribution of accents. Preliminary study and organization of works seems to be the most important here, emphasizing the role of consultancy blocks. Availability of construction materials and negative environmental impact are another set of barriers to this technology.

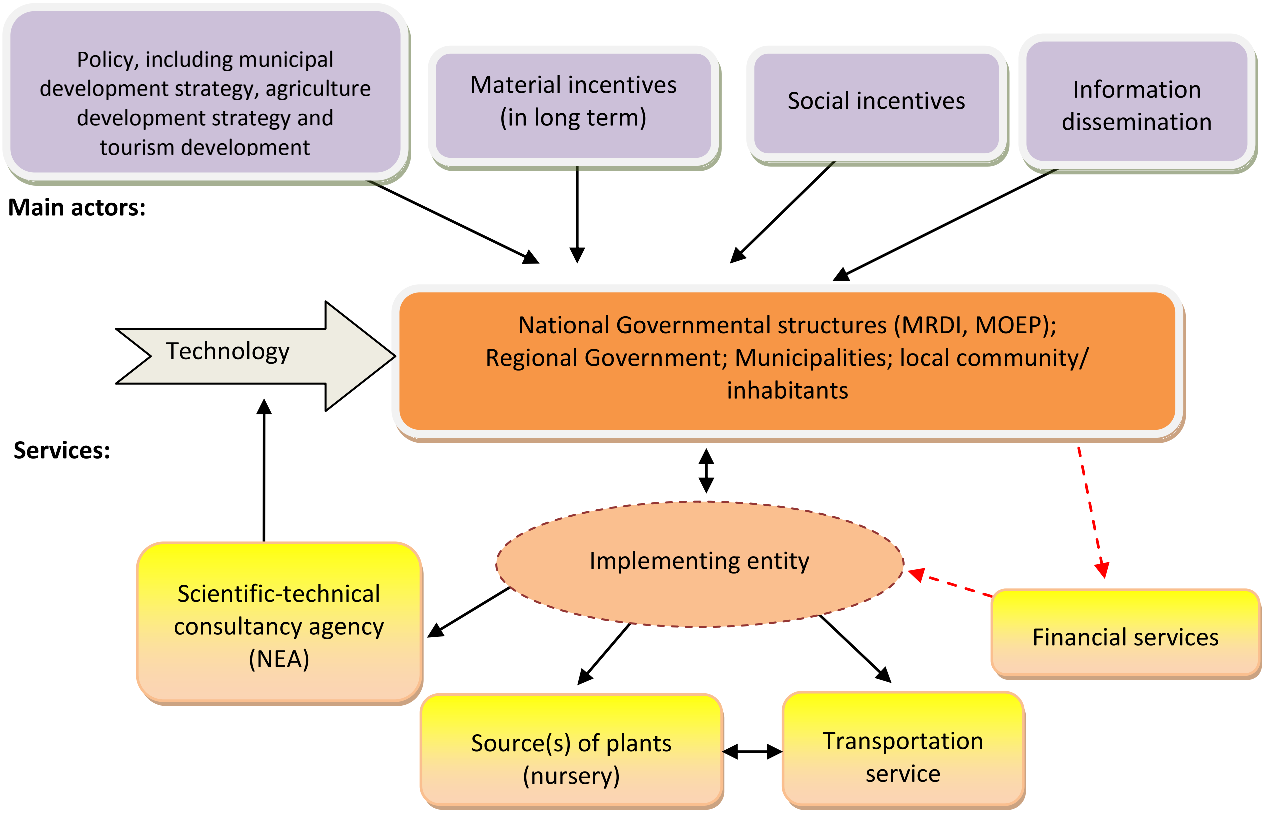
4) *<u>Phyto-melioration</u>*

This technology is one of the most effective and easy technologies for strengthening the landslide-exposed slopes. It can be used separately or in combination with other measures discussed above as it adds value to regulation of surface and underground waters along with raising resilience of slopes against landslides.

The methodology implies planting of appropriate vegetation in endangered slopes able to "catch" run-off, impedes infiltration of precipitation, transpires "surplus" moisture from the ground, roots of some trees taking moisture from the ground and firming the ground at the same time. The technology is easy to implement, the main load comes on preliminary study to identify proper vegetation and areas to be planted and providing the sufficient plants. The main barrier here may be the coordination of works between MoEP, Forestry Department and Municipality.

Market-mapping for this technology has a simplified view:

Enabling environment:

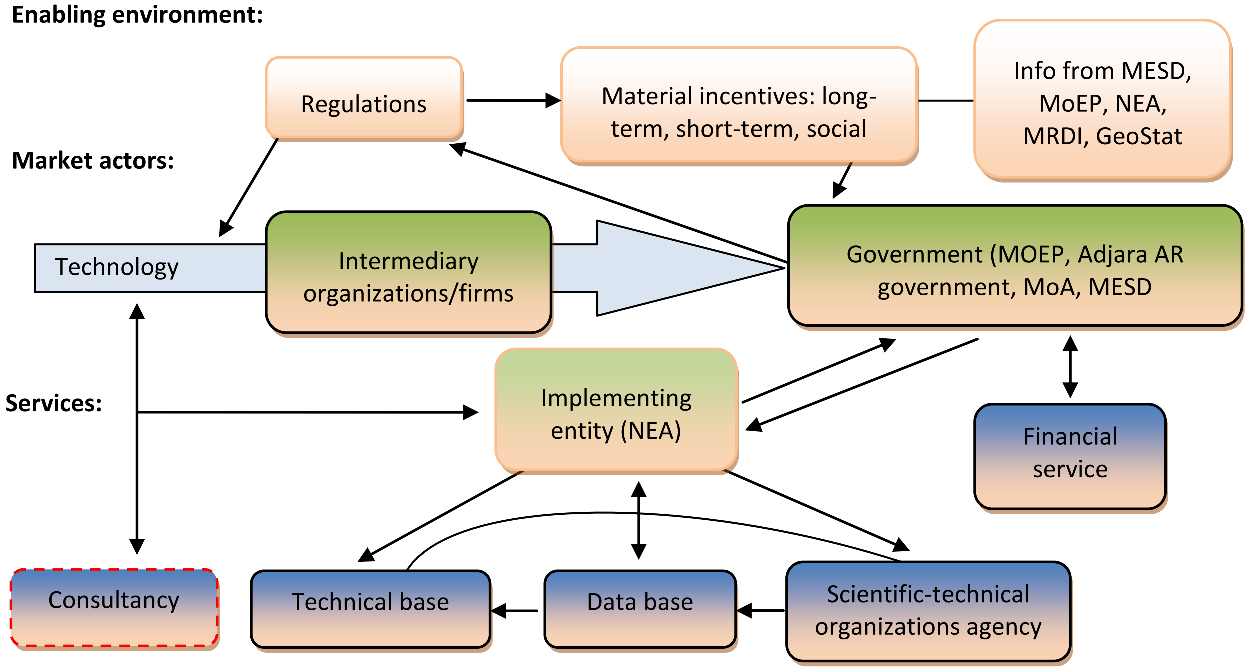


These technologies for landslide prevention may be used in combination or separately issuing from site-specific and local circumstances.

A system of long-term projection for activation of hazardous geological processes (landslides, mudflows, flesh-floods) under the Climate Change

The long-term projection of hazardous geological processes is very essential for Georgia as these processes are lying in the very foundation of hazards. Ongoing climate change puts additional load on the conditions. The system of long-term projections involves deep multi-factorial research and processing of data of various kind as well as appropriate technologies and software.

Market-mapping for this software-type technology transfer looks like as follows:

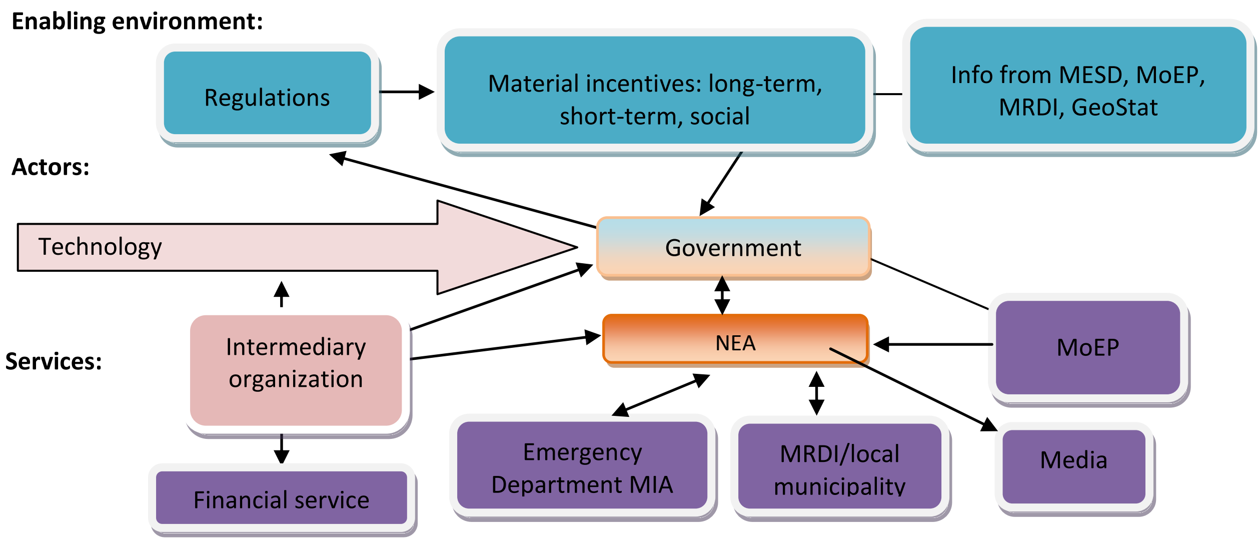


Implementing entity should be NEA acting as a main actor in implementation of the technology, through the DB formed from various scientific and observational sources. Technical base is also needed to house the software. Some consultancy is needed in the stage of selection of the technology (software for long-term forecast). Financial assistance will be needed regardless multiple budgetary organizations involved. It can be provided through official bilateral assistance programs or/and multilateral (international) organizations. Intermediary firms/entities may be also needed to facilitate the technology transfer. Training of staff in technology use should be organized on-line or/and during a training visit inside or outside the country.

Early Warning System for natural disasters projection and prevention

High-quality EWS are absolutely necessary to project in short-term and prevent natural hazards in Georgia, caused by complex geological and geographic conditions in the country enhanced with ongoing CC. Existing EWSs don't meet more and more increased requirements and modern advanced equipment is needed.

Market map for the transfer and installation of modern EWS is as follows:



Intermediary organization may be a foreign government through official assistance or a multilateral organization able to assist in purchasing and installation of the equipment. Financial service may be needed if the intermediary organization is a foreign government and any relevant bank may serve for this purpose. Training of the NEA local staff may be conducted *in situ* by the same intermediate organization or a producer-country technical staff.

Annex III

The Black Sea coastal zone (Anaklia)

Proposal I

Anaklia touristic segment of the Black Sea coastal zone have been chosen as pilot area for demonstration of new technology such as artificial reef-ball promoting the diving tourism in many countries poplar with the sea tourism. However, this technology is not enough for full protection of the coastal zone and it should be considered in combination with other additional measures recommended below for three different sections of this segment.

As the first priority for the section I of this segment it would be advisable to accomplish artificial piling of inert material and to create a shingly beach, as well as to construct an artificial peninsula north to the mouth of R. Tikori for consolidating the newly formed shingly beach. At the same time it would be expedient to create underwater reefs along the beach, which will serve as wave-breakers to dissipate the storm energy and as shelter for fish and shellfish. On the shore these measures have to be accompanied by the artificial heightening and widening of the row of shore line duns.

The same measures should be undertaken at the second section of the shore line, while at the third section main attention of duns, and focused on the heightening and widening of duns, and on the heaping of inert material along the shore line.

The piling of inert material could be performed in different ways, mainly ashore along the coastline in the form of washable piles, or in a broken way in the form of interrupted bermas in the sea, at the depth down to 2m. The sections of the berma could be 30m wide and 150m long with the interval between them of 80m. The total length of this part of shore line south to the mouth of R. Enguri, to be filled by shingly inert material is about 4 km.

To the north of mouths of rivers Tikori and Churia the heaping should be carried out perpendicular to the shore line, in the form of broken stone boons, with the length of more than 120m. Eventually this measure will result in the origination of a small artificial peninsula, which will serve as a barrier, detaining the sub-water sediments moving from the north and thus providing the coastline with a new beach forming material.

After undertaking the above mentioned measures to guarantee the protection of the coast it would be necessary to create a through underwater wave-breaker along the shore line. It will consist of 3 rows of concrete figures (reef-balls), mounted at the depth of 3-5m in the form of broken reefs. The length of reefs must be 150m, and the interval between them – 70-80m. The height of the reefball itself is 1,52m and the width – 1,83m.

In case of accelerating sea-level rise, reaching 5-7mm/yr, before the coastal duns had time to move into the depth of the coast, it would become necessary to increase artificially the parameters of shoreline rows of dunes, and in the exceptional case – to construct the artificial dam. For the high rates of sea-level rise the height of the dunes must be increased up to 4m, their width – up to 300m, and the regular heaping of coarse-fraction inert material is to be undertaken to stabilize the coastline.

Two of these recommended technologies, beach nourishment and creation of artificial capes have been practiced in Georgia since 1960-ties, while the reef-balls and artificial growing of coastal knolls in width and in height are relevantly new and not tested yet.

Advantages and disadvantages of each of these four technologies and tentative costs are provided in the TFS located in the www.tnageorgia.wikispaces.com

Main activities which should be conducted for implementation of this proposal are:

- Comprehensive feasibility study should be conducted for the project implementation;
- Based on the results of feasibility study final decision should be done by the local government on the set of technologies to be implemented;
- Local engineers should be well trained, because even in case of well known technologies (beach nourishment and creation of artificial reefs) modernized technologies should be implemented;
- Relevant financial sources should be identified for covering the additional costs borne by the sea level raise and choosing of more safe, preventive measures;
- Awareness of local government, population and private sector acting in tourism development is crucial in this process because some negative visual effects accompany some of these protective measures;

- Plan for efficient maintenance of implemented technologies and measures should be developed;
- Recommended measures should be implemented in step-wise approach giving higher priority to the most vulnerable segments

Agriculture

Proposal II

Measures to combat soil water erosion in Adjara

Overview of the region

The Adjara region, with the territory of 2,900 km2, is situated in extreme South-Western part of Georgia at the slopes of Meskheti and Shavsheti Ranges. To the West it borders the Black Sea, and to the South-Turkey. 80% of the territory is occupied by mountains, 15%-by foothills and 5%-by lowland. There are 16 rivers and 5 small lakes in Adjara. The largest rivers are Chorokhi, pouring from Turkey and Adjaris-tskali, crossin the region in longitudinal direction.

Despite the relatively small area, the climate and landscapes of Adjara are very diverse. Lowland with humid subtropical climate is covered by thick wet forests with evergreen underbrush, foothills and mountain slopes - by deciduous and coniferous forests, at higher elevation transforming into alpine meadows. Mean annual air temperature varies between 10 and 15 0C, and the annual sums of precipitation-between 1000 and 2800 mm. At the top of Mt. Mtirala in 15 km from Batumi the annual precipitation reaches 4000 mm.

According to 2009 census, the population of Adjara is 380.2 thousand, and for the last decade this number has slightly increased by 2.5%. Adjara is most densely populated regions of Georgia. The average density of population makes 129 persons/km2. The territory of Adjara is devided into 5 administrative districts (municipalities) with centers in Keda, Kobuleti, Shuakhevi, khelvachauri and Khulo. The largest city is the capital of Adjara-Batumi with 32% of total population. A 48.4% of total population is rural population. The level of unemployment is 22.1%, and the poverty level-35.1%.

Adjara's economy is closely tied with its natural resources that are represented by the sea-shore recreation potential, subtropical climate favorable to citrus growing, forest and virginal landscapes, and vast water resources conditioned by the abundant precipitation. Correspondingly, main sectors of region's economy are agriculture and fishery, tourism and recreation industry, processing industry and construction. Agriculture and tourism are leading industries. A 16% of population is self-employed in agriculture sector which is third after processing industry and construction.

Forests occupy 162.2 thousand ha (56% of Adjara's total territory), that facilitated the creation of Kintrishi Nature Reserve in the central part of the region and Mtirala Nature Reserve in the western mountainous part. There are 42 registered mineral springs with the total daily output of about 1300 m3. Five hydropower plants operate in the region with total capacity of 23.5 MW.

Problem description

In spite of the diversity of natural resources and huge potential for their use, there are many still unresolved problems, hampering the successful development of Adjara's economy. According to the document "Regional Development Strategy of Adjara" prepared in cooperation with the UNDP main problems identified by the project are:

- Migration of population to other regions and countries. According to the data provided by the IOM (International Organization of Migration) more than 13% of population was migrated from Adjara region because of fragile geological situation in high mountains. Main reasons of migration;
- High level of unemployment and poverty of population;
- Land erosion in the seashore line caused by the permanent sea level rise;
- Increased frequency of landslides, affecting settlements and causing the mitigation of population;
- Land degradation caused by soil water erosion at the slopes in mountain zone;
- Inferior environmental legislation basis, among them in the field of land resources management;
- Absence of integrated management system for the sea coastal zone;
- Absence of the regional programme on land protection;
- Inadequate development of region's rich hydroenergy potential;
- Unsatisfactory state of problem water supply to population and treatment of waste water in cities.

Hence, it could be seen that majority of listed above problems are associated with the state of agriculture in Adjara, as it is one of the most vulnerable to climate change sectors of economy.

State of agriculture in the region

The variety of climate zones and soil types determines the diversity of agricultural production in Adjara. Main directions in agriculture are citrus-growing, fruit-growing, vegetable-growing and animal husbandry. Traditional directions are viticulture, fishery, grain-farming, bee-keeping, and auxiliary directions – tea-growing, silkworm breeding, tobacco-cultivation, medicinal plant-growing.

Citrus plants occupy 5200 ha in lowland and foothill areas of the region. In recent years the annual harvest of citrus made 105 thousand ton, from which 590 ton are processed for canning.

According to official Register, tea plants occupy 5700 ha, but most part of them is weeded and obsolete. In 2004-2006 about one thousand ha of plantations have been rehabilitated and 2 processing factors are put into operation.

Fruit plants take 4420 ha, from which average annual harvest for the last 5 years varied in the range of 9-16 thousand ton. Vineyards occupy only 88 ha, and the annual harvest makes 1200 ton on the average.

In the grain-farming segment dominates maize, the production of which in 2009 made 14.9 thousand ton. From leguminous plants most popular is haricot, the harvest of which makes about 350-400 ton. Annual production of vegetables varies in the range of 12-14 thousand ton, and the production of potatoes in 2008-2009 has reached 43-46 thousand ton.

In the animal husbandry segment number of cattle in 2005-2009 has varied around 112 thousand, reaching 113.5 thousand in 2009. In the same year number of sheep and goats made 8.4 thousand heads. Gross milk production in 2005-2009 has varied in the range of 48.5-54.5 thousand ton, and the total harvest of honey has reached 306 ton in 2009.

The analysis of current state of agriculture in Adjara and the potential for its development indicates that among the positive features could be singled out the following factors:

Favorable climate and soil conditions for the production of organic and bio agricultural produce;
Unique subtropical climate conditions;
Presence of arable land, proper for cultivation;
Constantly growing requirements on the local agricultural produce;
Presence of cheap labor force;
Favorable trading regime for exporting the agricultural produce;
Multi-profile structure of region agrarian sector.

Among the negative features are to be mentioned:

Small number of large and medium-sized agricultural works;

Shortage of new technologies and low level of agrotechnology, including the use of machinery;
Depreciation of perennial plants and their sparsity;
Soil erosion processes and high density of population;
Low level of rural infrastructure development;
Low productivity and high cost price significantly caused by land erosion;
Inadequate functioning of agricultural produce collection, keeping and selling system.

It could be seen from this list that soil erosion is one of the most pressing problems in Adjara's agriculture sector and it needs to be treated with adequate care.

Soil water erosion in Adjara

Water erosion is the washing off and washing down of the surface layer of the soil by temporary flows of water (rain and irrigation). The energetic basis for the development of water erosion is the kinetic energy of rain. It is established that the amount of washed down soil particles from the slope is directly proportional to the index called "Erosion Potential of Rain" which is the product of rain kinetic energy and the maximal 30-minute intensity of rain, expressed as

$$R_{30} = \frac{E_k \, I_{30}}{100}$$

where R_{30} is the Erosion Potential of Rain (EPR) for the maximal 30-minute intensity of rain, (m•t/ha•min);

E_k - the kinetic energy of rain (m•t/ha•mm);

I_{30} - maximal 30-mm intensity of rain (mm/min).

In Georgia the mean multi-year value of EPR varies in the range of 3-120 units. Its maximum values (40-120) characterize the humid subtropical zone of West Georgia, while in arid zone of East Georgia the EPR value varies from 10 to 30 units, and in high-mountain regions of the Great Caucasus and the Javakheti volcanic Plateau the EPR drastically decreases down to 3-5 units.

According to the objectives of water erosion protection activities, different measures could be identified. They include: basic cultivation of soil, cultivation before the sowing, sowing (planting) and booking after the plants. All forms of soil cultivation, along with the main task (prevention of erosion) should carry out the soil protection function.

As it has been mentioned above, 95% of Adjara's territory goes to mountains and foothills. At the same time, the region, neighboring the Black Sea, is rich in atmospheric precipitation, that creates favorable conditions for the development of soil water erosion (SWE) processes. According to official statistics, the area of total arable lands in Adjara is 8,800 ha from which 5,300 ha (60.2%) is eroded at different degree. For the whole territory of Georgia this percentage makes 30.5, indicating the urgency of SWE problem in Adjara.

In recent years some measures have been undertaken to combat the land erosion processes in rural areas of the region. In 2004 under the special programme of the Adjara Ministry of Agriculture 5000 saplings of nut-tree were planted at the erosion endangered slopes in different mountain districts. In 2005 this activity was continued with planting 5515 more saplings of nut-tree, known for its deep root system, preventing the erosion of soil.

Objective

Objective of the proposal is to implement the technology worked out in the USA and aimed at increasing the water erosion resistance of agricultural lands soils. Considered technology implies the identification of water erosion decreasing cultivation and sowing measures for arable lands and pastures. These measures will be further recommended to the farmers and households. Selection of measures is based on multi-parameter assessment methodology conducted for each concrete plot according to its inclination, environment conditions and climate feature. Technology could significantly reduce losses in agriculture, increase the productivity of agricultural lands and promote the adaptation of erodible soils to climate change.

This technology could be recommended for the entire territory of Georgia where the inclination of plots under crops exceeds 50 and suitable conditions exist for soil water erosion. Most of all it is recommended for the high-mountain villages in Adjara, where water erosion of soil creates particular hazard to local population.

For implementation the recommended technology requires information about various parameters such as: soil erodibility factor, inclination, (EPR - erosion potential of rain) and soil tolerance which is not easy accessible for ordinary farmers and in particular for small farmers. For the implementation and dissemination of this technology it is necessary to create relevant local services in the regions, which will provide local population with specific recommendation and at the same time carry out monitoring both of obtained results and parameters reflecting climate change to guarantee the maximal efficiency of technology implementation.

In the financial aspect the technology is accessible even for small farmers, as it is relatively inexpensive. The assessment method, which is necessary to work out recommendations, is free in Internet. Certain expertise on this subject exists in the country, that requires further development.

Description of technology

The Technology considers a number of cultivation methods, serving to protect soil from erosion:

Longitudinal – contour cultivation. This method is cheapest, but effective measure, in which the soil is cultivated along the contours of an inclined slope, and not in a cross-cut manner. It has been experimentally established that compared to the cultivation along the slope inclination, the longitudinal-contour cultivation 10-15 times reduces the soil surface runoff, increases the water content of 1m deep soil layer by 10-15 mm (100-159 m3/ha) and promotes the rise of cereals productivity by 0.15-0.30 t/ha.

Deep tillage of soil. The use of this method stipulates the increase in soil water permeability and correspondingly the decrease in slope surface runoff and relevant washing down of the soil. The ploughing at the depth of 20-22 cm is considered to be normal, and at 25-27 cm and more-to be the deep tillage. The deepening of ploughed layer by 1cm results in the lessening of liquid runoff by 0.8-4.0 mm. Such wide range is related with the peculiarities of winter season and the depth of soil cultivation. For the reduction of slope surface liquid runoff, most effective is ploughing at the depth of 27-30 cm.

Deep stripe loosening of soil. Deep tillage is highly effective, but very energy consuming measure. So it could be carried out once in 2 or 3 years, usually by turns with the ordinary ploughing. At the same time, to save the expenses, instead of deep tillage it is recommended to till with subsequent deep stripe ploughing. During the spring cultivation the width of stripes equals to 1.2-3.5 m, and the distance between them makes 10-15 m. The application of these measures lessens the washing down of soil 1.5-2.5 times and increases the productivity of corn by 4-16%.

Stepped tillage of soil. The idea of stepped tillage is based upon the use of stepped form bottom of the plough to create the consecutive furrows of different depth at the soil surface, that prevents the formation of intrasoil and surface runoff. Stepped tillage allows to retain at the slope 10-12 mm of water on the average, washing down of soil from 1 ha decreases by 5.8 m3, i.e. about 7 tons per hectare, and the yield of cereals increases by 0.24 t/ha.

Swelling of ploughed area. It has been established that at slope having the inclination of more than 6-70, the longitudinal-contour cultivation does not provide the reduction of surface runoff to the minimum. Hence, during the ploughing it becomes necessary to create small swells along the furrow. For this purpose a large wing is attached to the ouyward body of the plough, which creates during the tillage small swells of soil at some distance between each other.

Shooting of soil. Usually this method is applied ring the autumn ploughing. The depth of shoots can vary from 15 to 60 cm, and the distance between them – from 100 to 150 cm. Working bodies are shooting knives, attached to the frame of the plough. This device is particularly effective in the steppe (plains) zone. The described method allows to increase the water content of the soil by 30-35 mm, lessen the soil washing off and rise the productivity of cereals by 0.4-0.5 t/ha.

Arrangement of drainage furrows. In zones of intensive development of water erosion for the prevention of soil from erosion good results are obtained through the arrangement of draining or anti-erosion furrows in the longitudinal-contour direction to the inclination of the slope. Draining furrows can be arranged parallel to the sowing with mounting of additional body at the external side of the plough, or after the sowing, using ordinary or two-body tractor plough. The distance between furrows depends on the slope inclination and the intensity of water erosion development. The more is inclination and the water erosion development risk, the less should be the distance between them.

Broken furrowing of soil. This method is conducted to regulate the surface runoff of water flowing down the slope. It is applied during the autumn ploughing, or between rows of chooppered crops, at the rime of their cultivation. This measure reduces the surface runoff by 10-17 mm, the washing down of soil by 4 tons from 1 ha, and promotes the increase of cereals productivity by 0.1-0.2 t/ha.

Parallel to soil cultivation the following methods of sowing are applied:

1) Cross-cut sowing of crops. At broken down complex slopes most effective is cross-cut sowing, when the first stripe is sown in the direction of slope inclination, and the second – along the contour. This technology of sowing is reducing by several times the washing down of soil and provides the increase in cereals productivity due to the even distribution of plants.
2) Stripe sowing of crops. Plants sown in stripe are more resistant to soil erosion processes than usually sown plants. They provide the reduction of liquid runoff by 20-30% and of solid runoff (losses of soil due to erosion) – by 25-50%. At the same time the crop-capacity of cereals increases by 0.15-0.20 t/ha.
3) Stripe by turns disposition of crops is used for protecting soils from water and wind erosion. In case when the width of buffer stripes and the distance between stripes is equal, this represents another anti-erosion technology – the stripe disposition of plants and contour-stripe farming. In this case the width of stripes usually varies in the range of 30-40 m;
4) Arrangement of buffer stripe at plots under hoeing plants after harvesting the perennial and annual plants (winter wheat, rye, mix of cereals with leguminous plants). This measure is conditioned by small size of tilled land areas in mountains, and hence farmers avoid to apply technologies that restrict maximal use of the plot. The offered soil protection technology does not lessen the useful area of cultivated land and it promotes even the increase of the yield. At the same time the soil will be protected from degradation and the decrease in fertility. Furthermore, this technology does not require any additional expenditures from the farmer;
5) Sowing of interim crops. In the foothill and mountain zones of Georgia, particularly in Western Georgia, after harvesting plants in autumn, interim crops are sown to protect the soil from erosion. In early spring the biomass of these crops is tilled down into the soil, and later on the major plant is sown at the plot.

The combination of above listed cultivation and sowing methods allows to work out recommendations according to features of the plot and environmental conditions. The selection of recommended methods is conducted using the USLE equation.

The potential loss of soil resulting from water erosion is expressed as

$$A = RKLSCP,$$

where

A is the loss of soil, t/ha per year;

R – Erosion Potential of Rain, m.t/ha.min

K – Soil erosion factor, numerically equal to amount of washed down soil from the standard plot (length 22,12m, inclination 4,50), divided by the EPR. The plot should be the bare fallow through the year.

L – The slope length factor (dimensionless);

S – The slope inclination factor (dimensionless);

C – Factor, reflecting the vegetation, crop rotation, agrotechnics and soil cultivation system (dimensionless);

P – Factor describing the impact of erosion protection measures on the washing down of soil (dimensionless).

EPR- precipitation factor;

Some more details about the values of these parameters are provided in Annex I.

Barriers to the implementation and dissemination of technology

- The legislation does not exist on the protection of agricultural lands and on retaining of their fertility, which determines the rights and obligations of land owner in respect of soil protection.
- The monitoring is not being conducted of parameters, which are necessary for the assessment of soil erodibility and other quantities. Hence, the creation of this system requires additional expenses, that should not burden the land owners.
- The application of offered technology requires the determination of historical and projected trends of climate parameters (precipitation, temperature), the reliable forecasting of which using regional climate models is so far not possible. The resolution of regional models is higher than that of global models, but is still insufficient to assess the local trends, especially in high-mountainous regions. Models often produce contradictory results, that complicates to convince the decision makers of problem's urgency.
- The adoption of this technology requires to create additional local services, which will elaborate recommendations for each particular plot according to climate conditions and soil parameters. The climate change trend should be considered as well.
- The awareness rising of population, farmers and local officials on the economic efficiency of this technology and on the possible aggravation of climate change adverse impact is of paramount importance for the introduction of this technology and provision of its further sustainability.
- It would be necessary to train local expert

Activities to be conducted for implementation of pilot project and for removing the barriers

Nine most vulnerable villages have been selected during the site visit in the Khulo region. The list of these villages is attached as annex III. In total 2100 ha eroded arable lands will be covered by the pilot project. 700 ha of these lands are used for potatoes and the rest 1400 ha for maize.

Following activities should be implemented for demonstration of ways for removing the existing barriers:

Table: *Schedule and cost of pilot project activities*

Activities	Quarters								Cost of Activity
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	
1. Assess the current status of erodibility of soils in the pilot villages	x	x							10,000 USD
2. Assess the current climate change impact on intensification of water erosion of arable lands and pastures in the pilot villages	x	x	x						30,000 USD
3. Assess the economical losses per ha caused by the aggressive water erosion of arable lands			x	x					10,000 USD
4. Prepare recommendations for each household and each plot on water erosion preventive measures		x	x	x	x				15,000 USD
5. Mobilize and train (awareness raising) the most vulnerable local communities for implementation of pilot measures and implement recommended measures	x	x	x	x	x	x	x	x	50,000 USD
6. Evaluate the demand on consultancy in agriculture and elaborate options of demanded service.							x	x	5,000 USD
Total									**120,000** USD

As a result of these activities minimum 8-10% will increase the productivity of per ha arable land.

Effectiveness of technology

One of the priorities of country's social development is the poverty eradication. Main result of land degradation is the aggravation of poverty among indigent part of population, resulting from the significant decrease in soil fertility. Hence, it's obvious that the offered technology could make important share in implementing the priority direction of country's social development.

The progress in agriculture always has been one of major priorities for the Georgian government. Latterly this traditional sector of economy has drown particular attention, resulting in the realization of different serious projects. However, in these activities less consideration is given to the problem of land degradation and to technologies of its prevention and holding up, getting particular importance at the background of climate change in Georgia. Implementation of this technology will contribute to the sustainable development of agriculture sector in Georgia.

The combat adverse results of climate change is one of priorities of Georgia's Environmental Action Plan-2. One of the most important resources endangered by climate change is the agricultural land. The project will facilitate the implementation of NEAP-2.

Proposal III

Proposal for rehabilitation, renewal and optimization of irrigation systems in Kakheti region

(River Alazani Basin)

River Alazani basin borders on Southern slope of Caucasus mountain ridge at the North and on Kakheti and Tsiv-Gombori ridges and river Iori plateau at the South and South-West. At the South-East the basin borders with Azerbaijan. Three types of relief can be distinguished within the basin: steep slopes of the bordering ridges, foothills, slopping parts of the valley, which are mainly built with external cones of materials brought down by the river tributaries, and plain parts of the valley.

River Alazani takes origin on Southern slope of the Caucasus ridge at the altitude of 2750 m. The segment from the source to the joining point of the tributary Samkuristskali is called Tsiplovnistskali by local population, while the rest of the river is called Alazani. Near village Kortabude, the river comes out from a narrow canyon and runs 18 km over the wide Pankisi ravine until joining river Ilto. After that it runs to South-East over the Alazani valley and after joining the river Agrichai it changes its direction and runs to the South, enters Azerbaijan territory and flows into Mingechauri reservoir. Dry gorges can be found in the South-Eastern part of the right side of the river.

Total length of the river is 390 km, total basin area is 16 920 km2, average altitude – 850 m, total dip – 745 m, average tilt – 2,12 %. The basin comprises over 500 rivers with total length of 1 770 m.

Significant tributaries: Ilto (length – 43 km), Khodashenistskali (31 km), Stori (38 km), Turdo (28 km), Lopota (33 km), Chelti (28 km), Kisiskhevi (37 km), Duruji (26 km), Chermiskhevi (35 km), etc.

Left tributaries of river Alazani, which flow down on Southern slopes of the Caucasus, are characterized by abundant waters, narrow and deep canyons, plural rapids, and waterfalls. They strengthen depth erosion processes, bring down big amount of sediments, develop external cones, and dividing into smaller branches, join river Alazani. Right side tributaries are less water abundant and characterized by lower dip.

Mountainous part of the basin is built by sand-stone material and clay-shale, which are most frequently represented on the left side of the river. Limestone and partly marl is mostly represented on the right side. Main rocks are covered with clay rocks and ground.

Water regime of river Alazani and its tributaries has been studied since 1912 at 26 hydrological stations. For the time being only one station is operational – station Shaqriani.

Feeding sources of the river are: ground waters – 40 %, rain waters – 31 %, and snow – 29 %.

Water regime of river Alazani can be described as: floods in springs, stable little water period – in winters, freshets – in springs and during rainfalls in summers.

Water flow of the river and its tributaries is not evenly distributed during the year: 37 % - in springs, 31 % - in summers, 21 % - in autumns, and 11 % - in winters.

Water resources of the river (within the territory of Georgia) are assessed as 3.10 km3 (570 mm). Module of water-flow along the river flow fluctuates within limits of 49.9 – 9 00 l/sec km2.

Left tributaries of river Alazani, which flow down the Southern slopes of the Caucasus, are distinguished by water abundance. Mudflows are common for both side tributaries of the river.

The whole basin is divided into 5 hydrological districts. The districts are defined by average altitude of the flow.

Water balance: precipitations – 800 mm, evaporation – 470 mm, water flow – 330 mm, ground water flow – 135 mm. River Alazani has a relatively favorable water balance structure. Losses (sum of the surface water flow and non-productive evaporation) are assessd as 66 %.

Orography of the river Alazani basin and the dominating directions of air masses (West, South East) define climate peculiarities of the area. The basin is surrounded by high ridges from three sides that protect the valley and foothills from entering of cold air masses. The basin area is open at South-East that allows entering warm air masses that influence its thermal regime and forms specific climate features in general. Air masses entering from both sides provide for development of abundant atmospheric precipitations.

Soil cover of the river basin is very diverse. There are represented laptosols of loamy and clay composition, dystric cambisols, brown forest acid soils, and eutric cambisols.

Alluvial carbonate soils are represented on the left side, while alluvial carbonate free are on the right side of the river. Meadow brown, brown, brown leached soils with heavy clay composition are represented on Tsiv-Gombori North-West slopes.

Water of the river is low mineralized and used mostly for irrigation.

Alazani region has one of the most significant economic potentials for Georgia. Viticulture and vine growing are the main profiles. Grain crops and animal breeding are also quite important for the region. As agriculture has a defining role in economy of the region, food production is also developed there, main sector of which is vine production. Oil and gas extraction should also be noted, as well as extraction and processing of limestone, marble-shale, woo, etc.

Kakheti region has a high potential of tourism development. It has rich and diverse natural and cultural-historical resources. Number of tourists and visitors and the related income has been increased by 50-60 % during the last several years.

Almost whole region is supplied with electricity. All municipal centers and a part of rural population (25 %) are supplied with natural gas.

Four hydro power stations are operational in Kakheti region: ‘Khadorhesi’ in Akhmeta district, which develops 24 megawatts in case of full-capacity operation; ‘Intsobahesi’ in Kvareli district with capacity of 1 megawatt; ‘Kabalhesi’ in Lagodekhi district with capacity of 1,5 megawatts, and ‘Alazanhesi’ in Gurjaani district with capacity of 1,5-2,5 megawatts.

Contemporary climate change during the last four-five decades has been revealed in East Georgia in increased temperature and decreased precipitations. River Mtkvari water flow has been decreased by 25-30 % to compare with 1940. Taking into account an increased pressure of anthropogenic factors, all above mentioned factors together contribute to desertification of arid areas of the region.

Though there are different data (often controversial) on hydrological processes, in case of global warming, the following scenarios could take place in the region: annual distribution of water flow will be enduring significant changes, rather than annual water flow total amount; water flow of comparatively low water period will be decreasing and the water flow of a high water period will be increasing; frequency of freshets will be increasing, while their intensity will be decreasing.

Based on forecasted trends in the frame of climate regional model – PRECIS, the climate change influence on water flow of upper Iori and Alazani rivers has been assessed according to changes of temperature and precipitations. In accordance with the obtained results, water flow of river Alazani will be decreased by 10% by the end of 21st century. Taking into account the last period climate changes in the region and due to the increased frequency of droughts, some preconditions for developing of desertification processes have been created in East Georgia (including Kakheti).

According to the developed forecast, by the end of XXI, a hydro-thermal coefficient will be decreased fro 11 to 0,7 in Southern part of Kakheti (Dedoplistskaro Municipality). Such changes can transform the dry sub-tropical region into a strongly arid category. Obviously, these changes will more or less cover whole Kakheti territory. Warming processes will affect (prolong/change) the duration of vegetation period and increase water consumption for irrigation purposes. Besides that, it should be noted that annual distribution of water flow in this region is not synchronized with the irrigation water consumption.

Desertification processes have been even more intensified due to destroying of irrigation systems, intensive use of winter pastures, and by cutting of wind belts. Rehabilitation of irrigation systems is one of the first priorities for detaining the above mentioned processes and one of the most effective adaptation measures to resist the climate change processes.

Since 90s of XX century in Georgia, the existed irrigation network has been significantly decreased and correspondingly, the irrigated areas. For the time being the system is being rehabilitated all over the country, but it is still very small to compare with 90s. For example, the upper Alazani irrigation system covers area of 22 464 ha, while in 90s it covered 44 300 ha. The lower Alazani system covers now 20 071 ha, while in 90s it covered 34 426 ha.

Kakheti irrigation systems in whole do not meet modern technical requirements. Efficiency output of the most of them do not exceed 0,4-0,6 values. Around 60 % of total water is lost due to filtration, 20-25 % - due to technical reasons, and 3-5 % - by evaporation from the surface.

Kakheti has a leading position in agriculture of Georgia. Main part of the population (> 80 %) is involved in agricultural activities and the region in whole is a typical agricultural region. Taking into account natural conditions of the region, it is necessary to provide its lands with artificial irrigation. Around 150 000 ha have to be irrigated in Kakheti, though actually, technical conditions allow to irrigate only 50 000 ha of lands. Besides that, due to expectable changes which could be caused by global climate change, necessity of the development of new types of irrigation systems and correction of existing technologies is quite evident. The trends of extension of areas which would need to be irrigated should also be taken into account.

Irrigation Systems Operational in Alazani Basin

Upper Alazani Irrigation System covers area of 22 464 ha. It is 78 km long. It takes start in Pankisi gorge near village Doe. The last point is located near village Velistsikhe of Gurjaani district. The roundabout 8 km long Kalaur-Velistsikhe pipe is destroyed and does not operate at all.

Naurdali Irrigation System covers 5 273 ha of irrigation area. It irrigates the villages of Telavi Municipality: Pshaveli, Saniore, and Napareuli. The system length is 11 km.

Lower Alazani Irrigation System covers 20 071 ha of irrigation area. It is 95 km long. It takes start in village Kondoli of Telavi district and ends near village Zemo Keda of Dedoplistskaro Municipality.

For the time being, almost all irrigation systems are more or less operational, but they do not operate with full capacity. The Lower Alazani Irrigation System is in comparatively better state. The Upper Alazani Irrigation System operates with interruptions and only as far as Gurjaani Municipality. In case of implementation of the mentioned project, up to 70 000 ha of the area of valleys vulnerable to droughts, such as Taribana, Eldari, and Iori, will be provided with irrigation. For the time being, rehabilitation of Upper Alazani Irrigation System is under way. A project on rehabilitation of Zilicha System, which would cover up to 2 400 ha of area vulnerable to droughts is already developed.

The most rational way of artificial irrigation for Alazani basin is arranging gravity flow channels with mechanic water-lifting facilities, artificial raining aggregates and droplet systems. For the time being only surface gravity flow technology is used. Main part of Kakhety plain is almost fully provided with gravity flow irrigation channels (including those to be rehabilitated).

The Gravity flow irrigation can be used in areas, tilt of which does not exceed 0.02-0.03. In case of mountainous relief, if the tilt is over the mentioned values, irrigation is connected with a number of difficulties. That is why a method of artificial raining is more feasible in such conditions. On the right side of river Alazani (for instance in the surroundings of village Bakurtsikhe), where the orientation of network of gorges complicates the use of mechanical droplet and surface gravity flow irrigation technologies, it is reasonable to use the artificial raining technology.

Measures to be taken for the rehabilitation and optimization of Alazani Irrigation System on the background of global climate change:

1. Completion on the project on Upper Alazani Irrigation System (Duisi-Arashenda-Ole Tba-Taribana-Eldari. Main channel length – 190 km);

2. Rehabilitation of 'Zilicha' irrigation system;

3. Inclusion of Alazani-Agrichai artesian basin ground waters into the irrigation network of southern part of the basin.

4. Establishment of automatized water management systems together with water supply control;

5. Rehabilitation or establishment of wind belts for the purpose of decreasing of wind power in the areas where artificial raining method of irrigation is used;

6. Providing of irrigation systems with collection-drainage network (central ways);

7. Cleaning up of the irrigation systems/canals;

8. Inventory, rehabilitation, and liquidation of the abandoned irrigation channels and boring wells;

9. Facilitate the community mobilization process for rehabilitation of farm-based or community-based inner-irrigation systems (through involvement of local population);

10. Revising of traditional agricultural directions with the aim of assessing of cultivation of less water-demanding plants;

11. Providing trainings in standards for operation of irrigation technologies and techniques, maintaining of irrigation norms and dates taking into account agricultural requirements of separate districts and zones.

12. Vertical shifting of natural zones due to global climate change (approximately 300-400 m) and the trends of increasing of areas to be irrigated, need to be reassessed and appropriate correction of types and technologies of irrigation systems should be done. For these purposes the following action should be done:

a) Prepare cadastral maps of Alazani basin agricultural lands;

b) Develop high resolution digital model of irrigated area relief;

c) Establish the bank of orthogonal photos of Alazani basin;

d) Zoning of the basin area according to vulnerability level;

e) Zoning of irrigated lands according to irrigation technologies and techniques used and preparation appropriate recommendations.

The above given information and data treated through geo-informative technologies would allow determining: optimal configuration of gravity flow irrigation channels, optimal water flow speed which would not wash out, nor leave the sediments. Besides that, it would be possible to select proper irrigation agglomerations, and to reveal the negative forms of relief in case of using artificial raining techniques.

Treatment through geo-informative technologies of the above mentioned information would allow:

a) selecting proper irrigation agglomerations;

b) defining optimal configuration of gravity flow irrigation channels;

c) defining optimal water flow speed which would not wash out, nor leave the sediments;

d) revealing negative forms of relief in case of using artificial raining techniques

Preliminary costs of these activities assessed through different sources are provided in the table below.

Table of activities for optimization, reHabilitation and renewal of irrigation systems in Khakheti region considering the ongoing and projected climate change featires in Georgia.

Activity	Time for implementation (Years)	Costs (in USD)
Completion on the project on Upper Alazani Irrigation System (Duisi-Arashenda-Ole Tba-Taribana-Eldari. Main channel length – 190 km)	3	2,720,000
Rehabilitation of 'Zilicha' irrigation system	2	2,200,000
Inclusion of Alazani-Agrichai artesian basin ground waters into the irrigation network of southern part of the basin.	1.5	2,000,000
Providing of self-flow irrigation systems with collection-drainage network Establishment of automatized water management systems together with water supply control	1	150,000
Cleaning up of the irrigation systems/canals	1	500,000
Facilitate the community mobilization process for rehabilitation of farm-based or community-based inner-irrigation systems (through involvement of local population)	3	150,000
Inventory, rehabilitation, and liquidation of the abandoned irrigation channels and boring wells	1.5	150,000
Revising of traditional agricultural directions with the aim of assessing of cultivation of less water-demanding plants	1	300,000 Feasibility study (could be covered by different sgricultural projects under the climate change)
Vertical shifting of natural zones due to global climate change (approximately 300-400 m) and the trends of increasing of areas to be irrigated, need to be reassessed and appropriate correction of types and technologies of irrigation systems should be done. The following actions should be implemented:	2	300,000 Feasibility study (could be covered by different projects under the climate change)
a) Prepare of cadastral maps of Alazani basin agricultural lands	2	200,000 Public Registry
b) Develop high resolution digital model of irrigated area relief	1	10,000
c) Establish the bank of orthogonal photos of Alazani basin	1	Included in feasibility study in (a) Public Registry
d) Zoning of the basin area according to vulnerability level	2	200,000 Feasibility study
e) Zoning of irrigated lands according to irrigation technologies and techniques used and preparation of appropriate recommendations	2	Part of feasibility stady above
Rehabilitation or establishment of wind belts for the purpose of decreasing of wind power in the areas where artificial raining method of irrigation will be recommended	3	2,000 (per hectar including the maintenance cossts for the first three years)
Providing trainings (including practical training on site) in standards for operation of irrigation technologies and techniques, maintaining of irrigation norms and dates taking into account agricultural requirements of separate districts and zones	1	50,000 Private services established locally and technology providers
System monitoring and annual monitoring		4,000-5,000

Barriers to the succesful implementation of the proposal

- **Information about market availability and technology standards**. Technical appliances for drip irrigation – water distributing and regulatory systems should be bought at the international market. Good technical knowledge and practical experience in operationalization of such systems is necessary for selection optimal for the specific site system. Such knowledge and service is not in country and therefore consultant from outside should be invited each time increasing with this the transaction costs of the project.
- **Operationalization of modern technologies**. Modern drip irrigation systems has irrigation process auto-regulatory functions as well which is very important in case of Georgia due to the negative attitude from stakeholders having in mind the negative (soil salination) past experience caused because of improper operationalization of systems.
- **Energy supply**. Irrigation systems using energy are not economically feasible in Georgia yet. Energy consumption in irrigation increases the production cost which affects the price and makes product uncompetitive at the market.
- **Ownership**. This is expensive technology and has high financial risk for one farmer.

Extreme Geological Events

Proposal IV

Long-term Forecasting (25-30 years) of Spatial and Temporal Development Trends of Hazardous Geological Processes (Landslides, Mudflows, Erosion) in Ajara region on the Background of Global Climate Change

Project Goal and Activities

On the background of global climate change and increased intensity of earthquakes all over the planet, the elemental catastrophic geological processes in Georgia, like in many other mountainous countries, impacted over 70% of the territory of the country, as well as all human activity fields – social and economical, demographical, ecological, etc. It became urgent to recognize that these processes should be managed at national level. For the management of catastrophes it became necessary, first of all, to create an effective early notice system. The system must have been based on reliable long-term forecast of the spatial and temporal development trends of elemental geological processes. For these purposes in 1997 the President of Georgia issued a special Order (N66) on the development of long-term forecasting of elemental processes. Unfortunately, due to lack of financial resources, this very important problem is still not solved.

Development of the long-term forecast of geological elemental processes depends on availability of completely different comprehensive information, such as geological, climatic, ecological, geo-physical, agrarian, urban, engineering-ecological, and etc. data. This information should be processed, analyzed and generalized, that require special knowledge in modern methodologies and relevant soft ware. It is evident that different specialists of different fields should take part in selection and processing of risk factors which can provoke natural and anthropogenic geological elemental processes.

As far as the development of long-term forecast for whole Georgia would take at least 3 years and cost around 300 000 USD (relevant soft ware not included), it would be reasonable to develop the long term forecast only for Ajara region, which is recognized as the most vulnerable region in Georgia towards elemental processes. Besides that the region is distinguished by heavy anthropogenic press and especially high sensitivity to climatic conditions, by large scale activation of elemental geological processes.

Taking into account that this region is under special attention due to its economic development potential from one hand, and due to actual risks to population, engineering and economic facilities from the other hand, minimization and wherever possible, avoidance of such risks gains special importance in the country general strategy.

There is the widest network of meteorological stations in Ajara. The stations have good locations and conduct long-term observations which can provide clear picture of maximum permitted alterations of negative meteorological elements provoking geological elemental processes. The long-term forecast on activation trends of elemental geological processes (on the background of climate change) developed for Ajara region can be used as a pilot model for similar climatic-landscape mountainous regions of whole Georgia.

This comparatively small scale project will take about 15 months and it will cost approximately 90 000 USD (soft ware not included).

Expected Outcome

In case of implementation of this project, the main expected outcome is the assessment of development regularities of elemental geological processes on the example of Ajara region, taking into account the expectable climate changes, and the long-term forecast on activation trends of these phenomena. The relevant forecasting map will be composed.

Such forecast will provide basis for the protection of population from expectable elemental geological processes and ensure safe operation of engineering and economic facilities, as well as their safe location. Besides that, these maps are very useful for making amendments in short-term forecasts on possible activation of elemental processes and for effective planning of adaptation measures/technologies aiming at avoiding or minimization of risks on regional level.

It is very important that the role and place of a climate change factor in generation/re-activation of geological elemental processes, as well as the long-term forecast of their activation will be determined for the South Caucasus region for the first time.

Project results will serve as significant information for the Ministries of Environment, Infrastructure and Regional Development, Agriculture, for the Department of Emergency Situations of the Ministry of Internal Affairs, for the Departments of Border Protection, and Tourism, as well as for relevant authorities of Ajara Autonomous Republic and local municipalities. Besides that it will be useful for different international, national and non-governmental organizations involved in ecological and construction activities, for farmers, and etc. Such information will be the base for strategic planning and concept development. It should be also an important component of spatial planning for such countries as Georgia.

Implementation stages and financial expenditures of the project (Main types of activities and stages)

##	Activity	Time (months)	Cost (thousands USD)
1.	Statistic analysis of the main factors provoking elemental geological phenomena (preparation of model input data)		
1.1	Re-qualification and updating of data on constant factors, such as geological constitution, lithologic and tectonic data. Assessment of geo-morphological features in connection with climate change. Composition of relevant GIS maps (1: 50 000).	1.5	25.5
1.2	Defining of regimes of slowly changeable factors – contemporary tectonic movements – taking into account changes of climatic parameters; assessment of hydro-geological conditions for the purposes of defining the Black Sea iso-static and eco-static changes; inventory of changes taken place in the plant cover.	1.5	3.0
1.3	Analysis of rapidly changeable factors – meteorological elements (precipitation, humidity, temperature, sun activity stages, etc.). Analysis and correlation of within-year, seasonal and daily data with regard to mean multi-annual data for the whole observation period for 6 meteorological stations of Ajara.	2.0	10.0
1.4	Determination of trends of earthquakes according to years; assessment of the released energy and negative results of earthquakes	1.0	3.5
1.5	Changes hydrological regime during the years.	0.5	3.0

1.6	Anthropogenic changes in geological environment and activation level of the connected elemental geological processes.	1.0	6.0
1.7	Statistical analysis of hazardous geological processes activated by climate change in different years and the damage caused in Ajara.	1.5	7.0
1.8	GIS processing of geo-dynamic map of damages caused by hazardous geological processes provoked and activated by climate changes in Ajara.	1.0	30.0
2	Acquiring and transfer software(adaptation to the conditions in Georgia) necessary for development of long-term forecasting of hazardous processes.	15	50.0
3	Training of local personal and establishment of service centers for consultations on the relevant protective measures.	5.0	47.0
	Total	185.0	

Barriers

- Advanced methods for the development of long-term forecast in Georgia have not been used yet. Hence the first barrier might be defined as absence of appropriate specialists.

Specialists should be educated through different programs and by the suppliers of particular methodologies. As a rule, such educational seminars are conducted and financed by different international donors on the ground of a country request. Such request can be done during the process of preparation of Third National Communication.

- A long-term forecast computer model might be so expensive that it will be impossible for country to purchase it.

Some primary investigations have been conducted within the frame of this project and supposedly there should exist some low price (or even free of charge) soft ware for the risk assessment, though their adaptability to the conditions in Georgia is still a question and needs some additional studies and time.

- Older statistics may not meet the requirements of a selected model, needed for calibration and validation of the model. Monitoring of the current processes is not conducted which is very important for determination of the actual changes and for the assessment of correlation with climate change.

It is quite difficult to define in advance the ways of removal of these barriers. The optimal ways of removal of the barriers should be discusses separately for each parameter, for which there does not exist previous statistic data, or the monitoring was ceased, or has not been ever conducted.

Alongside with acquainting with a model and developing forecasts, the ways and means of delivering of the obtained results to the customers should be studied and best of them selected together with the relevant stakeholders. Involvement of the private sector in this process is very important.

Proposal V

Landslide Preventive Measures for Minimizing of Risks to Population and Engineering and Economic Facilities in Ajara Region

According to investigations dedicated to the elemental geological risks existing in Ajara Region, population of this region live today in a critical geo-ecological phase. Beyond this phase the unrecoverable catastrophes can take place and the engineering and economic facilities will not operate safely. During the last period the geological situation in the region was seriously aggravated due to climate global changes and heavy anthropogenic pressure. Up to 80% of negative consequences are directly connected to the above mentioned factors.

Actually, the critical situation developed due to performance of hazardous geological processes needs the elaboration of complex scenario of adaptation measures, implementation of which must be based on integrated management principles. According to international experience, protection of population and agricultural lands from hazardous geological processes and safe operation of engineering and economic facilities needs the development of a special program which would optimally envisage potential risks. In particular, the program should provide comprehensive analysis of locations and types of natural phenomena or a chain of phenomena which have already taken place or are expected to take place; conditions, dynamics, mechanism, and geometry of generation of the mentioned processes; assessment of risks of their transformation into catastrophes; perspectives of activation of the processes which can cause the risks; determination of geographical risk areas.

Adaptation measures should be selected taking into account types of hazards (or a chain of processes) and the category of threatened facilities, as well as the level of possible damage. It is obvious that all territories damaged by large scale hazardous geological phenomena cannot be addressed by expensive comprehensive measures. Moreover, comprehensive measures for the protection from deeper deformations and large scale landslides often do not have desirable results. Such measures are carried out only in special cases to protect especially significant objects.

Taking into account that during the last period the development scale of hazardous geological processes in Ajara is increasing and on the background of climate change the recurrence intervals are significantly decreasing, constantly involving new areas, the palliative (preventive) measures have been considered as the more effective direction within the frame of this project.

Preventive adaptation measures allow protecting not only the areas under dynamic process, but also wider areas under the risk of geological processes. Besides that the preventive measures can be implemented much easier and they will be much cheaper. Local population can be actively involved that is one of the main directions emerged within the frame of this project as a new approach in this filed (new technology).

Risk minimization for wider areas through preventive measures allows addressing not only one particular phenomena but a complex of different dangerous phenomena. This kind of preventive regional scheme was developed for the first time for Ajara region in early 80s of last century aiming at risk minimization for the area of 1440 km^2. Government was fully responsible for the implementation of this scheme, while population was not involved in the process at all. After destroying of the Soviet Union, approaches for many different issues have been changed. This created new barriers in implementation even of those technologies, which used to be easily implemented by the Government during Soviet time (relevant knowledge existed). Lack of capacity and awareness to involve local population in implementation process of preventive measures is the main barrier in using of this technology.

Preventive measures

Description of different landslide preventive measures successfully implementable in Soviet time in Georgia and implementation of which for the time being need new approach for removing the barriers emerged under the market economy, is given below.

Landslide protective technologies being in use worldwide and widely used in Georgia:

1. Regulation of surface waters and arrangement of water pipes, preventing penetration of water into the ground;
2. Regulation of ground waters (catching of ground waters or lowering the levels);
3. Change of relief topography with the aim of improving of slope state;

4. Phyto-melioration;
5. Strengthen of slopes by supporting constructions (counter-banquet, counter-force; anchor, piles;)
6. Artificial improvement of rock features (resistance to sliding; stability; cementation of splits of landslide and other origin; applying of clay; applying of silicates; electro-osmotic draining; electro-chemical strengthening; covering with gunite and spray concrete; etc.);
7. Changing of lanslade ground – arranging of so called 'terramesh'.

According to the world practice, implementation of the comprehensive landslide protective measures such as technologies 5, 6, and 7, are very costly and difficult. Therefore such measures are implemented only for the protection of especially significant objects. The first four measures, such as regulation of surface waters, water drain pipes, prevention of water filtration, regulation of ground waters (catching of ground waters or level lowering), draining of watered rocks, changing of landslide topography with the aim of slope stability; removing of landslide masses, construction of river benks protective stone gabions and phyto-melioration belongs to a group of palliative (preventive) measures. These measures are quite effective and not very difficult in terms of implementation. These preventive measures are used for improving of wide areas of damaged territories, for the protection of so called "climitogenic landslides". These measures do not require complex and expensive technologies and the local population and farmers who are standing in face of serious risks can be easily involved in the implementation process.

Actually, before the implementation of the mentioned measures, it is necessary to conduct proper assessment of engineering-geological conditions of the territory in question. The assessment should serve as a ground for planning of practical measures. Two main groups of technologies are used for the neutralization of "climatogenic" landslide phenomena. First group includes objects which require regulation of surface waters by following methods:

Regulation of surface waters by open shallow water pipes; in case of encountering of ground waters it will be necessary to deepen the pipes to the level of their appearance. It might be required also to strengthen the sides of the pipes with concrete plates and to arrange special brush revetment on the pipe bottom or to pour the drainage mining ballast for organized discharging of ground waters. Phyto-melioration (bio-engineering) measures are used for strengthening of surface landslide slopes and gorges generated in aeration zones. Surface water flows can be significantly regulated by using the phyto-melioration technologies. These technologies help preventing infiltration of rain and snow waters and removing of excess dampness of ground through transpiration; plant deep roots (6-20 m of acacia, oak, beech, etc.) not only can absorb significant amount of moisture, but also can strengthen the sliding slopes and protect gorges from washing out processes. The simple technology of the same group is - covering of splits on landslide slopes with high plastic clay.

The second group of landslide protective measures includes, from one hand, the regulatory technologies of ground waters which take especially significant and decisive part in generation of the landslide processes (catching of ground water horizon, lowering of levels, arranging of closed drainage), as well as directing of regulated ground waters into water receivers. From the other hand, these are passive measures for strengthening of endangered slopes – supportive walls, removal of landslide masses, or loading of landslide bodies with big amounts of mining masses.

It should be noted that depending on complexity of a landslide area, the technologies of both above mentioned groups of measures can be applied together. For instance, landslide protective measures were conducted on over 200 ha of right side of river Vere in one of the central districts in Tbilisi. As a result of these measures the territory has been recovered sufficiently to be used for urban construction. Though it is noteworthy, that quite big amount of mining ballast was used for loading of landslide slopes. Ground removed during the construction of subway was used for these purposes. One of the most frequent barriers in planning of such large scale measures is – a source of mining ballast.

Preventive measures on pilot areas

Several pilot objects have been selected for conducting preventive measures against elemental geological processes in different municipalities of Ajara region. 2 landslide areas have been selected In Khulo municipality, in particular, in Vashlovani Community – village Shurmuli and village Vashlovani ('Sabauri district'). Both areas are located on the right side slopes of river Ajaristskali gorge. Actually, it is impossible to conduct any cardinal protective measures against landslide in the area of Shurmuli district (19 living houses and up to 100 inhabitants registered within the area of the landslide body), which would fully solve the existing problems. Though for decreasing of potential activation of the landslide processes connected with climate conditions, it would be possible to conduct some quite effective preventive measures. For instance, regulation of surface waters through draining pipes and terraces (berms). These works would cost approximately 51 000 USD.

A landslide body of secondary generation can be determined within the limits of large active landslide area in village Vashlovani, which covers up to 80 ha. 50 families (over 300 inhabitants) live in the threatened area. The landslide basis is the motor road. The first generation landslide in Vashlovani is of tectonic-seismic-gravitational origin. It is almost impossible to conduct cardinal measures there due to high costs. Infrastructure in this area could be protected only in case of existing of state interest. The only technological measure for improving the actual situation and for the protection of population is regulation of surface waters in combination with arrangement of drainage system. Approximate cost of these works is 65 000 USD. At the territory of district 'Lentorgi' of Shuakhevi municipality, right bank of river Ajaristskali is being intensively washed out threatening 5 living houses. The problem can be fully solved by arranging of a 120 m costal gabion which would cost about 80 000 USD. It should be noted that the material for gabion can be obtained within the same riverbed.

Nearly whole territory of village Jalabashvilebi of Keda municipality is under risk of landslide processes (87 families). 21 families are under especially high risk. Especially risky area covers 25 ha. The landslide being in active dynamics takes origin at the bottom of watershed slope, in so called 'Chanchrobi' district. The landslide area is tectonic-seismic-gravitational, which has been activated several times. The basis of this landslide is also the motorway. Full stabilization of the landslide district of village Jalabashvilebi, like in the above mentioned case, is impossible. The only possibility to recover the situation and to slow down the process can be regulation of surface waters, draining of wet areas at the border of the landslide body and directing of waters into the neighboring natural water bodies through drainage pipes. These works would cost approximately 90 000 USD.

Intensive erosion takes place at the left bank of river Chakvistskali in village Chaisubani of Kobuleti municipality. During last 15 years about 7 ha of highly productive and valuable lands of different destination were lost due to erosion processes. Different constructions have been damaged and destroyed. Now the existing school-boarding house and the motorway are threatened. Damage of the motorway will lead to isolation of 995 families. To stop the process it will be necessary to arrange a 300 m cost protective gabion, which would cost about 200 000 USD.

As it was mentioned above, major part of the landslide preventive measures are comparatively affordable from economic and technical point of view. Maximum involvement of the local population in these processes is considered as a very important factor that must be ensured. The most complex and the most expensive among the considered simple measures is the arrangement of closed drainage pipes, which requires considerable amounts of mining ballast and which has considerable impact on the environment. This issue is discussed bellow in the assessment of ways for removal of existing barriers.

Measures to be implemented

Project proposal on the implementation of landslide preventive measures prepared within the framework of this project envisages implementation of the following measures for the pilot areas in Ajara region (village Vashlovani, village Shurmuli, village Lentorgi, village Jalabashvilebi, village Chaisubani).

#	Activity	Time (months)	Cost (thousand USD)
1	Investigation of engineering-geological conditions of the pilot territories and selection of effective measures for each area under particular risks.	12	100 (one landslide area)
2	Intensive consultations with population on possible risks and the ways to avoid them for the awareness raising purposes	Continuously	50 (per year)
3	Opening of local Service Centers (regional and municipal) or using the existing ones (for the time being such centers are established by the governmental initiative for the purposes of servicing the Agricultural Sector). Supplying of such centers with a package of effective measures for risk minimization of the dangerous processes.	1 year	500 (opening of one center), 100 annually
4	Mobilization of village population/communities around the mentioned problem and ensuring of their maximum involvement into the monitoring of the dangerous processes and to the implementation of preventive measures.	Continuously	50 (per year)
5	Landslide area of village Shurmuli. Regulation of surface waters through arrangement of drainage pipes and berms.	Single measure 5 months Needs continuous maintenance	51 (one-time)
6	Large landslide area in active dynamics at the territory of village Vashlovani. Regulation of surface waters in combination with arrangement of drainage system.	Single measure 5 months Needs continuous maintenance	65 (one-time)
7	Washing out of right bank of river Ajaristskali in Shuakhevi municipality (so called 'Lentorgi district'). Full solution of the problem is possible by construction of a 120 m coastal gabion. It is significant that the material needed for the construction of the gabion is available in the riverbed.	Measure 6 months Needs continuous maintenance	80 (one-time)
8	Almost whole territory of village Jalabashvilebi is under risk of landslide processes. For the recovery purposes and for slowing down the process the following measures have been considered – regulation of surface waters, drying up of the wetland area located at the border of landslide, and directing of waters to the neighboring natural water bodies through drainage pipes.	Measure 6 months Needs continuous maintenance	90 (one-time)
9	Left side bank of river Chakvistskali in village Chaisubani of Kobuleti municipality endures intensive erosive washing. To neutralize fully this process it is necessary to construct a 300 m cost protective gabion.	Measure 9 months Needs continuous maintenance	200,000 (one-time)

Barrier analysis

Among the barriers emerged during implementation of this kind of projects the most significant are: awareness rising among population and shifting of management of the processes to the regional level. Main goal of this project is the removal of these barriers, or at least minimization of them.

- Risk assessment and risk management processes are still centralized even in those cases when the state does not take financial responsibilities for risk minimization.

Actually, the mentioned risks often have local character and represent a priority for local authorities and local people. The mentioned barrier should be removed through decentralization of solving processes and mechanisms. The mentioned pilot project is aimed at discussing of ways of decentralization and solving the local priority issues at local level.

- Some of these technologies are quite difficult for implementation and require involvement of highly experienced specialists; lack of relevant specialists who have knowledge in modern technologies is one of the serious barriers.

Since transiting to market economy, many specialties which were considered as very prestigious and valuable during Soviet time, including geology and hydro-geology are not prestigious anymore because there is not relevant demand on them. During the Soviet period the State itself provided demand on geologists. The State was economically strong (the last period is not taken into account) and took financial responsibilities for different geological works. For the time being the State provides finances only for large strategic objects (mainly roads), while the private sector is still quite weak and is involved rather in relatively easy businesses, than in businesses which require continuous geological monitoring. Such monitoring and prevention are necessary for business safety and risk minimization, but private business representatives do not still comprehend it. There is still no demand on such specialties in population as well, because people do not still have appropriate awareness and information on possibility of doing something independently on the ground of consultations with proper experts, as these issues were subject to state management and the local population did not have any experience in taking part in these processes.

To improve this situation there should appear a demand on geologists and hydro-geologists at local, regional, and municipal levels, who would serve the local population. Actually, the decentralization of management process and relevant specialists must be conducted.

- Measures to be implemented are expensive;

Measures to be undertaken to avoid risks of landslides, mudflows and floods are quite expensive, though they are highly needed at the regional, municipal, and village levels. Locations where acute problems reveal must be addressed by permanent mobilization of particular funds using as the state finances, as private (population) resources. These local funds will mobilize, manage and provide target use of the financial resources to cover expenses for preventive measures.

Technical barriers

- One of the hindrances in implementation of preventive measures can be population density; dissatisfaction of population connected to cutting and destroying of agricultural lands and plantations;

An approach proposed by the project should presumably remove this barrier. In particular, when the state plans and implements something (notwithstanding serious consultations with stakeholders) the population quite often expresses resistance and dissatisfaction. If local population recognize the mentioned activities as their own task, than there is a chance to achieve the implementation of concerted and effective measures. Their awareness must be raised to the level when they would understand that by giving up something they would be able to achieve final success.

- Water losses in local springs and wells or lower inflows;

Sufficient knowledge of modern technologies is required for removing of this barrier. Information on the modern technologies is not available within the country. This problem cannot be solved only at national level. In this context it is *very important to establish regional consulting centers (Centers of Exellences) within the global process of 'technology transfer', where national experts would work together with international or more experienced foreign experts on technologies significant for each individual country. This will be especially important for adaptation technologies which are mostly very local and require taking into account a complex of local factors.*

- Worsening of actual state of the environment due to cutting of slopes and soil plant cover, and removal of ground;

Neutralization of this barrier is important taking into account needs of population and the State (in case of big projects). If certain impact on the environment is inevitable, the relevant compensation as well as rehabilitation measures for neutralization of the caused damage should be provided. Principles of sustainability should be maximally taken into consideration while planning the relevant measures (to avoid other damages), implementation of which requires very good knowledge of modern technologies.

- Finding of mining ballast and excessive costs in case of necessity of transportation.

This barrier should be considered and discussed separately for each particular case. The measures should be selected taking into account conditions of each single case.

Annex IV

Technology Needs Assessment (TNA) project

Project Steering Commission

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The First Stakeholder Consultation Meeting for TNA Project

Held on 9 September 2010

Ministry of Environment Protection and Natural Resources (MEPNR)

Tbilisi, Georgia

List of participants: **Grigol Lazriev**, head of climate change unit at the MEPNR); **Maka Tsereteli**, TNA project coordinator; **Marina Shvangiradze**, TNA adaptation team leader, **Anna Sikharulidze**, modeling expert from Tbilisi State University; **Paata Janelidze**, manager of UNDP project for promotion of renewable energy for local use, **Tamuna Pataridze**, USAID project on regional development, **Tamuna Mtvarelidze**, NGO CENN (Caucasus Environmental Network), **Levan Kobakhidze**, NGO “Solar House”; **Archil Zedginidze**, Ltd “Karenergo (windpower”); **Otar Vardigoreli**, Ltd. “Geothermia”; **Neli Verulava**, NGO “Energyefficiency and Environment Protection”; Giorgi Abulashvili, NGO “Energyefficiency Center”; **Temur Gochitashvili**, Gas and Oil International Corporation (GOIC); **Karine Melikidze**, Tbilisi Technical University (energy efficiency in buildings); **Vano Mtvarelashvili**, Association of Oil Products Importers; **Gia Ruso**, Department of coastal zone protection, **Emili Tsereteli**, emergency State Department (MEPNR); **Givi Metreveli**, the Black Sea coastal zone (Tbilisi State University); **Bakur Beritashvili**, Institute of Hydrometeorology; **Tamaz Turmanidze**, expert in agriculture; **Nato Mikadze**, Institute of Plants Protection; **Shalva Ninidze**, Heidelberg Cement Georgia, **Gudja Mikava**, Ltd “Dioskuria” (hazelnut processing); ??, irrigation systems.

Meeting was opened by the representative of the Ministry of Environment Protection and Natural Resources Mr. Grigol Lazriev. He highlighted the significance of the Technology Needs Assessment (TNA) project for the country in building of local capacity and expertise in assessment of needs in climate change adaptation and mitigation technologies and in development of local know-how. Importance of continuation of the first TNA process started in 2000 on the sustainable basis and integration of the findings of Georgia's SNC to the UNFCCC, previous TNA project and other projects implemented in country in the process of carrying out the TNA study was also focused by Mr. Lazriev in his welcoming speech.

Ms. Maka Tsereteli, TNA project coordinator, presented the project objectives and timeline schedule of activities for the project implementation to the stakeholder. The role of stakeholders in the TNA implementation process was also clarified with particular focus on needs to assess the indigenous know-how which need further development, piloting and marketing in case of success. With this regard it was highlighted by the several stakeholders that national bank (data basis) of know-how developed locally should be established. Difficulties in financial assessment of proposals and ensuring their bankability as well as uniformity of requirements from various donors are principle concerns raised by the stakeholders having working experience with financial institutions.

Next presentation has been done by Ms. Marina Shvangiradze, the TNA project consultant who also will be responsible for adaptation section. Preliminary assessment of technologies and sectors where the country's technological needs have been already identified through various climate change related projects was presented by Ms. Shvangiradze. Below are listed potential sectors and technologies which were presented to the stakeholders for further consideration and prioritization. The list is based on the findings from different climate change projects such as: INC, SNC, first TNA,

1. **Adaptation**

   Sectors: The Black Sea coastal zone, Water resources, Agriculture, Forest, Tourism

   Technologies: early warning systems for floods and heat waves, coastal zone and river banc protection measures, landslides, rehabilitation of degraded lands (including pastures), rehabilitation of irrigation systems

2. **Mitigation**

   Sectors: coal mining, gas/oil extraction, electricity generation, heat generation, transmission and distribution, residential/public consumption, city transport, cement industry, steel industry, fertilizer industry, food industry, landfills

   Technologies: wind plant, coal mining methane, capture and utilization of oil accompanying gases, renewables (biomass, biogas, solar, geothermal) in heat supply, pallet/briquette industry, development of biomass; energy efficiency measures in residential and transport sectors

3. **Capacity building**: management, local expert on-job training, software for climate change impact assessment studies, etc
4. Facilitation of **local know-how development** through overcoming the existing impediments: bio-fuel, solar installations, biogas installations, energy efficient wood stoves and bulbs

Issues discussed after presentation are: where (in which sectors) country has the urgent needs, which technologies could be considered as first priority in adaptation and mitigation process and development of local expertise including managerial skills. Common view of stakeholders was that adaptation needs and adaptation technologies are the first priority for Georgia. However, mitigation technologies should be assessed not only from the perspective of GHGs abatement but also as contributors to the increase in energy security and economical development of the country.

Particular attention from the participants has been given to the strengthening of local capacities through training (on-job) of local experts and providing the software tools for assessment of climate change impact on various ecosystems and economical sectors. Establishment of joint (North-South, South-South and triple) programmes for research and development of local know-how was considered as a possibility to ensure the piloting and marketing of new technologies. It was highlighted that technologies which could be used only locally, in particular environment and under specific conditions, have less opportunity to be considered in joint programmes and therefore it will be challenge for non-Annex I Parties to promote the development of such technologies. In this case the role of national and local governments is decisive.

Along with technologies and sectors, c**riteria for prioritization of these sectors and technologies** have been discussed by the stakeholders and ranged by their significance: priority (sector) for national government in country's development; priority for regional government in development of region; priority for local communities from tourism and agriculture development areas; contribution to sustainable development of regions (poverty reduction, unemployment reduction, sustainable utilization of local resources); contribution in climate change risk reduction; contribution to GHGs emission; clear ownership (responsibility) of project; commercialization status of technology; if soft part of technology (expertise for full implementation and training) is provided along with hard technology; guarantee of assistance until the 50% of technology lifetime; replicability. This range of criteria is not final and will be discussed and revised during further meetings.

The role and function of each stakeholder and particularly in the regions where these technologies should be implemented are very important for final success of the project.

Very preliminary discussions show that wind mills, briquette/pallet plants and early warning systems (floods, health, and landslides) are the first priorities in technology transfer project.

It was suggestion from the stakeholders to add forest sector and infrastructure development to the list of sectors under consideration. These two sectors are among the country's priorities.

Last presentation was done by Ms. Anna Sikharulidze, associated professor of the Tbilisi State University. Presentation was on implementation of MARCAL model in Georgia and in particular for planning of energy sector and GHGs mitigation measures. Model has data base of mitigation technologies with possibility to assess the most economically for countries options and measures. Main problem identified for implementation of this software is access to disaggregated country data.

Finally, stakeholders have been asked to submit their proposals on adaptation and mitigation technologies available locally or worldwide which could be implemented in Georgia in order to extend the existing list before the prioritization and before the detailed assessment.

List of Interviewed Experts

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8	Kakhaber Bilashvili	Professor of Tbilisi State University	+(995-599) 511157 (mob)
9	Zurab Savaneli	Engineer, hydrologist, expert in GIS	+(995-599) 909899 (mob)
10	Irakli Papashvili	Ltd “Gamma”, head of sea group	+(995-599) 103482 (mob)
11	Aleksandre Zedginidze	Engineer-Hydrologist, Environmental NGO “Hydrospero”	+(995-599) 272088 (mob)
12	Giorgi Kavlashvili	Ltd “Gamma”, constructor-engineer	+(995-322) 601529 (office)

List of Experts in Agriculture

#	Name/Surname	Field of expertise / position	Contact information
1	Prof. Dr. Tengiz F. Urushadze	President of Georgian Soil Science Society (GSSS); Chairmen of Georgian National Academy of Sciences Commission of Ecological Security	+(995-599) 582541
2	Otari Gordjomeladze	Agriculture, soil scientist. A member of science Academy of Agriculture	+(995-577) 115167
3	Tariel Jiadze	Soil scientist, Agrarian University, Associated prof.	+(995-599) 199933
4	Teo Urushadze	Soil scientist, Agrarian University, prof.	+(995-599) 908565
5	Dudu Dokhnadze	Land hydrology, Institute of melioration.	+(995-599) 203203

6	Revaz Lolashvili	Soil scientist, Institute of Soil Science, Lead Researcher	+(995-599) 446979
7	Temiri Gabisonia	Viticulturist, Institute of Viniculture	+(995-597) 074091
8	Leo Jorbenadze	Soil scientist, Institute of Soil Science, Lead Researcher	+(995-593) 752045
9	Lia Machavariani	Soil scientist, Tbilisi State University, Associated prof.	+(995-599) 234494
10	Ekaterine Sanadze	Soil scientist, Agrarian University, prof.	+(995-599) 141410
11	Besarion Kalandadze	Soil scientist, Tbilisi State University, Associated prof.	+(995-593) 305031
12	Tamaz Turmanidze	Agriculture, A member of science Academy of Agriculture	+(995-591) 170496

List of experts invited for assessment and prioritization of technologies for extreme geological events

#	Name/Surname	Field of expertise / position	Contact information
1	Emili Tsereteli	Engineer Geologist	+(995-599) 544888
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3	Omar Gogrichiani	Hydrologist	+(995-599) 466651
4	Giorgi Kunchulia	Engineer Geologist	+(995-599) 292961
5	Zaur Kvaratskhelia	Engineer Geologist	+(995-591) 404190
6	Merab Chalatashvili	Representative of local Municipality in Kobuleti	+(995-599) 115443
7	Leri Bakhtadze	Representative of local Municipality in Khulo	
8	Durmishkhan Chelidze	Household in Khulo region	+(995-591) 404038
9	Ilia Chkheidze	Household in Khulo region	+(995-591) 404034
10	Irina Jalaghania	Household in Kobuleti region	+(995-599) 540960
11	Marina Giorgobiani	Household in Kobuleti region	+(995-591) 404189
12	Tamaz Gerkeuli	Household in Kobuleti region	+(995-599) 108272
13	Ramin Gobejishvili	Prof. of Tbilisi State University	+(995-595) 171941

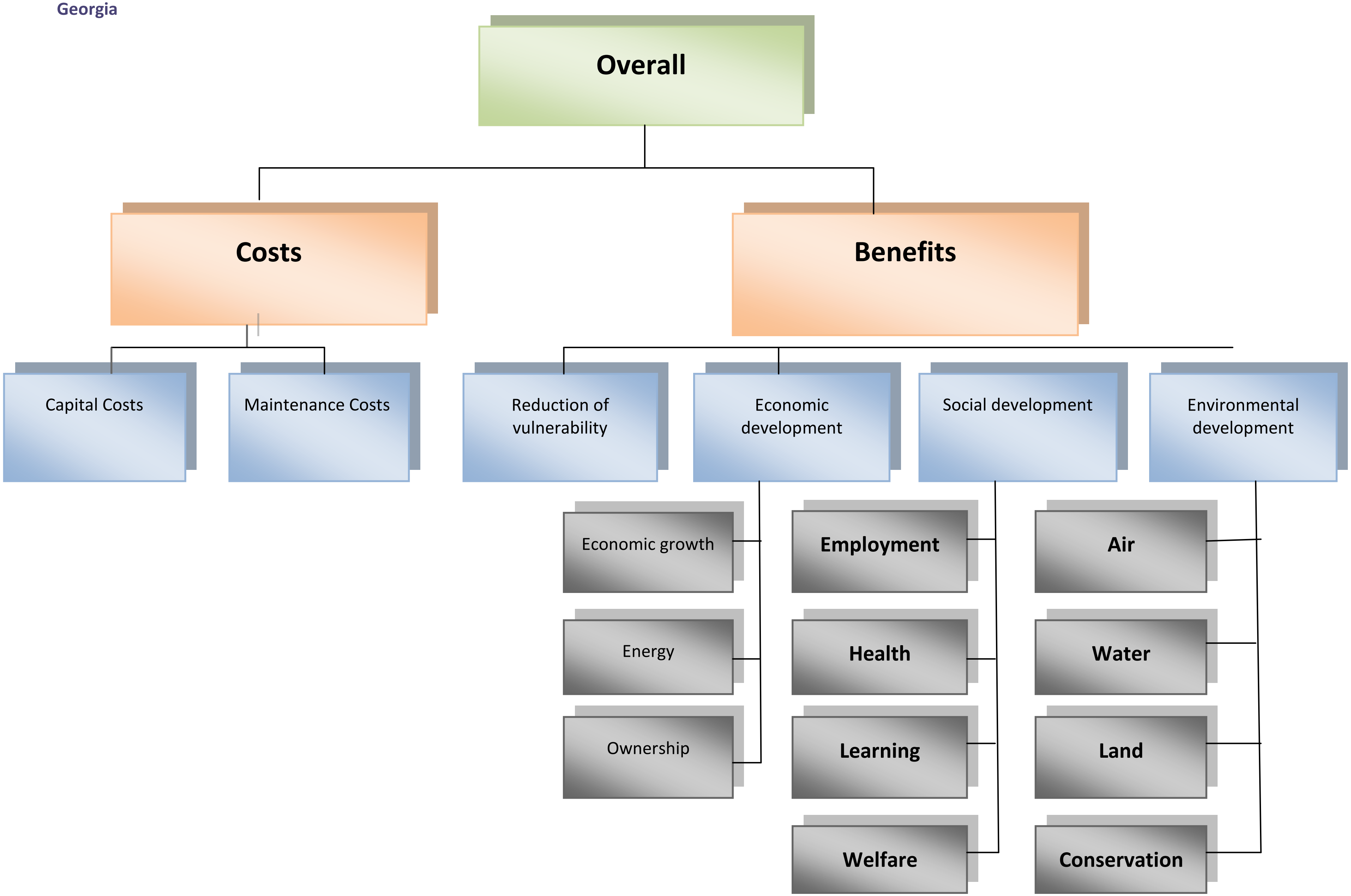
Annex V

Criteria for technology prioritization

In the table below are provided the criteria for prioritization of technologies. Normalization of weights approach is used when applying these criteria. Detailed weights for each criterion are provided in Annex V-1 MDCA. Initial sample weights have been provided by the Riso center together with the guidelines. During the stakeholder consultations the weights have been revised and approved by the PSC.

Definition of criteria

Reduction of Vulnerability (weight 23.3)	
Air	Improving air quality by reducing air pollutants such as SOx, NOx, suspended particulate matter, non-methane volatile organic compounds, dust, fly ash and odour
Land	Avoid soil pollution including avoided waste disposal and improvement of the soil through the production and use of e.g. compost, manure nutrient and other fertilizers
Water	Improved water quality through e.g. wastewater management, water savings, safe and reliable water distribution, purification/ sterilization and cleaning of water
Conservation	Protection and management of resources (such as minerals, plants, animals and biodiversity but excluding waste) and landscapes (such as forests and river basins)
Environmental benefits (weigh 15.1)	
Employment	Creation of new jobs and employment opportunities including income generation
Health	Reduction of health risks such as diseases and accidents or improvement of health conditions through activities such as construction of a hospital, running a health care centre ,preservation of food, reducing health damaging air pollutants and indoor smoke
Learning	Facilitation of education, dissemination of information, research and increased awareness related to e.g. waste management, renewable energy resources and climate change through construction of a school, running of educational programmes, site visits and tours
Welfare	Improvement of local living and working conditions including safety, community or rural upliftment, reduced traffic congestion, poverty alleviation and income redistribution through e.g. increased municipal tax revenues
Social benefits (weight 36)	
Growth	Support for economic development and stability through initiation of e.g. new industrial activities, investments, establishment and maintenance of infrastructure, enhancing productivity, reduction of costs, setting an example for other industries and creation of business opportunities
Energy	Improved access, availability and quality of electricity and heating services such as coverage and reliability
Ownership	Ownership of technology and its final product. Whether a technology becomes private good from public status.
Economic benefits (weight 25.6)	
Total weigh 100	


Overall
Costs
Benefits
Capital Costs
Maintenance Costs
Reduction of vulnerability
Economic development
Social development
Environmental development
Economic growth
Energy
Ownership
Employment
Health
Learning
Welfare
Air
Water
Land
Conservation

Annex V-1

Results of MCDA application

Figure 6.1 Applying MCDA: Detailed steps

1. **Establish the decision context.**
   - 1.1 Establish aims of the MCDA, and identify decision makers and other key players.
   - 1.2 Design the socio-technical system for conducting the MCDA.
   - 1.3 Consider the context of the appraisal.
2. **Identify the options to be appraised.**
3. **Identify objectives and criteria.**
   - 3.1 Identify criteria for assessing the consequences of each option.
   - 3.2 Organise the criteria by clustering them under high-level and lower-level objectives in a hierarchy.
4. **'Scoring'. Assess the expected performance of each option against the criteria. Then assess the value associated with the consequences of each option for each criterion.**
   - 4.1 Describe the consequences of the options.
   - 4.2 Score the options on the criteria.
   - 4.3 Check the consistency of the scores on each criterion.
5. **'Weighting'. Assign weights for each of the criterion to reflect their relative importance to the decision.**
6. **Combine the weights and scores for each option to derive an overall value.**
   - 6.1 Calculate overall weighted scores at each level in the hierarchy.
   - 6.2 Calculate overall weighted scores.
7. **Examine the results.**
8. **Sensitivity analysis.**
   - 8.1 Conduct a sensitivity analysis: do other preferences or weights affect the overall ordering of the options?
   - 8.2 Look at the advantage and disadvantages of selected options, and compare pairs of options.
   - 8.3 Create possible new options that might be better than those originally considered.
   - 8.4 Repeat the above steps until a 'requisite' model is obtained.

Source : Chapter 6, Multi Criteria Handbook

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Sr. No	Technology Options	Carried forward for prioritization	Reason	Criteria	Capital Costs	Maintenance costs	Reduction of vulnerability	Economic Growth	Energy	Ownership	Employment	Health	Learning	Welfare	Air	Land	Water	Conservation	Total
				Normalised weight	11.6	14.0	23.3	14.0	4.7	7.0	4.7	2.3	1.2	2.3	3.5	5.8	2.3	3.5	100
Black Sea coastal zone																			
1	Further mapping of flood risk areas on the Black Sea coastal zone				80.0	90.0	70.0	40.0	0.0	50.0	80.0	0.0	95.0	0.0	0.0	10.0	10.0	10.0	
2	Models for monitoring and forecast climate change impact on a sea coastal zone				40.0	60.0	70.0	40.0	0.0	50.0	90.0	0.0	95.0	0.0	0.0	10.0	10.0	10.0	
3	Development of national and regional infrastructures and policy to improve long term resilience to flood and sea level rise risks				80.0	80.0	80.0	70.0	0.0	60.0	70.0	80.0	80.0	80.0	0.0	80.0	60.0	80.0	
4	Early warning system for Rioni delta				40.0	40.0	95.0	50.0	0.0	95.0	60.0	80.0	40.0	40.0	0.0	80.0	70.0	70.0	
5	Beach nourishment 1 (Rioni Delta) (Pilling of inert material from the Nabada delta in the area of “Didi” Island and the mouth of the Supsa River (soft measure))				30.0	20.0	90.0	50.0	0.0	70.0	60.0	20.0	0.0	20.0	0.0	90.0	0.0	20.0	
6	Beach nourishment 2 (Rioni Delta) (Heaping up of inert material from the bed of the Rioni River in the area of “Didi” Island and the mouth of the Supsa River)				20.0	20.0	90.0	50.0	0.0	70.0	60.0	20.0	0.0	20.0	0.0	90.0	0.0	20.0	
7	Increase of Poti City Canal capacity (soft measures)				80.0	89.0	60.0	40.0	0.0	80.0	20.0	40.0	0.0	70.0	0.0	90.0	50.0	0.0	
8	Construction of sediment-retaining pier at the Poti Canyon and of boons to the south of “Didi” Island (Hard technology)				80.0	80.0	70.0	50.0	0.0	50.0	20.0	20.0	20.0	20.0	0.0	90.0	0.0	20.0	

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9	Construction of piled rock and stone along the coast of “Didi” Island and of boons south of the island				**80.0**	**80.0**	**70.0**	**50.0**	**0.0**	**50.0**	**20.0**	**20.0**	**20.0**	**20.0**	**0.0**	**90.0**	**0.0**	**20.0**	
10	Early warning system for Adlia				**40.0**	**40.0**	**60.0**	**40.0**	**0.0**	**50.0**	**20.0**	**40.0**	**10.0**	**0.0**	**0.0**	**10.0**	**10.0**	**10.0**	
11	Beach nourishment (Adlia) (Refilling of beach-forming material at the Adlia emergency section Piling of 150-200,000 m3 of material at the coastal zone (soft measure))				**50.0**	**50.0**	**90.0**	**50.0**	**0.0**	**70.0**	**20.0**	**20.0**	**0.0**	**30.0**	**0.0**	**90.0**	**20.0**	**0.0**	
12	Construction of sediment retainers in front of Batumi underwater canyon and refilling of beach-forming material at the Adlia emergency section (combined method)				**30.0**	**30.0**	**70.0**	**50.0**	**0.0**	**50.0**	**20.0**	**10.0**	**10.0**	**20.0**	**0.0**	**70.0**	**20.0**	**0.0**	
13	Construction of the boon system in the Batumi-Adlia coastal zone Piling up of 750,000 m3 of inert material over 25 years For the optional creation of recreational beaches amid boons, filling up of 2 million m3 of beach-forming material in the same period				**50.0**	**70.0**	**70.0**	**50.0**	**0.0**	**50.0**	**20.0**	**20.0**	**10.0**	**20.0**	**0.0**	**70.0**	**20.0**	**0.0**	
14	Creation of stone piles at the emergency strip (about 2 km) in Adlia Heaping of 50,000 m3 of beach-forming material annually Creation of stone piles at the emergency strip (about 2 km) in Adlia Heaping of 50,000 m3 of beach-forming material annually				**50.0**	**70.0**	**65.0**	**30.0**	**0.0**	**50.0**	**20.0**	**20.0**	**0.0**	**20.0**	**0.0**	**40.0**	**20.0**	**0.0**	
15	Early warning system Anaklia				**40.0**	**40.0**	**70.0**	**30.0**	**0.0**	**50.0**	**50.0**	**50.0**	**40.0**	**30.0**	**0.0**	**40.0**	**0.0**	**30.0**	
16	Beach nourishment (Anaklia)				**60.0**	**50.0**	**70.0**	**30.0**	**0.0**	**20.0**	**20.0**	**20.0**	**0.0**	**30.0**	**0.0**	**40.0**	**0.0**	**30.0**	
17	Artificial knolls and rehabilitation of existing knolls (Anaklia)				**50.0**	**50.0**	**70.0**	**30.0**	**0.0**	**20.0**	**20.0**	**10.0**	**0.0**	**30.0**	**0.0**	**40.0**	**0.0**	**30.0**	

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18	Creation of artificial cape				40.0	40.0	80.0	10.0	0.0	20.0	20.0	20.0	30.0	30.0	0.0	30.0	30.0	30.0	
19	Creation of artificial underwater reef				80.0	80.0	95.0	90.0	0.0	80.0	70.0	70.0	70.0	50.0	0.0	80.0	0.0	30.0	
20	Floodplain development policy introduced to improve long term resilience to flood/flash flood risks in Rioni river low reaches				80.0	80.0	70.0	70.0	0.0	70.0	10.0	0.0	60.0	50.0	0.0	20.0	20.0	20.0	
21	Early warning system for Rioni river low reaches				40.0	40.0	90.0	70.0	0.0	70.0	20.0	20.0	70.0	60.0	0.0	40.0	40.0	30.0	
22	Community-based adaptation measures, such as bank terracing, vegetative buffers, bundles and tree revetments				60.0	70.0	80.0	70.0	0.0	80.0	20.0	10.0	60.0	80.0	0.0	80.0	70.0	60.0	
23	Flood plain seasonal productive systems (e.g. short season annual cropping, cattle rearing plots or seasonal pastures, agro-forestry)				70.0	80.0	80.0	70.0	0.0	80.0	20.0	10.0	60.0	80.0	0.0	80.0	70.0	60.0	
	Land degradation																		
	Irrigation																		
1	Surface self-flow. Technology in which the flow of water is ensured by the natural inclination of relief.				60	50	90	80	0	50	10	20	10	70	0	70	10	50	
2	Surface self-flow with mechanical uplifting of water.				45	30	90	80	0	50	10	20	10	70	0	70	10	50	
3	Artificial raining				30	30	100	95	0	70	30	20	80	85	0	90	50	90	
4	Drip irrigation				40	30	100	95	0	70	30	20	80	85	0	90	50	90	
5	Optimization of existing irrigation systems considering the climate change impact on water resources and precipitation				70	50	50	90	0	30	0		75	40	0	75	60	90	

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	Water erosion																		
6	Soil water erosion protective technology (pilot proposal)				**70**	**50**	**80**	**80**	**0**	**70**	**0**	**10**	**80**	**60**	**0**	**60**	**10**	**80**	
7	Terrace				**10**	**30**	**95**	**90**	**0**	**70**	**10**	**15**	**10**	**60**	**0**	**90**	**10**	**80**	
	Wind erosion																		
8	Agroforestry-Wind breakers				**40**	**70**	**90**	**70**	**0**	**80**	**10**	**20**	**10**	**90**	**90**	**90**	**70**	**100**	
9	Low till with synchronized soil processing options (Agro-technical measures ….)				**30**	**60**	**80**	**50**	**0**	**70**	**10**	**0**	**40**	**80**	**0**	**70**	**0**	**80**	
10	No till				**40**	**90**	**80**	**50**	**0**	**70**	**10**	**0**	**40**	**80**	**0**	**80**	**0**	**80**	
	Technologies against salination																		
11	Liming of alkaline soils				**60**	**0**	**90**	**70**	**0**	**70**	**30**	**0**	**0**	**70**	**0**	**90**	**30**	**90**	
12	Desalizination by washing salts into deep layers of the soil				**30**	**50**	**60**	**50**	**0**	**50**	**50**	**0**	**50**	**50**	**0**	**60**	**-10**	**60**	
13	Biological melioration				**80**	**90**	**90**	**90**	**0**	**90**	**40**	**0**	**0**	**90**	**0**	**90**	**30**	**90**	
Extreme geological events																			
	Landslides																		
1	Regulation of surface waters and arranging of water channels; preventing of infiltration of waters into the ground				60	60	40	40	5	40	15	20	10		0	60	5	65	
2	Regulation of ground waters (keeping of ground waters or lowering levels)				30	30	60	60	5	60	15	30	10		0	60	0	60	
3	Changing of topography landslide relief for the purpose of improvement of slope stability				40	40	50	50	0	50	10	25	10		0	5	10	15	
4	Phyto-melioration				80	90	70	70	0	70	10	40	10		0	70	25	90	
5	Increasing of slope stability by supporting constructions (counter-banquet, counter-force; anchor; piles)				20	15	80	80	0	80	15	40	5		0	50	50	70	

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6	Artificial improvement of rock features (resistance to shifting and improving stability; cementation of landslide and other kinds of splits, applying of clay, silicate, electro-osmotic draining, electro-chemical reclamation, burning out, covering with concrete spray, gunned material, etc.)				20	15	80	80	0	80	20	40	5		0	5	5	10	
7	Changing of landslide ground – arranging of so called 'terramesh'				10	0	90	90	0	90	20	45	5		0	5	5	10	
	Mangement of landslides and mudflows																		
1	Mapping of climate related landslides and monitoring				60	70	70	70	0	70	5	20	50	70	0	5	5	10	
2	Long-term forecast of landslides				40	0	60	60	0	60	5		70	60	0	5	5	10	
3	Early warning system regime-monitoring on large-scale landslides				30	30	80	80	5	80	20	50	80	80	0	5	5	10	
5	Response-training				50	50	70	70	0	70	0	50	80	80	0	0	0	0	
	Mudflows																		
8	Protruding dyke and cleaning up the riverbeds				50	50	80	80	5	80	40	50	10	80	0	5	10	15	
9	Iron-concrete through construction (Kherkheulidze design);				5	10	70	70	5	70	10	50	40	70	0	5	10	10	
10	cleaning and leveling of riverbeds				80	70	80	80	5	80	40	50	10	80	0	5	10	15	
11	arranging of basins in the riverbed transit-accumulation zone				80	70	50	50	5	50	40	40	40	50	0	5	40	45	
	Riverbanks																		
12	Bioengineering measures – construction of gabions or big stones and fortification of the riverbanks by planting of deep-rooted trees.				30	70	50	70	10	70	20	70	30	70	0	70	70	70	
					50	60	100	60	20	30	20	10	5	10	15	25	10	15	430

Scores for Technologies

#		Costs	Reduction to vulnerability	Development and social benefits	Environmental benefits	Total
1	2	3	4	5	6	7
		25.6	23.3	36.0	15.1	100.0
Black Sea coastal zone						
1	Further mapping of flood risk areas on the Black Sea coastal zone	21.9	16.3	13.9	1.2	53.2
2	Models for monitoring and forecast climate change impact on a sea coastal zone	13.0	16.3	14.4	1.2	44.8
3	Development of national and regional infrastructures and policy to improve long term resilience to flood and sea level rise risks	20.5	18.6	21.9	8.8	69.8
4	Early warning system for Rioni delta	10.2	22.1	19.7	8.7	60.7
5	Beach nourishment 1 (Rioni Delta) (Pilling of inert material from the Nabada delta in the area of “Didi” Island and the mouth of the Supsa River (soft measure))	6.3	20.9	15.6	5.9	48.7
6	Beach nourishment 2 (Rioni Delta) (Heaping up of inert material from the bed of the Rioni River in the area of “Didi” Island and the mouth of the Supsa River)	5.1	20.9	15.6	5.9	47.6
7	Increase of Poti City Canal capacity (soft measures)	21.7	14.0	14.7	6.4	56.7
8	Construction of sediment-retaining pier at the Poti Canyon and of boons to the south of “Didi” Island (Hard technology)	20.5	16.3	12.6	5.9	55.2
9	Construction of piled rock and stone along the coast of “Didi” Island and of boons south of the island	20.5	16.3	12.6	5.9	55.2
10	Early warning system for Adlia	10.2	14.0	11.0	1.2	36.4
11	Beach nourishment (Adlia) (Refilling of beach-forming material at the Adlia emergency section Piling of 150-200,000 m3 of material at the coastal zone (soft measure))	12.8	20.9	14.0	5.7	53.4
12	Construction of sediment retainers in front of Batumi underwater canyon and refilling of beach-forming material at the Adlia emergency section (combined method)	7.7	16.3	12.2	4.5	40.7
13	Construction of the boon system in the Batumi-Adlia coastal zone Piling up of 750,000 m3 of inert material over 25 years For the optional creation of recreational beaches amid boons, filling up of 2 million m3 of beach-forming material in the same period	15.6	16.3	12.4	4.5	48.8

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1	2	3	4	5	6	7
14	Creation of stone piles at the emergency strip (about 2 km) in Adlia Heaping of 50,000 m3 of beach-forming material annually Creation of stone piles at the emergency strip (about 2 km) in Adlia Heaping of 50,000 m3 of beach-forming material annually	15.6	15.1	9.5	2.8	43.0
15	Early warning system Anaklia	10.2	16.3	12.3	3.4	42.2
16	Beach nourishment (Anaklia)	14.0	16.3	7.7	3.4	41.3
17	Artificial knolls and rehabilitation of existing knolls (Anaklia)	12.8	16.3	7.4	3.4	39.9
18	Creation of artificial cape	10.2	18.6	5.2	3.5	37.6
19	Creation of artificial underwater reef	20.5	22.1	25.0	5.7	73.3
20	Floodplain development policy introduced to improve long term resilience to flood/flash flood risks in Rioni river low reaches	20.5	16.3	17.0	2.3	56.0
21	Early warning system for Rioni river low reaches	10.2	20.9	18.3	4.3	53.7
22	Community-based adaptation measures, such as bank terracing, vegetative buffers, bundles and tree revetments	16.7	18.6	19.1	8.4	62.8
23	Flood plain seasonal productive systems (e.g. short season annual cropping, cattle rearing plots or seasonal pastures, agro-forestry)	19.3	18.6	19.1	8.4	65.3
Land degradation						
	Irrigation technologies					-
1	Surface self-flow. Technology in which the flow of water is ensured by the natural inclination of relief.	14.0	20.9	17.3	6.0	58.3
2	Surface self-flow with mechanical uplifting of water.	9.4	20.9	17.3	6.0	53.7
3	Artificial raining	7.7	23.3	22.9	9.5	63.4
4	Drip irrigation	8.8	23.3	22.9	9.5	64.5
5	Optimization of irrigation systems considering the climate change impact on water resources and precipitation	15.1	11.6	16.5	8.9	52.1
	Water erosion of lands					
6	Soil water erosion protective technology (pilot proposal)	15.1	18.6	18.6	6.5	58.8
7	Terrace	5.3	22.1	19.8	8.3	55.5
	Wind erosion					
8	Agroforestry-Wind breakers	14.4	20.9	18.5	13.5	67.3

1	2	3	4	5	6	7
9	Low till with synchronized soil processing options (Agro-technical measures ….)	11.9	18.6	14.7	6.9	52.0
10	No till	17.2	18.6	14.7	7.4	57.9
	Salination					
11	Liming of alkaline soils	7.0	20.9	17.7	9.1	54.7
12	Desalizination by washing salts into deep layers of the soil	10.5	14.0	14.5	5.3	44.3
13	Biological melioration	21.9	20.9	22.8	9.1	74.7
Extreme geological events						
	Landslides					
1	Regulation of surface waters and arranging of water channels; preventing of infiltration of waters into the ground	15.3	9.3	9.9	5.9	40.4
2	Regulation of ground waters (keeping of ground waters or lowering levels)	7.7	14.0	14.3	5.6	41.5
3	Changing of topography landslide relief for the purpose of improvement of slope stability	10.2	11.6	11.6	1.0	34.5
4	Phyto-reclamation	21.9	16.3	16.2	7.8	62.1
5	Increasing of slope stability by supporting constructions (counter-banquet, counter-force; anchor; piles)	4.4	18.6	18.4	6.5	48.0
6	Artificial improvement of rock features (resistance to shifting and improving stability; cementation of landslide and other kinds of splits, applying of clay, silicate, electro-osmotic draining, electro-chemical reclamation, burning out, covering with concrete spray, gunned material, etc.)	4.4	18.6	18.7	0.8	42.4
7	Changing of landslide ground – arranging of so called ‘terramesh’	1.2	20.9	20.9	0.8	43.7
	Management of landslides				-	
1	mapping of climate related landslides	16.7	16.3	17.6	0.8	51.3
2	long-term forecast of landslides	4.7	14.0	15.0	0.8	34.4
3	regime-monitoring on large-scale landslides	7.7	18.6	21.9	0.8	48.9
4	response-training	12.8	16.3	18.6	0.0	47.7
	Mudflows					
1	Protruding dyke and cleaning up the riverbeds	12.8	18.6	22.0	1.0	54.4
2	Iron-concrete through construction (Kherkheulidze design);	2.0	16.3	18.6	0.9	37.7
3	cleaning and leveling of riverbeds	19.1	18.6	22.0	1.0	60.7
4	arranging of basins in the riverbed transit-accumulation zone	19.1	11.6	15.1	2.8	48.6
	Riverbanks					
1	Bioengineering measures – construction of gabions or big stones and fortification of the riverbanks by planting of deep-rooted trees.	13.3	11.6	19.7	8.1	52.7

Annex VI

Additional Technical Information Regarding the Technologies Offered

Annex (VI-i)

The Black Sea coastal zone

An investigation carried out in the framework of Georgia's Second National Communication (SNC) has clearly demonstrated a threat to the whole Black Sea coastal zone of Georgia caused by the sea-level rise. The rate of this process, related with the global warming, has accelerated here for the last two decades form 2,6 to 3,1 mm/yr, jeopardizing many elements of infrastructure in the cities of Batumi, Poti and Sokhumi, and seizing hectares of beaches along the shore line. In Poti and Batumi the problem is complicated by the distorted interaction between the sea and rivers of Rioni and Chorokhi, respectively, caused by the construction of port facilities and cascades of HPPs.

As the Anaklia sea-coast is situated at the mouth of River Enguri, in some 25 kilometers north to the city of Poti, it is facing the same problems as city Poti. Hence, in view of the large-scale projects to create a complex infrastructure here, it is of urgent necessity to work out corresponding adaptation measures for minimizing the anticipated risks related with the current and expected to 2100 sea-level rise.

The Anaklia seaboard contains the Kodori and the Poti littoral sectors of the Black Sea coastal zone. Its main feature is the presence of parallel to the shore row of sandy knolls with maximum height of 1,5 – 2,5m and the width in the range of 100 to 250m.

There are 3 major factors (ref), determining the formation of shore line under the conditions of sea-level rise:

1. Morphological features of seaboard, in particular the inclination of its submarine and above-water parts;
2. Stockpiles of the beach-forming material and the condition of its transport into the shore line;
3. Rate of sea-level variation.

The survey of a huge of empirical data (Ref. Kaplin and Selivanov, 1995) has indicated that there could be several types of accumulative sandy beach development for different inclination with the sea-level rise (Fig.1).

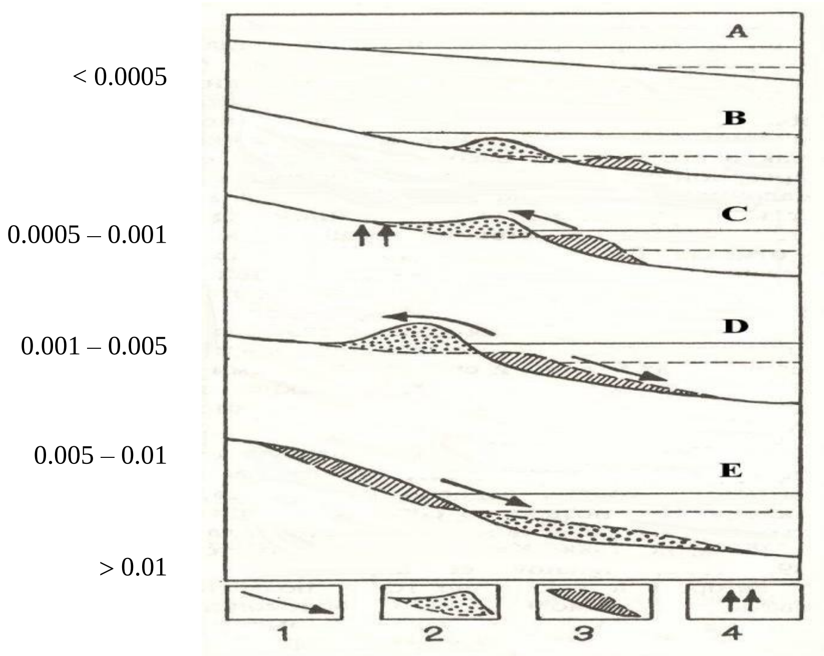


Fig. 1 Types of accumulative sandy beaches development for different inclination (tgd) of submarine coastal slope in case of sea-level rise. 1 – Direction of transportation; 2 – Accumulation area; 3 – Washing off areas; 4 – Inundation.

The comparison of these schemes with the actual data, available for the Anaklia shore line indicates that the conditions here most of all fit the (D) case featured by the inclination tgd = 0.005-3.0 and the rate of sea-level rise equal to 1.5-3.0 mm/yr.

No less important role in the formation of coastline belongs to the budget of solid sediment. Four main types of accumulative beach formation have been revealed depending on different rates of sea-level rise for abundant and deficient inflow of sediment in case of moderate inclination of the sea (Fig.2).

V

mm/yr

< 1

1 - 3

3 - 5

> 5 - 7

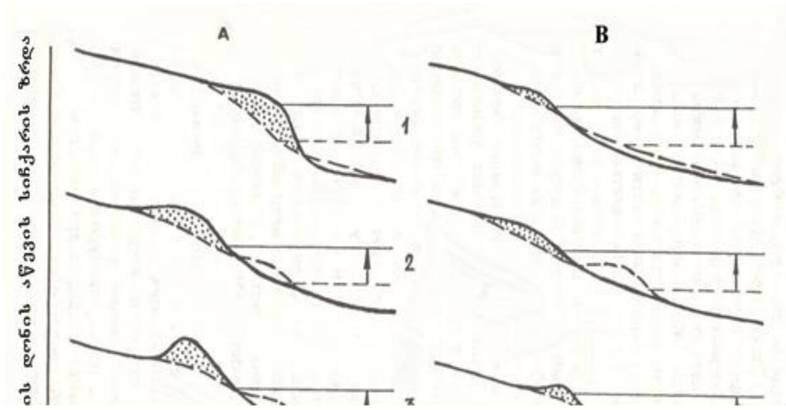


Fig. 2. Main ways of accumulative sandy beach formation for different rates of sea-level rise (V) in cases of abundant (A) and deficient (B) inflow of sediment (tgd = 0.0005-0.005).

1 – Sea level rise; 2 – Washing off; 3 – Accumulation.

The analysis of observation data on the deformation of 38 km long coastline between rivers of Eristskali and Khobi carried out since 1872, has shown that due to the excessive influx of solid sediment from the River Enguri, in the period of 1972-1933 the beach area has increased by about 100ha, while later it began to decrease with the annual rate of 3-11 ha/yr, making 4,4 ha/yr on the average. This drastic change of the sea-coast deformation pattern is caused by the construction of HPP and other structures at the R. Enguri, as a result of which the deficit of beach-forming material on the Anaklia shore at present equals to 70 thousand m^3/yr, stipulating the washing-off of the coastline here at the rate of 2-8 m/yr. By comparing this facts with the schemes given on the Fig. 2 it could be derived that at present the formation of Anaklia beach can be described by cases B2 and B3, which imply the degradation of littoral area and transport of the beach sandy material to submarine slopes and canyons.

The obtained results point out on the necessity to investigate the described above processes in more detail using relevant computer models. However, it is clear that in view of obvious degradation of the Anaklia coastline, resulting in the loss of an area of 25ha for the last 25 years, the preparation of coast protection measures here has already a vital importance for the sustainable development of Georgia's economy.

Annex (VI-ii)

Water deficit in agriculture

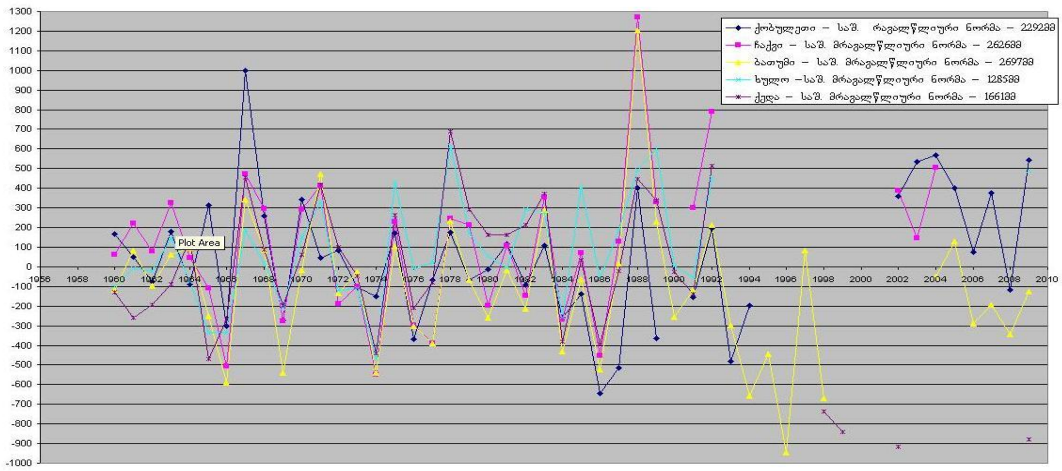
Dedoplistskaro region

Crop	Water deficit, mm						
	1960-1975	1976-1990	1990-2005	2021-2035	2036-2050	2071-2085	2086-2100
Winter wheat	163	147	133	185	181	215	236
Sunflower	229	243	249	230	239	247	293
Pastures	296	292	288	320	326	335	364

Crop water model (FAO) has been used past and future water deficit in Dedoplistskaro region for some crops and pastures. Results are provided in the table.

Annex (VI -iii)

Time series illustrating precipitation anomalies at different meteorological stations in Georgia and related number of landslides are presented on the figures below.



Year

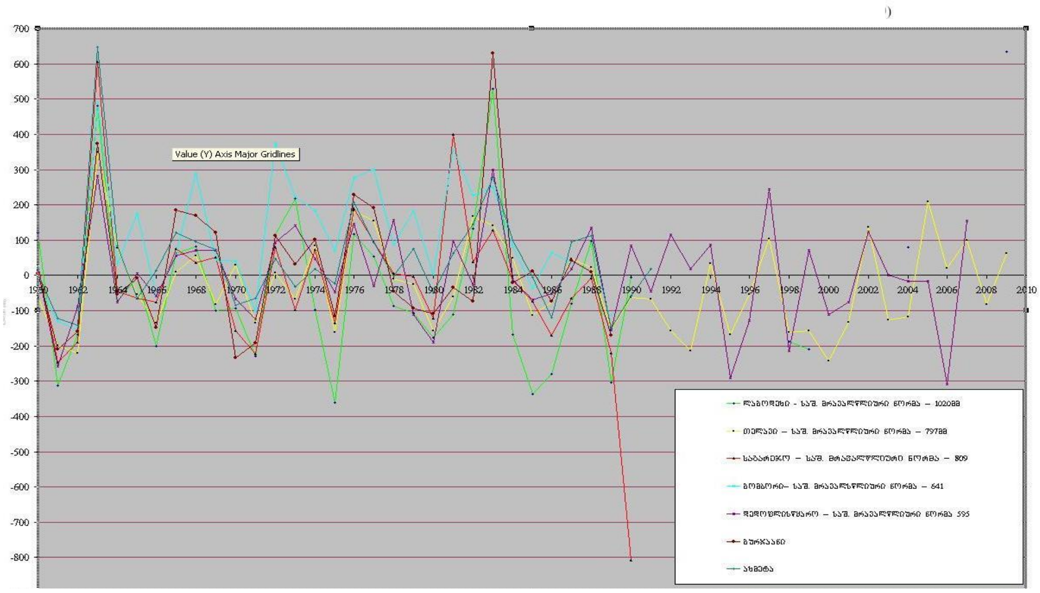


Figure 4. Precipitation anomalies at meteorological stations of Adjara Region (a) and corresponding landslide dynamics in the area.

The comparison between the graphs (a) and (b) indicates the definite relation between the anomalies in precipitation and the number of observed landslides in one of the most rainy and landslide – active regions of Georgia. Relevant analysis has shown that the time period between consecutive extremes of precipitation here varies in the range of 3-8 years. At the same time it has been revealed that the activation of landslides does not simply correlate with the sequence of precipitation maxima and the relation between fall of precipitation wetting of slopes and activation or generation of landslides is a very complicated process, which largely differs from region to region.

TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY ACTION PLANS FOR CLIMATE CHANGE ADAPTATION