Community based climate change adaptation and disaster risk reduction action plan for the Sagvichio community of Khobi Municipality, Lower Rioni Watershed, Republic of Georgia

Integrated Natural Resources Management in the Republic of Georgia Program

Technical Summary Report

Community based climate change adaptation and disaster risk reduction action plan for the Sagvichio community of Khobi Municipality, Lower Rioni Watershed,

Republic of Georgia

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Global Water for Sustainability Program

Florida International University

Biscayne Bay Campus 3000 NE 151 St. ACI-267

North Miami, FL 33181 USA

Email: glows@fiu.edu

Website: www.globalwaters.net

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Contents

Preface

The present report has been developed within the framework of the program Integrated Natural Resources Management in Watersheds (INRMW) of Georgia, being implemented by the following partners:

- Florida International University (FIU)
- UNESCO-IHE Institute for Water Education
- CARE International
- Winrock International
- Caucasus Environmental NGO Network (CENN)

The geography of the program covers the following watersheds of Georgia: the Rioni River basin in West Georgia, and the Iori River and Alazani River basins in East Georgia. The following pilot watershed areas were selected for the implementation of the pilot program:

- Upper Rioni pilot watershed area – Municipalities of Oni and Ambrolauri
- Lower Rioni pilot watershed area – Municipalities of Khobi and Senaki
- Upper Alazani pilot watershed area – Municipalities of Akhmeta and Telavi
- Lower Alazani Iori pilot watershed area – Municipality of Dedoplistskaro

The program considers the development of a community based climate change adaptation and disaster risk reduction plan for one community in each targeted municipality.

The present report contains the community based climate change adaptation and disaster risk reduction plan developed for the Sagvichio community of Khobi municipality (Lower Rioni pilot watershed area).

1. Methodology

Process

The process of developing the community based climate change adaptation and disaster risk reduction plan consisted of the following main stages:

- selection of a pilot community;
- community mobilization and working meetings with community members with the purpose of identification of urgent issues;
- experts' field visits to targeted communities;
    - working meetings with local communities;
    - field examination of hazards identified during working meetings with community members;
    - finalization of recommendations with community members;
- final report.

A brief overview of the methodology used at the key stages of the plan's development is given below.

Selection of pilot communities

The INRMW program considered selection of one community in each targeted municipality where participatory community based climate change adaptation and disaster risk reduction plans would be developed (7 communities in total).

A web-based decision support tool[1] developed by the Helsinki University of Technology was used to select targeted communities. This tool is often used for environmental research (e.g., EIAs, ESIAs).

The selection process comprised of the several stages:

- identification of selection criteria;
- data collection;
- integration of data into the web system;
- data processing (weighting, standardization, "criteria tree");
- web analysis of results;
- validation of the results of the web-based decision;
- finalization of the results with implementing partners.

[1] http://www.hipre.hut.fi/

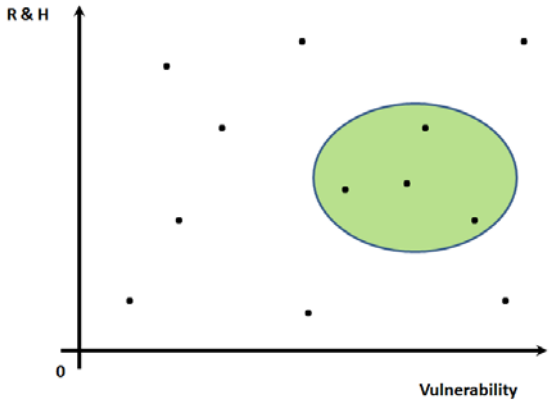
One of the most important stages of the selection process was the identification of selection criteria. These criteria included:

INRMW program pilot community – pilot communities should be selected from pilot communities of the INRMW program. Therefore communities with a small number of members were excluded from the very beginning**.** This approach ensured the availability of a Community Based Organization (CBO) in each selected community (the INRMW program has established CBOs in pilot communities) which would be responsible for the development of adaptation plans.

vulnerability of the community – vulnerability of communities to climate change and natural disasters was one of the main selection criteria. The highest value of vulnerability was used as a selection criterion. The vulnerability of the targeted municipalities of INRMW program was assessed at the previous stages of the program[2].

hazard and risk index of the community – hazard and risk indices of the communities were taken into account during the selection process (hazards and risks of the targeted municipalities of INRMW program were assessed at the previous stages of the program)[3]. An average value of hazard and risk was used as a selection criterion. The diversity of natural hazards identified in the community was given special attention.

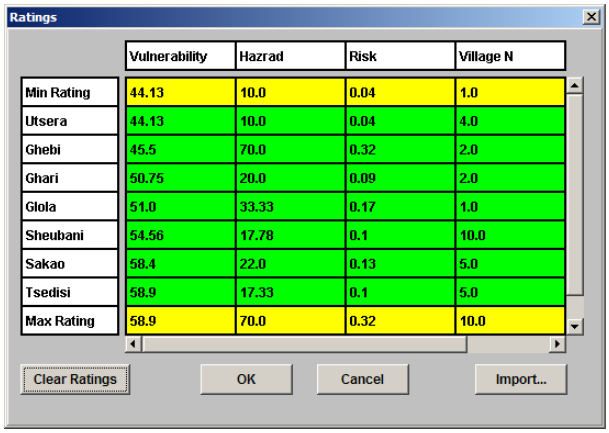
The diagram below illustrates the selection criteria. The diagram shows that communities with high vulnerability and medium hazard and risk values were given preference in the selection process (see Diagram below).

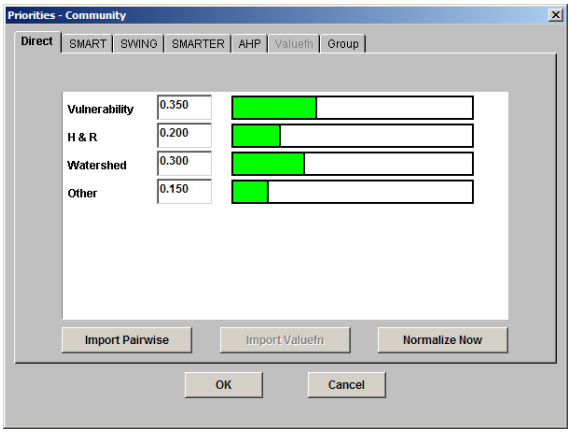


Along with the abovementioned, other criteria were also used for the selection of pilot communities: location of a community within a single watershed, potential impact on other communities, area of the community, number of villages in the community, size of population, area of forested land, etc.

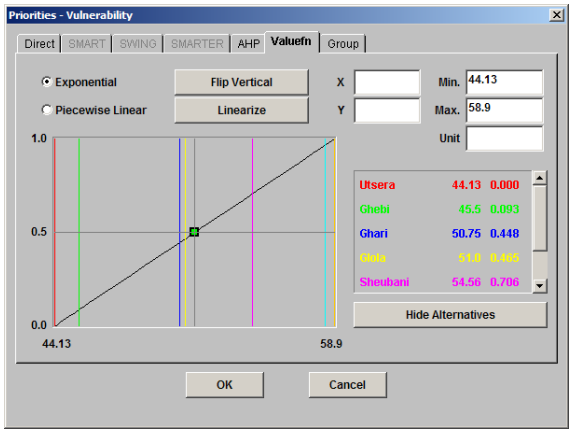
After identification of criteria the data corresponding to these criteria were integrated into the special web-based database. Each criterion was assigned a weight for formulation of a final decision.

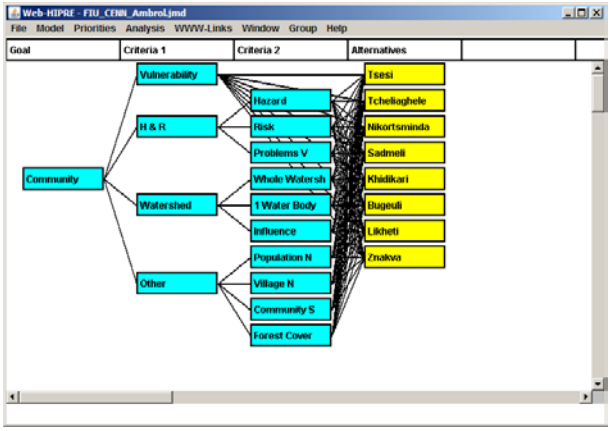
[2] see reports – Assessment of the vulnerability to natural disasters and climate change of INRMW program targeted municipalities. Adaptation and mitigation plan.
[3] Assessment of the vulnerability to natural disasters and climate change of INRMW program targeted municipalities. Adaptation and mitigation plan



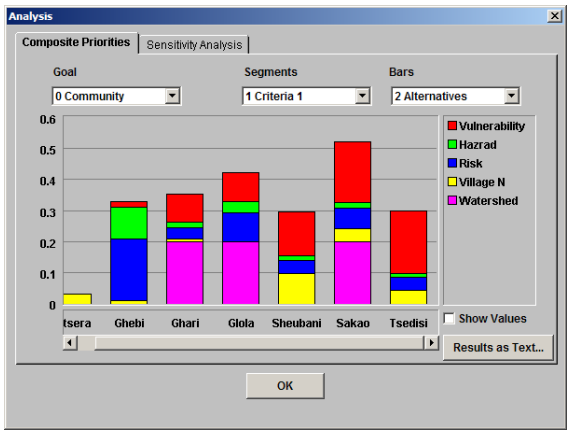


Following weighting the data was standardized and a so-called criteria tree was developed.





The system allows for multi-criteria analysis of the results, based on which potential targeted communities were identified.[4]



At the final stage of the selection process the data was communicated to the INRMW program implementing partners. On the basis of consultations the following communities were selected:

[4] for details refer to: http://www.hipre.hut.fi/ FIU_CENN_Khobi.jmd

INRMW program targeted municipalities	Selected community
Oni	Sakao
Ambrolauri	Likheti
Senaki	Zemo Tchaladidi
Khobi	Sagvichio
Akhmeta	Jokolo
Telavi	Ikalto
Dedoplistskaro	Samtatskaro

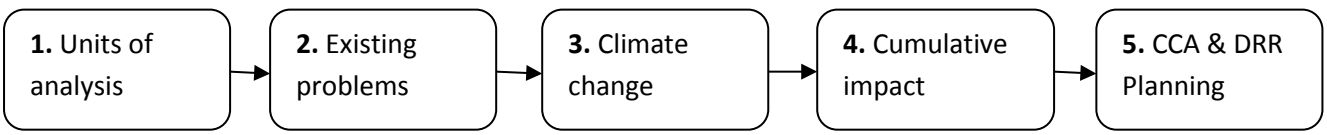
Development of community based natural hazards risk reduction and climate change adaptation plans

Participatory approaches implying the involvement of local community members at all stages of the plan development were used.

Experts were also involved in the process. They visited the local communities to study the situation on the ground and took part in the development of relevant recommended actions. It should be mentioned that the main purpose of the process was to discuss issues of natural disaster risk reduction in the context of climate change. Therefore the main goal was to study those geomorphological processes (erosion, mudflow, landslide, floods and flashfloods) occurring in the community, which are the main causes of natural disasters. Thus the experts of relevant fields were involved in this process.

Since the economies of the targeted communities are based mainly on agriculture, the agriculture expert was involved in the process of developing climate change adaptation and natural disaster risk reduction plans. Therefore, analysis of the agricultural sector and relevant recommendations constitute an important part of the final plans.

The process of the development of plans was divided into several logically linked stages that eventually formed the structure of the final versions of the plans. The diagram shows the general framework of the planning methodology. A brief description of each stage and the activities implemented at these stages is given below.



Stage 1: Identification of units of analysis

The aim of the first stage is to identify key aspects of the community (natural components, infrastructure, activities), to be analyzed at the next stages in the context of climate change and natural disasters.

Stage 2: Identification of existing problems

The aim of the second stage is to better understand the natural disaster related problems faced by the community. At this stage existing (not future) potential problems should be identified. The identified difficulties and problems should be linked to those units of analysis that have been identified at the first stage of planning.

The first two stages are the most important components of the planning process since the outcomes of these stages determine a content and character of the next stages of planning. The involvement of the local community is especially important at these stages. Therefore, the first two stages of the development of the present plan were implemented based on the working meetings with local community members.

Stage 3: Future climate change and its consequences

The aim of the third stage is to determine the patterns of climate change and its direct potential impact on units of analysis and the community in general. Climate change scenarios have been developed within the INRMW program during the process of assessing the vulnerability of targeted areas to natural disasters and climate change. Therefore the results of this assessment have been used in this case.

Stage 4: Combined impacts

The aim of this stage is to determine the interrelation between direct impacts of climate change and current problems and challenges. Therefore the aim of this stage is to develop a matrix of combined impacts.

To evaluate the level of impact on a specific unit of analysis the following matrix was used:

Scales of impact	**High**			
	Medium			
	Low			
		Low	**Medium**	**High**
		Duration of impact		

where the vertical axis shows scales of impacts of climate change and natural disasters. In this regard the following three levels are identified:

- low – impact occurs locally;
- medium – impact occurs in a considerable part of the community (about half of the community);

- high - impact occurs in the major part of the community.

The horizontal axis indicates scales and duration of impact caused by climate change and natural disasters. In this regard the three levels are distinguished:

- low – short-term impact (impact occurs during a relatively short period of time and quickly diminishes. Consequences of the impact are evidenced seasonally, during one or two days a season);
- medium – medium-term impact (consequences of the impact occur during a certain period of time, however they diminish with time. Consequences of the impact are evidenced seasonally, during up to one month a season);
- high – long-term / permanent impact (consequences of the impact occur over long periods of time or they never diminish).

Stage 5: Identification and planning of risk reduction activities

The aim of the final fifth stage is the development of an action plan that will ensure avoidance or mitigation of negative consequences of impacts identified at the previous stages. At this stage the involvement of experts is important. Therefore, the planning process at this stage has been implemented in close cooperation with the experts of relevant fields.

2. General characteristics of the community

Location and natural environment

The Sagvichio community is located in the southern part of the Khobi municipality, along the Rioni River. The community occupies both sides of the river, however, the main part of the community and settled areas are located on the right bank of the river. The total area of the community is 1,921 ha. The Sagvichio community consists of only one village, Sagvichio. The distance from the village to the municipal center (the city of Khobi) is 25 km.

The territory of the Sagvichio community belongs to the Kolkheti lowland. The community occupies the riverside plain located at about 5 m above sea level.

The Rioni River is the main watercourse of the community. The community is covered by a network of drainage canals that ensure removal of excessive surface runoff from agricultural lands and household plots of the local population. It should be noted that the community is crossed by the main water collection canal starting at the conjunction of the rivers Rioni and Tsivi and flowing into the Khobistskali River. The canal collects runoff not only from the Sagvichio drainage system but also drainage systems of the villages located downstream of the Rioni River.

The Khobi municipality, including the Sagvichio community, is located within the humid subtropical climate zone of the Kolkheti lowland and is characterized by relatively warm winters, hot humid summers and a long warm fall. In winter eastern winds prevail. Both onshore and offshore winds blow all year round. Maximum precipitation is recorded in summer-fall (mean annual precipitation varies between 1,700-1,730 mm). Average air temperature is 13.7-14.4^{0}C. Average air temperature in January – the coldest month – is 5.0-6.7^{0}C, while the average air temperature in August – the hottest month – is 22.6-23.8^{0}C.

The current character of the biodiversity in the Sagvichio community and the Khobi municipality in general is determined mainly by the presence of large wetlands in the north-western and southern parts of the municipality and in the coastal zone of the Black Sea. Beautiful fragments of wildlife rich in relict and endemic species of Colchic flora are found in the wetlands and adjacent Colchic forests. Most notable is the Colchic pheasant, the only habitat of which is the Colchic forests. Natural vegetation of the municipality has been substituted by crop plants; Colchic vegetation is found only at specific locations. Colchic forests comprised of oak, maple, hornbeam, chestnut and wingnut grow on the drained lowlands where the Sagvichio community is located. At certain location a relict species – zelkova – is found. English ivy, greenbrier, wild grape and silk vine are widespread. The underwood is formed by cherry laurel, Pontic rhododendron, boxwood, Colchic ilex and butcher's broom. Windbreaks are formed by plane, poplar, cypress, cedar and fruit trees at certain locations. Agricultural lands are occupied by subtropical species – tea, citruses and essential oil plants. Cereal crops (mainly corn) as well as perennials – hazelnut, laurel and tea – occupy large areas.

Representatives of Colchic fauna: wolf, jackal and fox are widespread in natural forests. Deer are found in the floodplains. Other mammals include: otter, polecat, and coypu; reptiles: pond turtle, sand lizard, Derjugin's lizard, grass snake, dice snake, Caucasus viper and smooth snake. Subendemic species of amphibians, including newt, different toads, tree frog and pond frog, are found in water

bodies of the Kolkheti Protected Areas. The ancient relict fish species - European sturgeon – that lives in the Black Sea and uses the Rioni River for spawning is noteworthy.

The Kolkheti National provides shelter to numerous migratory and other bird species. This is the main resting place for birds migrating from Europe and Russia. The Paliastomi Lake and its wetlands host magpies, whoopers, etc. in spring. According to an ornithological study up to ten thousand different ducks can be observed in every day of February. There are also many different cranes, such as grey heron, white heron, etc. Perching birds: Eurasian blackbird, tit, starling, raven, crow and swallow are notable for their diversity and quantity. The Kolkheti lowland is the birth place and the first habitat of the common pheasant. There are also many birds of prey, including black kite, falcon, red kite, royal eagle, etc.

Population

The population of the Sagvichio community is 638 (as of 2011).

The share of able-bodied people in the population of the community is large (73%). The shares of youth and pensioners are 14% and 13% respectively. The sex ratio of the local population is rather strange: the share of men is about 55% and differs from the absolute majority of Georgian settlements and the country in general where the number of women usually slightly exceeds the number of men. The reason for this situation was not identified during the working meetings.

An absolute majority of the local population is self-employed. The main source of their incomes are revenues from small private farms. The share of people with salaried jobs (school, kindergarten, administration, etc.) is about 8% of the able-bodied population. This is a very low index. 13 families are below the poverty line. Such a low index of employment plus low agricultural incomes determines the hard economic conditions and high level of migration from the community. Labor migration is primarily observed in the community. The able-bodied population leaves the community and moves to the large cities of Georgia (Poti, Senaki, mainly Tbilisi) in search of temporary jobs. The number of labor migrants is 108, about 24% of the able-bodied population of the community. This means that every fourth member of the community is a migrant. The migrants maintain contacts with the villages. According to the locals, money sent by migrants is one of the main source of income for the local population.

3. Units of analysis of the Sagvichio Community

The first stage in the methodology of planning the community based climate change adaptation and disaster risk reduction activities considered the identification of those units of analysis that are most vulnerable to hazardous natural processes and would be more severely affected in the future under the forecasted climate change scenarios. At the same time, these units have an important role in the life of the community and determine the level of adaptation of the community to the expected impacts of climate change.

In the process of identifying units of analysis for the Sagvichio community, important issues associated with the risks of natural disasters and expected impacts of climate change were identified. The following sources of information were used to identify the units of analysis:

- DRR and Climate Change Reports for targeted watersheds including lower Rioni watershed area developed within the framework of the INRMW program. The Sagvichio community is discussed in the context of the Khobi municipality.
- Meetings with the local population – the aim of these meetings was to study the views of the local community on problems, existing situation, expected impacts of natural disasters and climate change in the life of the community, as well as their perception of methods of future development for the community.
- The expert team working on community based adaptation plans was an important source of information. The team was involved in community meetings, as well as in collection of baseline information and identification and planning of relevant adaptation activities at the final stage of the process.

Based on these information sources and consultations with the local population and expert team the following environmental components have been determined as units of analysis for the Sagvichio community:

- Agriculture and agricultural lands – as the main source of income and food security of the community.
- Surface water bodies (the river, the main water collecting canal) of the community as a source of natural hazards occurring in the community.
- Drainage canals – the development of agriculture in the community entirely depends on proper operation of drainage canals. The majority of agricultural lands of the community are former wetlands reclaimed through drainage systems in the middle of the 20th century.
- River bank protection embankments – the safety of the community entirely depends on proper operation of the river bank protection embankments.
- Infrastructural facilities located on the territory of the community – including road infrastructure – motor roads, bridges, drainage canals, as well as drinking water supply infrastructure, residential houses, electricity transmission lines, etc.

Below is given a short description of each components and a brief characteristics of their role and importance in the life of the community.

3.1 Agriculture and agricultural lands

Crop growing

The total area of agricultural lands in the Sagvichio community is 1,136 ha, of which 885 ha are arable lands, 100 ha are under perennials and 150 ha are pastures. Each household has 1.25 ha of arable lands as a result of land privatization process.

Corn is the main agricultural crop in the community. Its productivity is rather low, averaging 2-2.5 tons per ha. Beans and soybeans, as well as vegetables – cucumber, tomato, onion, garlic and pepper – are being cultivated. Hazelnut plantations occupying around 72 ha are noteworthy from perennials. According to the locals its productivity is 1 ton per ha. Citruses (especially feijoa), walnut, vine, fruit trees (apple, peach, pear, cherry plum, berries, persimmon) are also cultivated. The productivity of all crops is very low due to improper and outdated agricultural practices (negligence of agrotechnical terms, improper soil fertility management, etc.).

Animal breeding

Animal breeding is the main agricultural activity in the community. 1,400 heads of cattle are currently recorded. The average yield per dairy cow is around 5 l a day, which is a very low index.

The population of the Sagvichio community is also engaged in buffalo breeding – a traditional agricultural activity in the Samegrelo region. Currently about 200 heads of buffalo are recorded in the community. There are also small amounts of horses used for economic and transportation activities.

The majority of households are engaged in poultry breeding. The locals mainly have chickens (about 3,000), ducks, geese (around 400) and turkeys (200).

Pig breeding is also a traditional activity in the Samgerelo region, however, the number of pigs has sharply decreased (50 pigs) in the community due to their high morbidity rate and this traditional activity no longer exists in this area. This problem is caused mainly by the spread of African Pig Plague in Georgia over recent years, and has resulted in a decline in this activity and the majority of local households abandoning pig breeding.

A few households are engaged in beekeeping. There are around 60 beehives in the community.

Despite the described diversity of agricultural activities, dairy products and grain crops (corn) are the main marketable products. Revenues received from the sale of cheese constitute the largest portion of local incomes.

3.2 Rivers flowing on the territory of the community

The Rioni River and its general hydrological characteristics

The Rioni River takes its rise on the southern slopes of the Greater Caucasus at the foots of the mount Pasi at an elevation of 2,620 m and flows into the Black Sea at the city of Poti.

The length of the river is 327 km, the total drop is 2,620 m, average gradient – 7.2 ‰. The area of the watershed is 13,400 km^2. The mean elevation of the watershed is 1,084 m.

The river gorge from its source up to the city of Oni is V-shaped, afterwards it becomes box-shaped. The slopes of the river gorge are dissected by gorges of tributaries, the majority of which are characterized by the occurrence of mudflows. The width at the bottom of the riverbed varies between 0.1-1.5 km. The river terraces are two-sided and their height varies between 2-6 m, width – 250-600 m, length – 0.3-5 km. The floodplain is built of alluvial materials. Its width is 50-400 m, and its height is 1-15 m. During floods and flash floods the depth of water covering the floodplain reaches 0.3-0.8 m.

The riverbed is branching within the curved and angled gorge. The width of the flow varies between 6-60 m, depth – 0.5-3.0 m, velocity – 0.7-1.5 m/sec to 2-4.2 m/sec. The bottom of the riverbed is covered with pebbles and stones, at certain location the riverbed is rocky. The banks of the river are high. Their height reaches 2-8 m at the locations where river banks merge with the terraces.

The river is fed by glacier, snow, rain and ground waters, however snowmelt and rain waters play the most important role. The hydrological regime of the river is characterized by spring floods and flash floods all year round. Monthly distribution of discharge is not even. Maximum discharge is recorded in May, minimum – in January.

High levels of floods and flash waters seriously threaten agricultural lands and infrastructure existing on the river.

3.3 Infrastructure

Water supply infrastructure

The majority of the community is supplied with drinking water from drinking water intake facility located in the neighboring village Nosiri, through a 300 mm main water pipeline laid to the city of Poti (this is the main source of drinking water supply for Poti). This pipeline serves some other neighboring villages, including the village Sagvichio. The population receives water 24 hours a day. During working meetings the local population noted that the quality of water and the water infrastructure were satisfactory. Individual water meters are installed. A small portion of the population use artesian wells as an additional source of water.

Drainage canals

When discussing the infrastructure of the Sagvichio community the network of drainage canals existing on the territory of the community should by separately noted. In general, the Kolkheti lowland (where the Sagvichio community is located) is characterized by an almost horizontal plain relief slightly inclined to the sea. Therefore rivers flow very slowly, meander and easily overtop their banks. Abundant precipitation cannot drain into the sea due to the low elevation of the terrain (0-4 m above) which leads to bogging. As a result the natural landscape of the Kolkheti lowland was formed by vast, often impassable, wetlands.

The mentioned landscape has been sharply changed since the 1930s. The old natural landscape was completely modified and transformed into the new cultural-agricultural landscape. The process of modifying bogged areas through draining was intensified in the middle of the 20th century, when the almost the whole Kolkheti lowland was covered by a complex network of drainage canals that ensured the drainage of excessive precipitation to the Black Sea. As a result of these large-scale activities the total area of reclaimed areas reached more than 110,000 ha (making up half of the area of wetlands of the Kolkheti lowland). New settlements with relevant infrastructural facilities and agricultural lands were established.

After the collapse of the Soviet Union, in conditions of economic crisis the maintenance works of the drainage system were not implemented timely or properly. Moreover, the transfer of internal networks into the ownership of land users (as a result of land privatization) further complicated the use of reclaimed areas. Low-income small farms could not ensure proper maintenance of the internal drainage canals.

As a result of the mentioned process the whole drainage system and its separate components, including main canals and internal canals have been heavily damaged. Their majority are filled with sediments. Pump stations and closed drainage systems are no longer operational. All this leads to the secondary bogging that is observed on the whole Kolkheti lowland, including the target communities.

The total length of such drainage canals in the Sagvichio community is around 10 km. An important component of this system is the main water collecting canal that crosses the territory of the community. The canal starts at the conjunction of the rivers Rioni and Tsivi and flows into the Khobistskali River. The main water collecting canal receives water from the drainage system of the community. In general, the mentioned canal is a key element of the drainage systems in the villages located downstream of the Rioni River. The canal receives waters not only from the drainage system of the Sagvichio community but also waters from drainage systems in the villages downstream of the Rioni River. According to the local population, 90% of the internal drainage system is damaged, filled and inoperative. The main water collecting canal is damaged and its carrying capacity has been decreased. As a result, the process of secondary bogging has developed, leading to a reduction in the area of available agricultural lands and the acceleration of soil erosion. This negatively affects qualitative and quantitative characteristics of yields and results in reductions to already scarce agricultural incomes.

River bank protection embankments

The system of bank protection embankments built at the Rioni River is an important component of the physical infrastructure of the Sagvichio community. A network of such embankments almost entirely covers the downstream banks of the Rioni River. The length of the embankments reaches a few hundred kilometers.

As has been already noted in the previous subchapter, large-scale melioration works were implemented in the Kolkheti lowland in the 1930s. As a result of these works large bogged areas were reclaimed, new settlements, roads, irrigation and other infrastructure, etc. were built in floodplains along the rivers. However, due to the low hypsometry of the Kolkheti lowland strong floods occurring around the rivers often resulted in the inundation of vast territories of reclaimed lands, causing serious damage to the settlements and economic facilities. This situation brought to the top of the agenda the need for implementation of river bank protection activities in the Kolkheti lowland (to prevent the inundation of riverside areas). Mainly riverside embankments (artificial earth fill embankments) were used in the Kolkheti lowland as a technical mean of protection from floods. As a result the banks of the Rioni River and its certain tributaries (Abasha, Tekhuri, Khobistskali, etc.) have been covered by a network of bank protection embankments. The majority of these embankments were constructed 40-60 years ago.

Considerable financial and labor resources were needed every year for the maintenance of these embankments. After the collapse of the Soviet Union, in conditions of economic crisis, no rehabilitation and maintenance works were undertaken at these embankments. As a result their surface is heavily deformed in many places. At certain locations, within floodplains between the embankments and the riverbed, the riverbed of the Rioni River has merged with embankments as a result of changing river flows. At these sites the threat of scouring exists the embankments exists, which would lead to the inundation of adjacent areas.

The described river bank protection structures are an element of the wellbeing and safety of the Sagvichio community. The villages of the community are among those villages that are located on abutting embankments. Therefore if the protection structures are damaged the village will face the risk of large scale natural disasters.

Road and social infrastructure

The length of the main motor road on the territory of the community is 12 km. The length of internal roads is 10 km. According to the locals the roads are in a bad condition and require urgent rehabilitation.

The residential houses of the community are mainly one-storeyed permanent buildings built of blocks. There are 168 residential houses in the community.

The Sagvichio community is provided with electricity supply; individual meters are installed. The electricity supply system is outdated and requires urgent rehabilitation. According to the locals the population often repairs damaged electricity lines themselves, as a result electricity cutoffs often

occur and the risk of damage due to improperly repaired electricity lines is high. Electricity poles are also damaged and have to be replaced.

The territory of the Sagvichio community is crossed by the main gas pipeline, however, the population is not provided with natural gas due to the absence of internal infrastructure. Therefore natural gas is not available for the locals.

The community has no sewerage system. The population uses simple latrines constructed themselves. Household waste waters flow directly into the main water collecting canal though the drainage canal, resulting in pollution of the Khobistskali River. The drainage system is out of order and requires rehabilitation.

There are no dumpsites in the community. The population disposes of garbage in nearby areas. The majority of household waste ends up in the Rioni River and the main water collecting canal (the Khobistskali watershed), littering the environment.

There are no infrastructure facilities posing threat to the community.

Medical service

A first aid post (ambulance) is served by a local nurse and is operative in the community. During the working meetings the community members stressed that the ambulance lacked medicaments and basic medical equipment. The local population also receives medical services in the hospitals of the cities of Poti, Khobi, Senaki and Zugdidi, in critical cases they visit hospitals in the cities of Kutaisi and Tbilisi.

In emergency cases a first aid brigade comes from the city of Khobi. However, the quality of services provided by the first aid brigades is not satisfactory and often do not arrive in a timely manner because of remoteness, the bad condition of roads and insufficient number of first aid brigades (only 2 brigades are dislocated in the city of Khobi).

Table 1 provides a summary of information on the units of analysis for the Sagvichio community identified during the working meetings with the local population and consultations with the relevant experts.

Table 1. Units of analysis identified in the Sagvichio community

Unit of analysis	Description/Importance
Agriculture/Agricultural lands	• Agriculture is the main source of income for the community. • Total area of agricultural lands is up to 1,150 ha • Main crop – corn • Animal breeding is the main agricultural activity. 1,400 heads of cattle
Hydrographical network	• The river Rioni is the main watercourse of the community. • Drinking water is provided through pipeline laid from Nosiri. Some parts of

Unit of analysis	Description/Importance
	the community use artesian wells • The river Rioni is the main source of hazards occurring in the community
Drainage canals	• Total length of drainage canals exceeds 10 km • Main water collecting canal (the Khobistskali river watershed) – a key element of the drainage system of the downstream zone of the Rioni River crosses the community • Agriculture of the community entirely depends on adequate operation of drainage canals • The process of secondary bogging leading to the reduction of agricultural lands
Bank protection embankments	• The villages of the community are abutting embankments • Proper operation of the river bank protection embankments ensures protection of the community from large scale natural disasters (floods)
Infrastructure	• The condition of the road infrastructure determines the degree of vulnerability of the community to natural disasters • Outdated drainage canals and damage main water collecting canal facilitate the process of bogging • Road and social infrastructure is important for the development of the community and improvement of the living conditions of the population

4. Problems/challenges faced by the Sagvichio community

The present chapter contains a brief description of problems and challenges faced by the Sagvichio community. A special emphasis is palced on those natural hazards that determine the risk profile and the potential/ability of the community to adapt to expected climate change. The interrelation of these problems with the units of analysis identified at the first stage of planning is also described.

Problems of agricultural sector in the Sagvichio community

The main problem related to agriculture in the Sagvichio community is very low productivity of main crops (corn) conditioned by the failure to meet agrotechnical (mainly sowing) terms and inadequate soil fertility management. The majority of the arable lands are not fenced and are used for livestock grazing from harvesting until early spring. This is only possible due to the relatively warm and snowless winter. Often grazing periods last until late spring, resulting in delayed sowing by one or more months. This leads to a sharp reduction in yields, especially in droughty summers. According to the locals the reason for late sowing is disagreement over sowing periods among farmers: some farmers are in favor of using arable lands for livestock grazing and delaying shifting their cattle into controlled grazing, making difficulties for the implementation of spring works on the rest of these areas.

Improper soil fertility management is one of the main reasons for the reduction in productivity. Local farmers use nitrogen containing fertilizers - ammonium saltpeter under corn plantations at an amount of 200-300 kg per ha. However, fertilizers are not always applied in the required amounts due to the lack of financial resources. The situation has been relatively improved through agricultural coupons provided to farmers within the state program to support small sized farmers. The farmers were given the possibility to implement required spring works on their farmlands using these coupons.

Limited amounts of manure are also being applied along with nitrogen containing fertilizers. There is a shortage of manure to use as a fertilizer in the community due to the fact that cattle are kept on pastures all year round. Manure is difficult to collect and therefore the nutrient balance in soils might be disrupted and fail to meet the needs of crops.

Low soil fertility and inadequate utilization of its production potential is conditioned by an improper drainage system. In conditions of excessive humidity this is the main factor hampering the growth and development of plants. Internal networks of drainage systems have to be rehabilitated or cleaned at many locations, however, there is no special machinery required for the implementation of these works in the village. The depth of drainage for the majority of crops should be between 60-80 cm to ensure normal growth and development of root systems. Inadequate drainage creates difficulties during the tilling of soils with wheeled tractors. Moreover, the presence of excessive moisture in soils delays the process of soil warming in spring, leading to late sowing or prolonged germination.

Indigobush (*Amorpha Fruticosa*) (Pic.1) causes serious damages to the agricultural lands of the community. This plant is widespread and occupies increasingly large areas not only on the territory of the Sagvichio community, but also in almost all villages of neighboring downstream communities located along the Rioni River. Currently about 30% of arable lands of the Sagvichio community are covered by indigobush.

Pic. 1. Indigobush (*Amorpha Fruticosa*)

This plant is characterized by rapid growth and replication, and is difficult to control because of these features. According to locals this plant has never been characteristic of the community (the native land of indigobush is North America). The spread of indigobush in the villages located downstream of the Rioni River was first recorded in 1987, after flooding. According to locals the seeds of indigobush were spread by the Rioni River from nurseries located in the middle course of the river during the flood. This opinion is also shared by experts. Therefore, the population lacks knowledge and experience in invasive species control. The plant occupies more areas of agricultural lands every year. According to locals the areas occupied by this plant cannot be tilled without the implementation of specific measures. If a land plot is untilled for just one year, indigobush will cover almost the whole plot, making it difficult to till for local farmers (we saw many such afforested plots during field studies). Indigobush cannot be fully controlled using only non-chemical methods, since it is characterized by extensive growth. Chemical methods of weed control are more effective, however, their application required relevant knowledge and skills. Chemical methods should be implemented in accordance with all safety rules to avoid potential negative impacts on human health and the environment.

Weeded pastures create problems to animal breeding in the community. The pastures are weeded mainly by perennial grass inula (*Inula sp.*) (Pic, 2) occupying around 151 ha of pastures and redering them useless. The mentioned pastures can be used only by bees to collect flower dust during their flowering in fall. This problem may get worse and make the larger areas of local pastures useless unless preventive measures are taken.

Pic. 2. Weed inula (*Inula sp.*)

The main problem related to animal breeding in the Sagvichio community is associated with the development of pig breeding, which is a traditional agricultural activity in the Samegrelo region. However, this activity is rapidly declining and the number of pigs in the community has been significantly reduced over recent years. The main reason for this situation is the spread of African Pig Plague in Georgia during recent years. This disease cannot be treated or prevented through vaccination. As a result pig breeding declined in the whole country and the majority of households quit this activity. Currently only some tens of pigs that survived this disease are recorded in the village Sagvichio.

The problem existing in pig breeding is associated mainly with the negligence or partial implementation of animal health care and sanitary-hygienic rules. In most cases the population is not informed and pays inadequate attention to the health of domestic animals. As a rule, preventive measures against those diseases that can be treated with medication or vaccination are not taken. Non-vaccination is the reason of the deaths of animals in the community. According to the locals the animals died from African Pig Plague, however, the signs of this disease are similar to those of Classical Pig Plague, which also causes death in non-vaccinated animals.

River erosion

The occurrence of catastrophic floods on the rivers of Georgia has considerably increased over the last 150 years. This problem is especially crucial in the Kolkheti lowland. Flows overtopping river banks during strong floods inundate large areas of agricultural lands causing serious psychological and material damages to the local population. For example, a flood that occurred on the Rioni River at the end of January 1987 led to the inundation of about 300 km^2 in the western part of the Kolkheti lowlands. The depth of water on these areas reached 1-3 m. As a result of the flood 1,615 residential houses, tens of schools and other public buildings were destroyed, roads and melioration facilities were damaged, more than 7,000 heads of cattle were killed, etc.

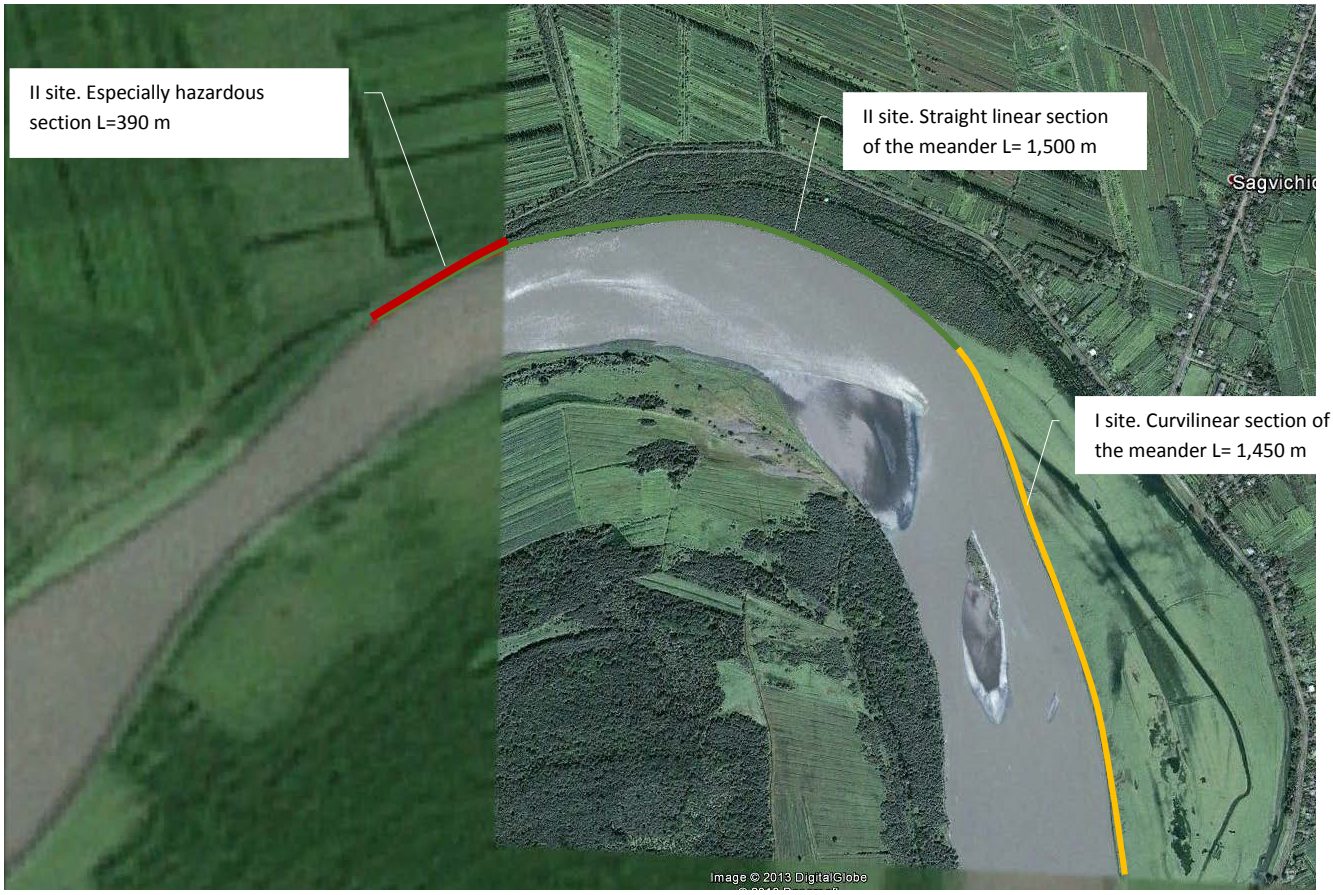
The situation is aggravated by the fact that the rivers flowing on the plain of the Kolkheti lowlands, especially the Rioni River, are meandering and create numerous islands within their riverbeds. Such a hydromorphological situation facilitates intensive scouring of river banks and significantly reduces water carrying capacities of the riverbeds. Therefore the riverbeds fail to carry maximum discharges, leading to scouring of their banks and the inundation of vast riverside areas.

Identification/survey of hazardous sites and sites exposed to risks as a result of floods and flash floods on the areas adjacent to the Rioni River within the territory of the Sagvichio community has been carried out in accordance with the results of consultations and working meetings with the local population during the field studies (undertaken within the framework of the INRMW program). During the field study the Rioni River gorge was observed in detail. As a result one hazardous section has been identified on the Rioni River in the village Sagvichio.

Village Sagvichio, right bank of the Rioni River (coordinates - X-73505; Y-4677075 – X737096; Y-4675705 WGS 1984 UTM Zone 38N).

The study section is located along a concave bank in a meander of the Rioni River. The left bank of the river is convex. Under its influence the water stream flowing in the riverbed makes a sharp turn to right and results in intensive souring of the right bank of the river.

In terms of undesirable morphodynamic processes the two sites can be distinguished (Pic. 3):



Pic 3. Village Sagvichio. Eroded right bank of the Rioni River

I site is a 1,450 m long straight linear section (coordinates - X-736691; Y-4676953 – X-737096; Y-4675705 WGS 1984 UTM Zone 38N) at the meander of the Rioni River. The width of the floodplain located between the riverbed and the earth-fill protection embankment varies within 200-400 m. Consequently, the earth-fill protection embankment located along the right bank of the river is not prone to erosion even during strong floods. However, the floodplain (elevation 2.5-3 m) located between the embankment and the river bank is used for livestock grazing by the local population (Pic. 4). Therefore scouring occurring at this site at different rates (Pic. 5) negatively affects local agriculture through the reduction of agricultural lands and corresponding incomes.

Pic. 4. Village Sagvichio. I site. Right floodplain of the Rioni River

Pic. 5. Village Sagvichio I site. Eroded bank of right floodplain of the Rioni River

II site is a 1,500 m long section where the meander makes a turn (Pic. 3) and intensive lateral erosion occurs. The site is separated from the earth-fill protection embankment by a 150 m wide strip of floodplain forest (Pic. 6). The situation is most complicated at the 390 m long section where the distance between the riverbed and the protection embankment is only 10-15 m, as a result of intensive scouring of the river bank. According to the locals this process has an active nature and results in the river approaching the village by 10-20 m a year on average.

Pic. 6. Village Sagvichio. II site. Right eroded bank of the meandering riverbed of the Rioni River

In case of further development of the process residential houses and household plots, as well as agricultural lands, pastures and utilities of the community will be put at risk. It should be noted that if the river destroys the embankment it will not be able to hold excessive water at this section during large scale floods and river flows will inundate not only agricultural lands of the village Sagvichio, but also almost the whole village Sagvamichao.

System of bank protection embankments

As has already been stated, the system of bank protection embankments is an essential component of the physical infrastructure of the Sagvichio community and the villages located downstream of the Rioni River. Generally speaking, the existence of these settlements largely depends on proper operation of these structures. To ensure proper operation of bank protection embankments the implementation of significant maintenance works is required every year. Over the last decade only small-scale works have been implemented on these structures. Reinforcement and rehabilitation works have been undertaken only at specific sites, mainly at failing embankment sections. No monitoring activities to assess the condition the bank protection structures, identify potentially hazardous sites and develop a plan of rehabilitation activities on the basis of a damage degree and complexity are being implemented.

Therefore, deformations are observed at a number of sections of the bank protection embankments, built along the both banks of the Rioni River. At certain locations crests of the embankments have

lowered as a result of use of these zones by the population for transportation. At certain locations the flattened parts of the crests are used for the movement of tractors and vehicles, therefore these sections of the embankments are lowered and heavily deformed. Such sites are found along both banks of the Rioni River, including the Sagvichio community. At these sites the embankments are no longer functioning, and are not able to withstand surges flowing from the Rioni Riverbed. Therefore the floodplains and the population living in these floodplains are at risk of inundation. Moreover, strong surges that overtop the deformed sections of the embankment can inundate not only adjacent areas, but also larger territories. As has been already stated, the surface of the Kolkheti lowland is almost perfectly flat in its western part on the both sides of the Rioni River. It is slightly inclined, allowing surges the possibility to spread over large areas. Therefore embankment failure at one specific location can lead to inundation of large territories.

A situation similar to the described scenario occurred in January 31, 1987, when the Rioni River broke a 300 m long section of the embankment at the village Sagvichio. Water flows inundated not only this village but also its environs. The area covered by water was 2-3 km wide and 10 km long (from east to west). The depth of water in these areas reached 1.5-2.8 m. The flood resulted in human deaths and considerable damage: hundreds of cattle were killed, a majority of houses and utilities were damaged. At present this section of the embankment is rehabilitated, however, this could occur at other sections of the embankment, therefore permanent monitoring of the embankment and implementation of required maintenance/repair works is important.

Table 2, below, contains a summary of information on the problems and challenges identified in the Sagvichio community on the basis of working meetings with local population and consultations with relevant experts and their impacts on the units of analysis:

Table 2. Problems identified in the Sagvichio community and corresponding units of analysis

Identified problems/impacts	Corresponding units of analysis
Degraded agricultural lands. Inadequate soil cultivation practices (fertilizer application, agrotechnical terms) leading to low fertility of soils.	• Agriculture / Agricultural lands
Obsolescence of the drainage system leading to acceleration of the process of secondary bogging. Decreased agricultural lands and yields.	• Agriculture • Agricultural lands • System of drainage canals
Invasive species. Absence of the knowledge and experience in invasive species control in the community. Resulting reduction of agricultural lands. Considerable growth of agricultural costs due to ineffective measures against afforestation of agricultural lands and reduction of incomes from agriculture.	• Agriculture • Agricultural lands
Pig breeding – improper practice of management leading to deaths of animals, degradation of the traditional activity and reduction of incomes from agriculture.	• Agriculture

Identified problems/impacts	Corresponding units of analysis
Floods and flash waters occurring due to river bank erosion cause serious damages to the population of the community.	• Agricultural lands • Hydrographic network • Residential houses and household plots • Bank protection embankments • Infrastructure - motor roads, electricity transmission lines, etc.
Damaged riverside embankments posing high risks of large-scale floods to the community. Running maintenance works are not being implemented. Data on the technical state of structures are not available.	• Agricultural lands • Residential houses and household plots. Auxiliary structures • Bank protection embankments • Infrastructure - motor roads, electricity transmission lines, drink water supply infrastructure, other physical and social infrastructure etc.

5. Climate change and its consequences

After identification of the existing challenges in the community trends in climate change were identified to determine the potential direct impacts of climate change in terms of emerging new challenges and the aggravation of existing problems in the community. Climate change trends were identified on the basis of local knowledge/experience, as well as using the results of the climate change studies carried out at the previous stages of the program[5]. Table 3 contains the trends of climate change with a description of potential direct impacts and an indication of those units of analysis that might be potentially affected by the mentioned changes.

Table 3. Climate change and potential direct impacts

Climate change trends	Direct impacts	Corresponding units of analysis
Increase of average and mean maximum/minimum air temperature.	• Increased vulnerability of agricultural crops to climate change • Changed agricultural calendar (prolonged plant vegetation periods) • Decreased incomes from agriculture • Potential rise of mean multiyear level of the Black Sea	• Agricultural lands • System of drainage canals • Hydrographic network
Increase in annual precipitation. Sharp increase of daily precipitation. Increased number of days with heavy rains.	• Soil degradation. Acceleration of the process of secondary bogging • Maintained and increased risks of strong and even catastrophic floods and flash waters on the Rioni River • High probability of inundation of riverside areas and acceleration of erosion processes as a result of floods, flash waters and river erosion • The areas already prone to floods and flash waters will face increased risks • Increased vulnerability of agricultural crops to climate change • Accelerated damage/degradation of agricultural lands (inundation, water erosion) • Decreased incomes from agriculture	• Agricultural lands • System of drainage canals • Hydrographic network • Bank protection embankments • Infrastructure – residential houses, household plots, drinking water supply system, motor roads, electricity transmission lines, engineering structures and utilities, etc.
Increased number of tropical days and nights. Increased number of frosty nights and decreased number of frosty days.	• Increased vulnerability of subtropical crops to climate change • Changed agricultural calendar • Decreased incomes from agriculture	• Agriculture / agricultural lands.

[5] see INRMW program, report - Assessment of the Vulnerability to Natural Disasters and Climate Change for Lower Rioni Pilot Watershed Area & Plan of Mitigation and Adaptation Measures.

6. Combined impacts in the Sagvichio community

At this stage the potential combined impacts of the challenges faced by the community and the consequences of climate change on the units of analysis have been assessed. These assessmenbts were made based on the basis of the results of experts' work and participatory working meetings with the local population.

Impacts on agriculture

Current mean annual precipitation required for the main crops of the Sagvichio community is more than enough. Although future climate change scenarios predict increases in temperature and the number of drought days, mean annual precipitation will increase. Therefore, agriculture will be provided with an adequate amount of water. However, the removal of excessive water through the drainage system during the vegetation period of main crops will be more important, especially as according to climate change scenarios the number of days with heavy rains and mean seasonal precipitation will increase in summer and fall – during active vegetation periods.

Climate change scenarios predict an acceleration of floods on the river Rioni and an increase in cases of inundation of the areas located in floodplains and the agricultural lands, as well as an intensification of water erosion. All these will accelerate the degradation of arable lands, gardens and pastures of the community.

Increased precipitation, as well as the increased occurrence and intensity of floods, will accelerate the on-going process of secondary bogging leading to qualitative and quantitative degradation of agricultural lands and consequent reduction of incomes from agriculture. It should be also taken into account that increased precipitation will lead to increased maintenance costs of the drainage system.

Based on the above-mentioned it can be concluded that climate change will have a substantial impact on agriculture in the Sagvichio community.

Negative natural phenomena

The analysis of the existing situation shows that the Sagvichio community is being affected by negative natural phenomena such as river erosion leading to inundation of the territory of the community and causing damage of the infrastructure during floods and especially during flash waters.

According to existing climate change scenarios the present high risk of occurrence of floods and flash floods will be increased. Therefore these processes will presumably lead to an acceleration of river erosion and increased damages to the Sagvichio community from negative natural phenomena. The areas currently being threatened by these hazards will be most affected. Large scale catastrophic floods/flash floods that occurred in the past in the community should be also taken into account. Based on this it can be asserted that future climate change will pose an increased risk to almost the whole territory of the community. Therefore the predicted growth in the risk of floods is associated with an increased probability of large-scale disasters in the Sagvichio community.

Moreover, a potential rise in the mean multiyear level of the Black Sea by even few centimeters may become one reason for the acceleration of floods and flash floods in the community. It is well known that climate change determines sea level rises. In this case ponding of the Rioni River at its estuary may occur, leading to a rise in river water during floods and flash floods, the spread of surges on adjacent areas and a growth in the frequency of inundation of these territories.

Analysis of the combined impacts of climate change shows that it will have a significant impact on the development of hazardous natural processes in the Sagvichio community.

Table 4, below, contains a summary of the information on combined impacts.

Table 4. Combined impacts identified in the Sagvichio community

Combined impact	Corresponding units of analysis
Soil degradation (deterioration of quality), reduction of the volumes and deterioration of the quality of agricultural products due to increased precipitation, increased risk of inundation and acceleration of erosion and secondary bogging processes. Resulting decrease of incomes from agriculture.	• Agricultural lands • System of drainage canals • Hydrographic network • Bank protection embankments
Floods, flash waters, river erosion will lead to increased damages to agricultural lands and infrastructure of the community.	• Agricultural lands • System of drainage canals • Hydrographic network • Bank protection embankments • Residential houses • Infrastructure

7. Adaptation and disaster risk reduction activities

The final stage of the selected methodology of planning climate change adaptation and natural disaster risk reduction activities considers the development of an action plan to ensure prevention or mitigation of negative impacts of the impacts identified at the previous stages of planning. The following set of activities for each impact identified for the Sagvichio community have been selected in close cooperation with the experts of relevant fields.

Agriculture

As has been described in the previous chapter, the main problem of agriculture in the Sagvichio community is the low productivity of main crops determined by improper agricultural practices and degradation of agricultural lands. Moreover, the analysis of climate change predictions shows that climate change will lead to degradation of agricultural lands (bogging, erosion, flooding). Therefore the implementation of the following measures is suggested to build the resilience of local agriculture to future climate change:

1 *Drainage systems*

Corn is a moisture-loving and drought tolerant plant. Mean annual precipitation recorded in the region is more than enough to satisfy corn's demands for water. Although climate change scenarios predict an increase in temperature and the number of draughty days, the region will be characterized by abundant precipitation. Therefore, removal of excessive water through drainage systems during vegetation period will be more important (especially since the number of humid days when daily precipitation will reach more than 50 and 90 mm will increase, according to climate change predictions). It should be also taken into account that according to climate change scenarios the increase in excessive precipitation is expected during the active vegetation period of this plant.

For the rehabilitation and improvement of canals the use of special ditching equipment (Pic. 6) is recommended. They will simplify the maintenance process of the drainage systems and give local farmers the opportunity to make maximum use of agricultural lands and increase their productivity.

Pic. 6. Example of a special ditching machine

This devise installed on a tractor of the required capacity (60-140 hp) is able to dig a ditch up to 30 cm wide and up to 1.6 m deep 10 times faster than an excavator. Drainage systems have to be built on pastures, in lowered areas prone to inundation. Prolonged waterlogging of pastures results in declines in their productivity and the substitution of grasses that have high nutrition value with moisture loving and low-energy or inedible grasses. Open drainage canals on pastures may cause animal injury, therefore the canals have to be filled with cobble (Pic.7). The canals should have a gradient of up to 1-3%.

Pic. 7. Filled drainage canal

2 *Introduction of a practice of sowing mixed crops*

To ensure growth in the productivity of corn, it is important to introduce a practice of sowing other crops with corn. The best accompanying crops for corn are beans, soybeans, pumpkin, cucumber and sunflower. Mixed plantations ensure the implementation of several functions – soils are

enriched with biological nitrogen, soil surface is better covered, corn protects other crops from high temperatures.

3 *Soil fertility management system*

To increase crop productivity a soil fertility management system has to be developed on the basis of existing soil fertility and relevant measures have to be taken. The correct application of fertilizers and observation of agrotechnical periods can increase the existing yields of corn up to 5-6 tons per ha, exceeding the existing average productivity by 2.5-3 times using local seeds. It is very important to select proper forms of fertilizer, and strictly observe the periods and rules of their application to minimize losses, the probability of which will increase with increases in the number of hot and rainy days. Nitrogen fertilizer loss due to evaporation and washing may be as high as 80%, contributing to a growth in the amount of nitrogen oxides released into the environment and the index of pollution of underground waters.

4 *Manure storages / composting*

Construction/improvement of manure storages to is one of the most important issues for the Sagvichio community; protection from precipitation prevents local pollution and minimizes the loss of nutrients. This is a simple measure that increases the amounts of organic fertilizers that are easily available in the community. Heaps of manure should be placed on a pad made of chips, saw dust, hay or straw to protect soils and groundwater from leakage and potential pollutants contained in drained water. The thickness of the pad depends on the materials used, moisture content and amount of manure. Periodically (e.g., twice a year – in early spring and autumn) the masses collected in these storages should be used to prepare compost using hay, stubble or straw. The received compost is a valuable organic fertilizer for agriculture and is much more effective than so-called naturally fermented manure, which is often impoverished and not valuable.

5 *Introduction of an effective practice of cattle feeding. Improvement of local breeding stock*

To increase the productivity of cattle improvement in the local breeding stock is required. Currently the average yield per dairy cow is around 5 l a day, which is a very low index. Dairy production is an important source of income for the local population. Therefore relevant measures have to be taken to increase its output. First of all, adequate forage has to be created to provide milk and dry cows with sufficient and nourishing forage. One milk cow needs around 50 kg of green grass a day. For this amount of green mass 1 ha of medium productivity pasture is required. In conditions of high pasture loads the livestock do not receive adequate forage to satisfy their minimum needs, this is reflected in reduced milk yields and growth retardation. In addition, the livestock is not provided with supplemental nutrition, which also increases the pressure on pastures. To ensure proper nutrition of the livestock in conditions of inadequate grazing a concentrated foodstuff should be provided at an amount of 1 kg per day (e.g., 1:1 mix of corn and soya). During cold seasons (from late fall to early spring) and droughts both succulent (e.g., silage) and dry fodder (e.g., hay, straw) have to be provided along with concentrated food. It is also important to improve the local breeding stock and select relevant breeds: dairy, beef and dairy-beef breeds. However, productive breeds will not ensure good milk and beef production unless he livestock is provided with adequate amounts of nourishing forage.

6 *Pig breeding – traditional animal breeding activity*

The problem of pig breeding is mainly associated with the negligence or partial implementation of animal health care and sanitary-hygienic rules. Therefore cases of deaths among pigs are frequent, according to the locals they are caused by African Pig Plague, however, the signs of this disease is similar to those of Classical Pig Plague, which also causes deaths of non-vaccinated animals. Therefore, all required preventive measures have to be taken. Sick animals have to be isolated as soon as the first symptoms of a disease become noticeable. Local veterinary services have to be immediately informed and all recommendations have to be implemented to diagnose, ensure adequate treatment and/or prevent the spread of the disease.

7 *Indigobush*

Indigobush - an invasive plant species creates problems for the local farmers. A considerable proportion of agricultural lands is degraded due to the spread of this plant. The population is unable to solve this problems and lose more areas of agricultural lands every year due to propagation of this plant. It is characterized by fast growth and spread, making its control very difficult. Indigobush cannot be fully controlled with non-chemical methods as it makes strong and fast growing sprouts, however, its spread and propagation can be restricted through repeated defoliating, uprooting and cutting roots at 7-10 cm below root necks. This measure should be kept repeating until plant stops sprouting. Chemical methods of weed control are more effective, however, they should be applied in accordance with safety rules to minimize their negative effects on the environment. From the available herbicides clopyralid or glyphosate containing agents are used. A clopyralid containing agent registered in Georgia is “Lion”, while glyphosate containing agents include “Klin”, “Uragan Forte”, “Rumbo”, “Dominator”, etc. Prior to herbicide application plants have to be cut close to the ground and sprayed within 1 hour from cutting. In case of clopyralid containing agents a 50% water solution shall be prepared, while in case of glyphosate containing agents – 3-4 l/ha herbicide has to be dissolved in 150-200 l water. The best period for herbicide application is the dormant period (winter) or the period of active growth of weeds (May-June). Herbicides have to be sprayed in dry and calm weather, early in the morning after the dew has dried. Herbicides should not be sprayed during droughts. When spraying masks, protected eyeglasses and gloves should be used. Since highly concentrated solutions are used, a spraying device should be washed carefully to avoid the contact of herbicides with crops. Livestock and poultry shall not be allowed on the areas treated with herbicides for a period of two weeks.

8 *Improvement of natural pastures*

When speaking about adaptation the measures for improving the natural pastures of the community should be discussed. As has been stated above, a parts of the pastures are weeded (weed inula (*Inula sp.)* and useless for grazing. To support animal breeders these pastures need to be recovered. Since they are partially weeded and edible grasses have been replaced, the pastures require significant improvement. For this purpose weeds have to be removed from the pasture. Weeds have to be mowed, preferably before seed formation and then uprooted as far as possible (in conditions of sufficient soil moisture). The sprouts of the weeds have to be mowed again and/or uprooted in the case of small areas. Mowed green mass mixed with manure and other organic wastes can be used to prepare compost. In other cases mowed weeds have to be collected and burned, especially if they are mowed when seeds have already formed. It is important to avoid seed formation,

otherwise the weed control will become more problematic. To improve pasture productivity nourishing grasses have to be sowed (e.g. English ryegrass, white clover, meadow fescue, cocksfoot). Grasses should be sowed in early spring. In waterlogged conditions, the seeds of grasses should be sown superficially, at small depths. During the first year after sowing grazing should be restricted. Grasses may be sown once, taking into account the level of their development. In the case of weeds spreading selective herbicides may be applied. Terms and conditions of application, as well as safety rules, should be strictly observed.

Floods and river erosion

To mitigate river erosion and protect eroded river banks (which in turn will ensure protection of residential houses, agricultural lands and road and social infrastructure from floods and flash floods) the following activities should be implemented at the hazardous sites identified during field studies.

Village Sagvichio, right bank of the Rioni River (coordinates - X-73505; Y-4677075 – X737096; Y-4675705 WGS 1984 UTM Zone 38N). As has been stated above the bank of the Rioni River at this section is concave. Therefore the water stream flowing in the riverbed makes a sharp turn to the right and the flow velocity increases, resulting in intensive souring of the right bank of the river. This process threatens agricultural lands, utilities and household plots of the community, as well as the whole population of the neighboring Sagvamichao community where the residential houses are under the direct risk of inundation.

On the basis of a detailed analysis of the situation recommendations for the reduction of risks of large-scale natural disasters have been developed. Since the implementation of bank protection works on the Rioni River require substantial funding, at this stage urgent reinforcement of only a 390 m long section of the riverbank at site II (Pic. 9) is recommended. To protect the hazardous site from lateral erosion an existing river bank high stone-fill berm (2.5 m on average) has to be built.

At this study section the discharge of 1% probability is 3,750 m^3/sec. On the basis of the results of field works carried out with simple surveying instruments it was calculated that the maximum depth of the river during design floods, including scouring and flooding, is 11.6 m.

The estimated diameter of the required stones is 1.0-1.2 m. According to preliminary estimations 37 m^3 of stone will be required for 1 linear meter of a stone-fill berm, therefore 14,500 m^3 of stones will be needed to protect the study site.

The estimated cost of construction-assembling activities is 1,500,000 GEL.

Pic. 8. Village Sagvichio. Suggested bank protection measure at the eroded right bank of the Rioni River

The system of bank protection embankments

The system of riverside embankments is an essential component of the Sagvichio community, the well-being of which largely depends on proper operation of these bank protection structures. No assessments of the condition of bank protection structures and running maintenance works have been implemented on these embankments over recent decades (from the 1990s). The condition of these structures is likely to be considerably worsened, posing risks of large-scale disasters not only to the Sagvichio community but also to other villages located along the Rioni River. Therefore the condition of these embankments has to be studied in detail, damaged and potentially hazardous sites have to be identified and regular monitoring of their condition has to be established.

Early warning system and emergency response plan

As has been already noted the riverside settlements located in the downstream areas of the Rioni River are under increased risks of floods and flash floods. Large scale natural disasters occurred in this area in 1842, 1895, 1900, 1911, 1922, 1956, 1577, 1982, 1983, 1987, 2003, etc. This serves as evidence of the above-stated. In conditions of predicted climate change the mentioned settlements (including the Sagvichio community) will face increased risk of floods and flash floods. Therefore the establishment of an early warning system is considered an important risk reduction measure. The system will ensure that the populations are warned about expected disasters. Although the

establishment of such a system is beyond the capacity of a single community (Sagvichio), the Sagvichio community and its population will be major beneficiaries of the system.

In this context the development of a community based emergency response plan (primarily covering floods and flash floods) that will detail the activities to be implemented by each community member and local governance after receipt of a warning on expected hazard is important.

Table 5, below, contains a summary of information on climate change adaptation and natural disaster risk reduction activities to be implemented in the Sagvichio community.

Table 5. Summary of climate change adaptation and disaster risk reduction activities to be implemented in the Sagvichio community

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
Global aim of the activities: • Adaptation and increase of the resilience of agriculture of the Sagvichio community to climate change and natural disasters • Reduction of vulnerability of the community					
Rehabilitation – cleaning/repairing the drainage canals of the community. Construction of covered drainage canals on pastures	• Adaptation to climate change • Removal of excessive water from agricultural lands • Reduction of the process of secondary bogging • Increase of the productivity of main crops (including corn) • Reduction of degradation of arable lands and their improvement • Increase of incomes from agriculture	50,000 – 100,000	**LT**	• Local farmers • Agricultural development services • Local self-governance • Regional government • Ministry of Agriculture	• Local farmers • Agricultural development service • Local budget • State budget • NGOs • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.)
Introduction of a practice of sowing mixed crops on agricultural lands of the community	• Increase of the productivity of main crops (including corn) • Enrichment of soils with biological nitrogen • Increase of incomes from agriculture	< 50,000	**ST**	• Local farmers • Agricultural development services • Local self-governanc	• Local farmers • Agricultural development service • NGOs

[6] Short-term (ST) implementation period – less than 1 year; medium-term (MT) – 1-5 years; long-term (LT) – more than five years

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
Development of a soil fertility management system of the basis of the existing soil fertility and taking relevant measures	• Increase of soil fertility • Increase of the content of organic matter in soils • Increase of incomes from agriculture	< 50,000	**ST**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.)
Arrangement of manure storages and introduction of composting. Education and awareness raising of farmers on application of this method (Chapter 7. Manure storages / Composting)	• Preparation of high quality organic fertilizer • Qualitative improvement of soils • Protection of the environment from pollution (evaporation of nitrogen compounds, washing into surface water bodies)	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.)
Introduction of an effective practice of cattle feeding. Teaching and awareness raising of farmers on application of this method. (Chapter 7. Effective practice of cattle feeding)	• Increase of the productivity of cattle • Increase of incomes from animal breeding	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Development of pig breeding: • Observation of health care and sanitary-hygienic rules in pig breeding	• Development of traditional pig breeding in the community	< 50,000	**ST**	• Local farmers • Agricultural development services	• Local farmers • Agricultural development service

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
• Regular implementation of necessary preventive measures including vaccination against diseases • Teaching the population on animal care and disease prevention methods	• Increase of incomes from animal breeding			• Veterinary services • Local self-governance	• Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
Invasive species control • uprooting plants and cutting roots • chemical methods of weeds control (Chapter 7. Indigobush)	• Quantitative and qualitative improvement of agricultural lands • Increase of productivity • Reduction of agricultural expenses • Increase of incomes from agriculture	< 50,000	**MT**	• Local farmers • Agricultural development services • Veterinary services • Local self-governance	• Local farmers • Agricultural development service • Local budget • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
Improvement of natural pastures – weed control (Chapter 7. Improvement of natural pastures) Awareness raising of the population on measures of weed control	• Development of animal breeding in the community • Improvement of forage reserve for animal breeding • Reduction of pasture degradation • Maintenance and improvement of pasture productivity • Increase of incomes from agriculture	< 50,000	**MT**	• Local farmers • Agricultural development services • Veterinary services • Local self-governance	• Local farmers • Agricultural development service • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
Global aim of the activities: • Mitigation of hazards faced by the Sagvichio community and reduction its vulnerability to natural disasters and climate change • Reduction of risks of natural disasters in the community • Adaptation to climate change					
Village Sagvichio, right bank of the Rioni River (X-73505; Y-4677075 – X737096; Y-4675705. Chapter 7). Construction of a 390 m long erosion control stone-fill berm. Total volume of designed stone structure - 14,500 m^3.	• Abatement of river erosion • Reduction of the risk of floods and flash waters • Protection of residential houses and household plots • Protection of agricultural lands • Protection of communication facilities of the community	1,500,000	**MT**	• Municipal government • National Environmental Agency • Ministry of Regional Development and Infrastructure	• Local budget • State budget • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
Bank protection embankments: • Assessment of current condition; • Identification - rehabilitation of hazardous sites; • Permanent monitoring and maintenance	• Abatement of river erosion • Reduction of the risk of floods and flash waters • Protection of residential houses and household plots • Protection of agricultural lands • Avoidance of large-scale disasters	50,000 - 100,000	**MT**	• Local self-governance • Municipal government • National Environmental Agency • Ministry of Regional Development and Infrastructure	• Local budget • State budget • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
Establishment of an early warning system on the Rioni River	• Reduction of the risk of floods and flash waters	50,000 - 100,000	**MT**	• Local self-governance • Municipal government	• Local budget • State budget

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
	• Protection of the population and their property • Avoidance of large-scale disasters			• National Environmental Agency • Ministry of Regional Development and Infrastructure • Department of Emergency Situations Management Department of the Ministry of Internal Affairs	• Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
• Development of a community based emergency response plan	• Reduction of the risk of floods and flash waters • Preparation of the population for potential natural disasters • Protection of the population and their property • Avoidance of large-scale disasters	< 50,000	**ST**	• Local self-governance • Municipal government • National Environmental Agency • Department of Emergency Situations Management Department of the Ministry of Internal Affairs	• Local budget • State budget • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs

Global Water for Sustainability Program

Florida International University

Biscayne Bay Campus

3000 NE 151St. ACI-267

North Miami, FL 33181 USA

Phone: (+1-305) 919-4112