Community based climate change adaptation and disaster risk reduction action plan for the Jokolo community of Akhmeta Municipality, Upper Alazani 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 Jokolo community of Akhmeta Municipality, Upper Alazani 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 Jokolo community of Akhmeta municipality (Upper Alazani 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/

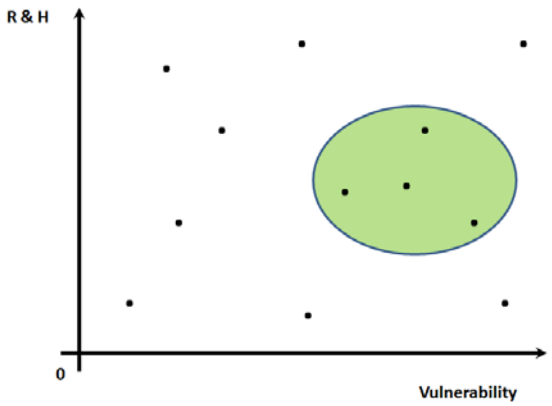
One of the most important stages of the selection process was the identification of selection criteria. These criteria included:

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.

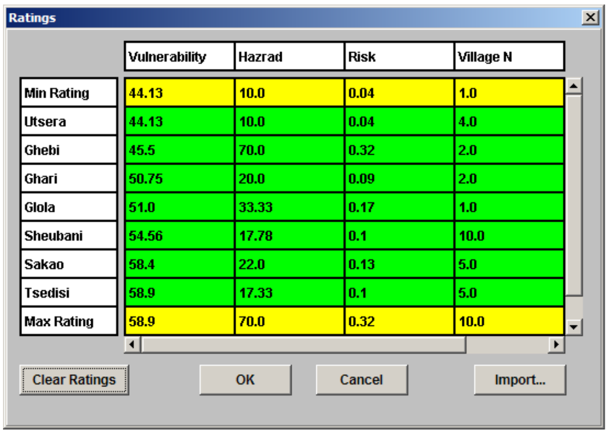
The diagram below illustrates the selection criteria. The diagram shows that communities with high vulnerability and medium hazard and risk values were given preference in the selection process (see Diagram below).

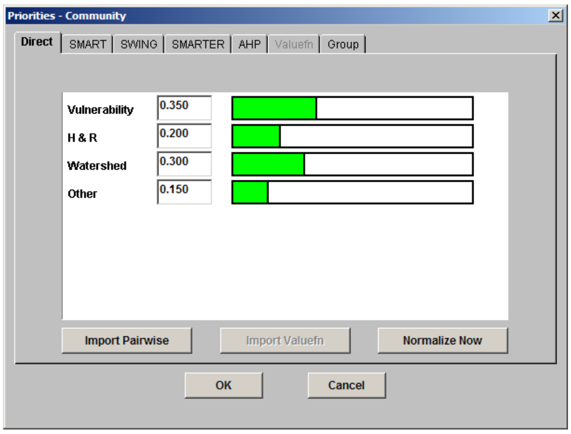


Along with the abovementioned, other criteria were also used for the selection of pilot communities: location of a community within a single watershed, potential impact on other communities, area of the community, number of villages in the community, size of population, area of forested land, etc.

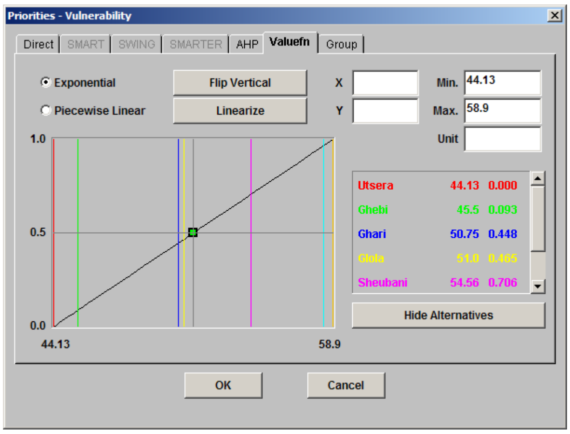
After identification of criteria the data corresponding to these criteria were integrated into the special web-based database. Each criterion was assigned a weight for formulation of a final decision.

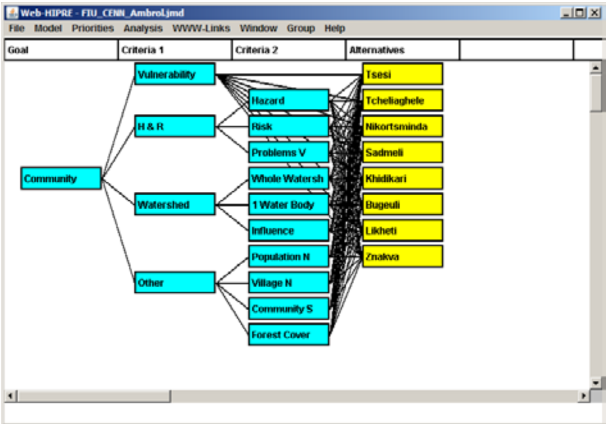
[2] see reports – Assessment of the vulnerability to natural disasters and climate change of INRMW program targeted municipalities. Adaptation and mitigation plan.
[3] Assessment of the vulnerability to natural disasters and climate change of INRMW program targeted municipalities. Adaptation and mitigation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



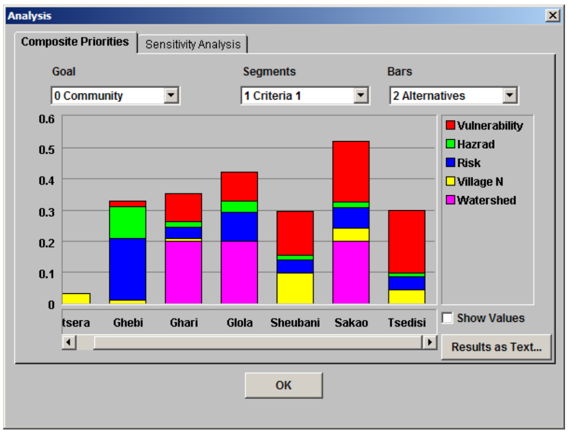


Following weighting the data was standardized and a so-called criteria tree was developed.





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_Akhmeta.jmd

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

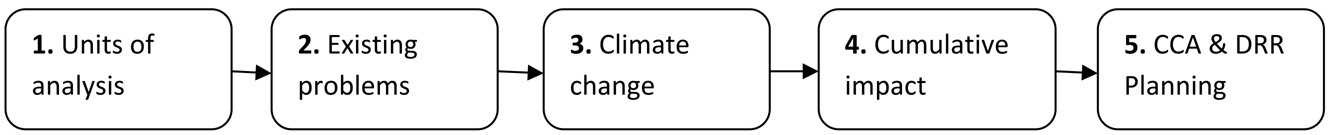
Development of community based natural hazards risk reduction and climate change adaptation plans

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 Jokolo community is located in the northernmost part of the Akhmeta municipality (except the territory of Tusheti, which also belongs to the Akhmeta municipality). The community borders the main Caucasus dividing ridge to the north and the territory of the Duisi community to the south.

The Alazani River crosses the territory of the community from north to south. Almost the whole community is situated along the river. The villages of the community: Birkiani, Dzibatkhevi and Jokolo are also located in the Alazani River gorge. The Kekhurisgora range with steep slopes which are not used by the population and the Sopro hill border the community on the west. Flood plains change to mountains dissected by ravines oriented to the Alazani River. The mean elevation of the community is 670 m above sea level. The distance to the municipal center is 22 km. The total area of the community is 4,498 ha.

The Alazani River is the main watercourse of the community. The area is dissected with the gorges of small tributaries of the Alazani River. All these tributaries flow into Alazani within the territory of the community. These include the rivers of: Batsara, Birkianis Khevi, Kvachadara, Chobio Khevi, Kvitezis Khevi (right tributaries of Alazani), and Murtsas Khevi and Khorojos Tskali (left tributaries).

In terms of climate the Jokolo community, and the Akhmeta municipality in general, belong to the transitional zone between subtropical-continental and marine climates. The areas located at an altitude of up to 700-800 above sea level (the part of the Alazani valley within the boundaries of the municipality and adjacent foothill zone) are characterized by a humid climate with moderate warm winters and long hot summers. The major part of the Jokolo community is located within this zone. At the elevations up to 1,200 m above sea level the climate is moderately humid with moderate cold winters and relatively cool and long summers. The climate of the areas located 1,200-2,000 m above sea level is moderately humid and cold with long winters and cool, short summers. The areas located above 2,000 m above sea level are characterized by a cold mountain climate with severe winters. Only a small part of the community is located within these zones.

The territory of the community, as well as the whole Akhmeta municipality, is rather diverse in terms of vegetation. Formations of valuable deciduous forests are found over large areas within the territory of the municipality. The existence of protected areas in upstream areas of the Alazani River: Batsara (bordering the territory of the community) and Babaneuri Protected Areas and the Ilto Reserve highlights the biological diversity of the municipality. Vegetation growing around the settlements is severely transformed. Agricultural lands (vineyards, arable lands, haylands-pastures) are located in the areas formerly occupied by oak-hornbeam and flood plain forests. Different formations of hornbeam, oak, chestnut, and beech forests as well mountain oak, mountain maple, birch, zelkova, poplar forests and separate forest fragments are found in the territory of the Akhmeta municipality.

From animal species, Chamois and tur live in the Alpine zone of the municipality. The Red Listed wild goat is found rarely. The following animal species are found in the forests: brown bear, lynx, deer, jackal, fox, wolf, weasel, badger, hare, etc.; birds: Caucasian black goose, Caucasian snowcock, gyps, eagle owl, crow, starling, owl, etc.; reptiles: sheltopusik, lizard, snake, toad and forest frog. Mursa, trout, asp, European chub, nase, and barbell are found in the rivers.

Population

There are 410 households in the community. Population - 2,087.

Based on the data obtained during field studies the population of the community is distributed amongst the villages in the following way (Table 1):

Table 1 Population of the Jokolo community

Village	Household	Population
Jokolo	230	1,100
Birkiani	148	867
Dzibakhevi	32	120
Total	410	2,087

Almost 45% of the population of the Jokolo community are able-bodied. About 14% are at pensionable age. The high share of people under 18 is noteworthy, they comprise 40% of the population.

Sex ratio information is not available in the community, however, during the meeting community members mentioned that the number of women exceeds the number of men.

An absolute majority of the local population is self-employed. The main source of their incomes are revenues from small private farms.

According to the statistical data obtained during the working meetings with the local population about 120 households (about 30% of the local population) is below the poverty level. This is a rather high index.

Such a social-economic condition determines a high index of migration. Young people constitute the major part of migrants. Community members migrate mainly to Russia (Chechnya), since a majority are Kists – an ethnic group affiliated to Chechnya. External migration to western European counties – Spain, Italy, Greece, etc. is also observed. According to the locals every family has at least one member working outside the community. The main source of income for the local population is money sent by migrants.

In the 1990s Akhmeta municipality, including the Jokolo community, provided shelter to Chechen refugees exiled from Chechnya as a result of the military operations of the Russian government. The majority of the refugees have since returned to Chechnya. According to the local population only 6 refugee families still live in the community.

3. Units of analysis of the Jokolo 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 Jokolo 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 upper Alazani watershed area developed within the framework of the INRMW program. The Jokolo community is discussed in the context of the Akhmeta 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 the consultations with the local population and expert team the following environmental components have been determined as units of analysis for the Jokolo community:

- agricultural lands – first of all pastures of the community, as well as arable lands and perennials, pastures – as the main source of income and food safety of the community;

- rivers flowing on the territory of the community – especially the Alazani River and its tributary small ravines (Kvitezi, Dzibatkhevi) having their source in the territory of the community - as a cause of natural disasters occurring in the community;

- forests adjacent to the community – used as the main source of heating for the community - as well as incomes from forests and the state of forests as a cause of natural disasters occurring in the community;

- infrastructural facilities located in the territory of the community – including drinking water supply infrastructure, motor roads, houses, electricity transmission lines, drainage canals, etc.

See below a description of each component and brief characteristics of their role and importance to the life if the community.

3.1 Agriculture and agricultural lands

Crop growing

The total area of agricultural lands of the Jokolo community is around 700 ha, including arable lands – up to 230 ha and pastures-haylands – 470 ha. As a result of the land privatization process, each household received 0.5 ha of arable lands.

Corn is the main crop in the community, its productivity is 3-4 tons per ha. From cereals wheat is mainly cultivated, however its productivity is very low – 0.5 tons per ha. Vegetables are produced mainly for household consumption.

Animal breeding

Animal breeding is the main branch of agriculture in the Jokolo community. The majority of incomes of community members are generated from the sale of goods produced in this field of agriculture.

At present there are 1,200 heads of cattle and 930 heads of sheep. The village faces the problem of pastures in cold seasons, when sheep have to be driven to winter pastures from mountain pastures. The village Jokolo, as well as other villages of the Akhmeta municipality, was using 700 ha of pastures on the Shiraki lowland until recent years. However, these pastures are no longer available to them. A part of the pastures have been privatized, while the other is being allocated under licenses. The narrowness of existing livestock driving routes is also creating problems in terms of increased driving time and expenses associated with the recovery of damaged crops along these routes. Livestock breeding is the main source of income despite the existing problems.

With regards to poultry, chicken has the largest share (about 1,900), followed by turkey (about 400), goose (60) and duck (50).

Beekeeping is also developed in the community. At present there are 162 beehives used mainly for honey production.

3.2 Forest

Forests adjacent to the Jokolo community play an important role in the life of the local population. The total area of these forests is about 403 ha. The forests grow in close proximity to the villages.

The population collects non-timber forest products, which is an additional source of income for them. They also use forests for grazing, however the forests are used mainly for collecting firewood. According to the locals, one household needs 10 m3 of firewood a year at a cost of about 300 GEL.

During summer season the population uses firewood only for cooking in small amounts, more commonly using liquefied gas for cooking (the cost of 5 kg of gas is about 13 GEL); provided to the population with special vehicles directly in the territory of the community.

3.3 Rivers flowing on the territory of the community

The Alazani river and its general hydrological characteristics

The Alazani River – the second largest river in eastern Georgia has its source on the southern slopes of the Caucasus Range at an altitude of 825 m, at the conjunction of two rivers - Tsiplovaniskhevi and Samkuristskali, at the village of Khadori. The Alazani River joins Mingachevir reservoir at the southern edge of the Gare Kakheti highland. The length of the river is 351 km, the total drop is 745 m, and its average gradient is 0.0021. The area of the watershed comprises 11,800 km^2.

1,803 tributaries of various types, with a total length of 6,851 km, flow into the Alazani River. The watershed of the river is asymmetric. 65.3% of the watershed of the Alazani river is located on the left side of the river. A 20 km long upstream section of the watershed, from the source up to city of Akhmeta, is located within the high and medium mountainous zones of the Caucasus Range. The remaining 330 km of the watershed stretches from the city of Akhmeta to the confluence, located on the Kakheti intermountain lowlands.

The watershed is bordered by the Caucasus Range in the north and north-east. The average height of the Caucasus Range at this section varies between 2,600-2,800 m above sea level. The western border of the watershed lies on the Kakheti Range and its extension – the Gombori Range. Their highest points vary from 1,682 m (Mount Manavis Tsivi on the Gombori Range) to 2,050 m (Mount Gareja on the Kakheti Range). The lower part of the watershed is bordered by the Gare Kakheti Plateau in the south-west. Its average altitude varies from 700 m to 1,084 m above sea level.

The upstream section of the Alazani River watershed, located within in high and medium mountainous zones of the Caucasus range, is dissected by deep gorges and eroded ravines. This part of the watershed is made up of sand-stones and clay shales, which are widespread on the left side of the watershed. On the right side of the watershed limestone and conglomerates are found. The downstream area of the watershed is made up of quaternary alluvial and alluvial–diluvial sediments. Soils and vegetation of the watershed are diverse. Loamy forest grey soils are found in the mountainous part of the watershed.

Alluvial non-carbonate forest soils are present downstream on the left side of the of the watershed, while alluvial carbonate soils are found on its right side. Medium and heavy loamy forest brown soils are widespread on the north-eastern slopes of the Tsiv-Gombori Range. Alpine meadows are found at altitudes from 2,000 m up to 2,200 m. Deciduous forests grow below 1,400 m. Lowlands are used mainly for agricultural purposes. Natural vegetation is formed of thin shrubbery and semi-desert vegetation. The head of the river gorge is box shaped. Its slopes merge with the slopes of adjacent mountains. The river gorge downstream of the city of Akhmeta is not clearly formed. The riverbed from the source up to the Chiaura bridge is meandering and branched. The river banks are steep and covered with pebbles. Downstream of the Chiaura bridge, the river flows in a single unbranched riverbed. The riverbanks are made up of argillaceous soils prone to erosion during floods and flashfloods. After joining the Matsimi River, the Alazani River becomes a freely meandering flow. As a result of washing from the meandering and riverbed straightening some forested floodplains appear on the territory of Azerbaijan. The width, depth and velocity of the flow vary from the river source to the convergence. The width of the flow varies from 10-12 m (at the village Birkiani) up to 60-80 m (downstream of the junction with the Argichay River). The depth varies from 1.0-1.5 m up to 4.5-5.8 m. The velocity varies from 1.5-2.5 m/sec to 0.8-1.2 m/sec. The riverbed is covered with pebbles at its source. Downstream of the Chiaura bridge the riverbed is sandy. The river is fed by snowmelt, rains and ground waters. The pattern of the flow is characterized by spring floods caused by Snowmelt, flashfloods caused by summer and autumn rains, and relatively low water levels in winter. The flow during the spring-summer flood period is 65-72% of the annual flow (35-40% during spring and 30-32% during summer). The autumn flow is 20-23% of the annual flow, although it often increases to summer levels. Winter is characterized by low waters. The winter flow is 8-18% of the annual flow.

Observations of the Alazani River runoff have been conducted by 11 hydrological posts since 1912. 4 hydrological posts were operational until 1991.

The Alazani River is used for irrigation and energy generation purposes. There are 23 irrigation canals, including 3 main irrigation canals and one large pump station on the Alazani River and its tributaries.

Other canals are of local importance. Besides the main and local irrigation canals there are 5 irrigation water reservoirs within the Alazani River watershed. The Khadori hydro power station, with 24 megawatt installed capacity, has been constructed and recently opened at the source of the Aazani River – at the conjunction of the rivers Samkuristskali and Tsiplovaniskhevi. The Alazani hydro power plant, with 4,8 megawatt installed capacity, operates on the main canal of the Lower Alazani irrigation system.

The Kvitezis Khevi River and its general hydrological characteristics

The Kvitezis Khevi River (village Birkiani) – a right tributary of the Alazani River flows through the territory of the village Birkiani. Morphologically, the river gorge is a symmetric watershed. Its main riverbed has developed a deep eroded gorge with dry ravines and dingles on its sides. The Kvitezis Khevi River takes its rise on the steep (35-40^0) south-west facing slope of the Sopro hill at an absolute elevation of 1,300 m. The river flows into the Alazani River from the right side of the village territory. The length of the river is 3 km. The difference between its height at the source and confluence with Alazani is 620 m; the area of the watershed is 3 km^2. The river is characterized by the occurrence of mudflows.

The Dzibatkhevi River and its general hydrological characteristics

The Dzibatkhevi River – a right tributary of the Alazani River flows north-west of the village Birkiani (the Pankisi gorge). The gorge is surrounded by the ranges of Kakhuris Gori and Sofaros Gori and borders the Batsara Reserve to the north. Morphologically, the gorge of the Dzibatkhevi River is a symmetric watershed with steep slopes and a number of V-shaped deep gutters, periodical watercourses and dingles.

The Dzibatkhevi River and its tributaries take their rise on the steep (30^0) east facing slope of the Kekhurisgora range at the absolute elevation of 1,340 m. The river flows into the Alazani River from the right side north of the village Birkiani. The length of the river is 3 km. The difference between its height at the source and confluence with Alazani is 615 m; the area of the watershed is 4,718 km^2. The total length of its river network is 15,981 km.

3.4 Infrastructure

Drinking water infrastructure

Based on the information provided by the locals during the working meetings there are eight water collection reservoirs in the territory of the community supplied with water from filtrates of the Alazani River. Water is supplied to the population through pipes. The pipeline network covers about 95% of the community but is outdated and requires rehabilitation. It is noteworthy that some of these water reservoirs are located within the Alazani Riverbed, thus creating an increased risks of accidents in the case of natural disasters; this may lead to a shortage of drinking water in the community.

Drinking water is supplied 24 hours a day. However, during droughts in summer the population is forced to use during water for irrigation due to the lack of an irrigation system, thus leading to a shortage of water in most cases.

According to the local population the quality of water is satisfactory, except during rainy seasons, when drinking water becomes muddy due to the critical condition of the water supply network. About 60% of the population have got wells they use for drinking, especially in bad weather.

Irrigation infrastructure

The irrigation system of the village Jokolo has been underdeveloped even over the past few years. At present it is completely destroyed and drinking water is being used for irrigation of some areas, which leads to a shortage of water in the summer.

Road and social infrastructure

The community is crossed by a 9 km long section of the main motor road (the road to the city of Akhmeta). The motor road located within the territory of the community is in a good condition (asphalted). The only exception is a 1 km long section located at the end of the village Birkiani that requires rehabilitation. The length of internal (village and access) roads is about 16 km. These roads are in a poor condition and require rehabilitation in many locations. There is one foot bridge connecting the villages of Birkiani and Omalo. The present condition of the bridge is satisfactory.

There are 410 residential houses (230 in Jokolo, 148 in Birkiani and 32 in Dzibatkhevi) in total in the Jokolo community. Mainly these are standard one or two-storied permanent structures built of stone and blocks.

The Jokolo community has a permanent electricity supply. The electricity transmission system covers the whole community. However, the existing electricity transmission infrastructure (power transmission networks, poles) is outdated and requires rehabilitation. The poor state of this system often, especially in bad weather, leads to electricity cuts that often damage household electric appliances. The total length of the electricity transmission system is about 25 km and requires rehabilitation.

The community is not supplied with natural gas.

Drainage channels are located along the main motor road on its both sides within the 9 km long section. The system is in a satisfactory condition, however, an additional 3 km section should be built to prevent damage to local infrastructure and sanitary problems in the community. The existing channels are in a good condition.

The community has no sewage system; the population uses simple latrines. Some proportion of domestic wastewater flows into sewer pits arranged by the population and the other part flows to so-called canoes - surface drainage canals.

There are no dumpsites in the community. A municipal garbage truck removes garbage from the waste bins located along the main motor road once a week, although the majority of the population disposes household wastes into self-made pits. The rest of the population throws garbage into the ravines and rivers.

There are no infrastructure facilities that pose a threat to the community.

Medical service

An ambulance service provides medical services to the community. According to the locals, the building of the ambulance service is in a satisfactory condition, however it lacks both drugs for first aid (bandages, iodine, serum, etc.) and basic medical equipment. 3 nurses are employed at the service. The first aid brigade providing medical assistance to the population of the Jokolo community is located in the village Duisi (at a distance of 5 km from the village).

Table 2 provides a summary of information on the units of analysis for the Jokolo community, identified during the working meetings with the local population and consultations with the relevant experts.

Table 2. Units of analysis identified in the Jokolo community

Unit of analysis	Description/Importance
Agricultural lands	• Agriculture is the main source of income for the community. • Total area of agricultural lands is up to 1,400 ha. • Main crop – corn. • Animal breeding is the main branch of agriculture. 1,200 heads of cattle, 930 heads of sheep.
Forests adjacent to the community	• Source of firewood. • The population uses non-timber forest resources. • Forests are used for grazing. • The area of forests in around 400 ha.
Hydrographical network	• Main rivers of the community are: Alazani, Kvitezis Khevi, Dzibatkhevi. • Filtrates of the Alazani River are the main source of drinking water for the community. • The rivers of the community are the main source of hazards occurring in the community.
Infrastructure	• Drinking water supply depends on the condition of the relevant infrastructure. • Road and social infrastructure is important for the development of the community and improvement of the living conditions of the population. • The condition of the infrastructure is an important factor determining the vulnerability of the community.

4. Problems / challenges faced by the Jokolo community

The present chapter contains a brief description of problems and challenges faced by the Jokolo community. A special emphasis is placed 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 in the agricultural sector of the Jokolo community

The agricultural sector of the Jokolo community faces a number of problems.

The main problems related to crop growing are the non-existence of an irrigation system in the community, low fertility of soils and improper land treatment practices.

As has been already noted, the irrigation system of the Jokolo community was underdeveloped even in the Soviet times. At present it is completely destroyed and therefore drinking water is used for irrigation of small areas, which leads to the shortage of water in summer and often gives rise to conflicts among community members. The shortage of irrigation water limits the choice of agricultural crops and harvests.

Unwatered conditions, low fertility of soils, non-existence of crop rotation practice and deficiency of quality seeds determine the extremely low yields of crops, especially wheat (0.5 tons per ha).

One of the main reasons for the low fertility of soils in the community is improper soil cultivation practices. In particular, the local population mainly uses manure as a fertilizer, however, the absence of manure storage facilities and/or improperly organized manure storages does not ensure preservation of nutrient content in manure. Manure stored in this manner, or so-called fermented manure, is ineffective at increasing soil fertility.

As has been stated, the main source of income for the local population is animal breeding. Therefore the problems existing in this field negatively affect the economic and social conditions of the local population, decreasing community resilience and increasing vulnerability to climate change and natural disasters.

Invasion of weeds (*Ambrosia sp.*) on the majority of pastures and arable lands of the community is one of the main problems related to animal breeding. The sections of pastures covered by this weed are not used. Ambrosia is also widespread on arable lands. The spread of ambrosia on pastures is caused by overgrazing and uneven distribution of livestock on pastures. Grazing and the quantity of livestock on pastures is not regulated according to the condition of pastures. As a result, some sections of pastures are overgrazed while others are unused.

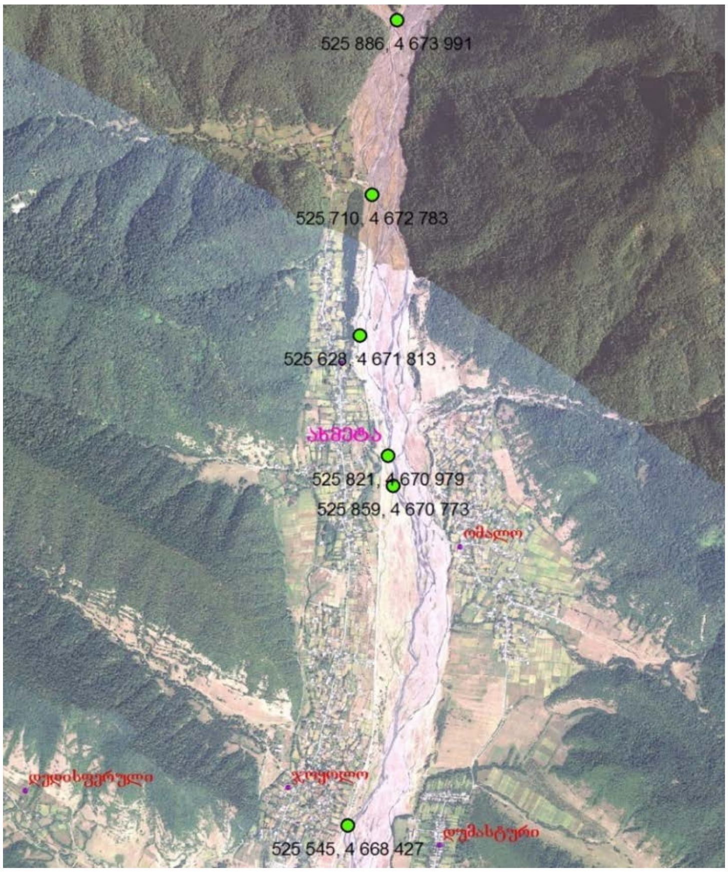
Eventually weeds, including ambrosia, occupy the overloaded pastures and livestock do not graze them, while thorns, shrubs and trees competing with valuable grasses cover unloaded areas along with weeds, leading to forestation of agricultural lands. Ambrosia is one of the most aggravating quarantine weeds flowers that causes hay fever – an allergic disease irritating the eyes and nose, and provoking a rash.

Along with the abovementioned problem, the community faces the problem of pastures in cold seasons, when sheep have to be driven to winter pastures from mountain pastures. The village Jokolo, as well as other villages of the Akhmeta municipality, was using 700 ha of pastures on the Shiraki lowland until recent years, however, these pastures are no longer available to them. Part of the pastures have been privatized, while the other part has been allocated under licenses. The existing narrow livestock driving routes also create problems in terms of increased driving time and expenses associated with the recovery costs of damage caused to crops along these routes.

<u>River erosion</u>

Identification/survey of hazardous sites and sites exposed to risks as a result of floods and flash waters on the rivers of the Alazani River basin within the territory of the Jokolo community has been carried out in accordance with the results of the consultations and working meetings with the local population during the field studies undertaken within the framework of the INRMW program. During the survey the gorge of the Alazani River from its confluence with the Batsara River up to the village Jokolo (a 6 km long section), was examined. As a result five hazardous sites were identified (Pic.1).

At the first section the Alazani River flows from a narrow V-shaped gorge, afterwards the river meanders through the floodplain, where the gorge is wider. The width of the floodplain along the study area reaches 200-400 m. There are many sites of accumulated sediments within the floodplain. The river does not have a single riverbed; it branches within the floodplain and threatens the villages, access roads and agricultural lands located on the right side of the Alazani River.



Pic. 1. Akhmeta municipality, hazardous sites identified in the Jokolo community

The first site (between coordinates - X-525886; Y-4673991 _ X-525710, Y-4672783 WGS 1984 UTM Zone 38N) – the riverside part of the village is situated on the right bank of the river from the confluence of the Batsara River up to the village Birkiani (at the confluence of the Dzibatkhevi River), on a low terrace. During floods and flash waters the river flows into the territory of the village and damages infrastructure and agricultural lands. As has been mentioned above, the floodplain and riverbed are filled with sediments transported by the river from upstream areas. The floodplain is located at almost the same elevation as the area.

Different types of bank protection structures (concrete, gabion) have been constructed in the community (Pic. 2, 3, 4). The majority of these structures are damped and require rehabilitation (their foundations have to be reinforced).

Pic. 2 The village Birkiani, the existing bank protection structure

Pic. 3, 4 The village Birkiani, damped bank protection structure, protection structures of concrete and gabion type

The second site (with coordinates - X-525628, Y-4671813 WGS 1984 UTM Zone 38N) – to mitigate the aggressive flow of the river a system of gabion toes has been constructed in village Birkiani (the central part). The length of the toes within the study site is 25-35 m, the distance between them is 130-150 m. These structures are not sufficient to mitigate the erosion processes and protect the area.

The third site (with coordinates - X-525821, Y-4670979 WGS 1984 UTM Zone 38N) during the survey carried out in the riverside zone of village Birkiani a distribution well of the local water supply system was found on the right floodplain of the Alazani River, in the immediate vicinity of the riverbed, at a distance of 11 m (Pic.5). The elevation of the floodplain at this site is rather low (0.2-0.4 m above the river level). A concrete toe has been built at a distance of 40-50 m from the well, however, the toe cannot ensure protection of the study area from flooding-scouring. Therefore the water supply system of the community is under threat.

Pic. 5. The village Birkiani, location of the water distribution well in the right floodplain of the river

The fourth site (with coordinates - X-525859, Y-4670773 WGS 1984 UTM Zone 38N) – as in the case of the third site, the water distribution well found at this site is located within a flooding and erosion zone (Pic.6).

Pic. 6. The village Birkiani, location of the water distribution well in the right floodplain of the river

Therefore the water supply system of the community is under threat of flooding-scouring.

The fifth site (with coordinates - X-525545, Y-4668427 WGS 1984 UTM Zone 38N) – a section of the Jokolo-Duisi motor road located within the village Jokolo, on the right bank of the Alazani River, is being scoured (Pic. 7).

Pic. 7 The village Jokolo, eroded right bank of the Alazani River

Within this site the motor road runs along the upper terrace of the river (at a height of 5-6 m above the river level). Therefore this area is not prone to flooding. Only side erosion occurs on the bank. The orthophoto shows that erosion of this site started many years ago. Currently the eroded step is observed 5-7 m from the motor road. In the near future the main motor road will be threatened if the present rate of this process is maintained.

As a result the whole population, farmlands and agricultural lands, as well as the road, drinking water and electricity supply infrastructure of the Jokolo community are threatened by the activity of the Alazani River (floods, mudflows, scouring). According to the locals 320 ha are at risk.

Denudation processes

Among natural the hazards occurring in the territory of the Jokolo community mudflow processes developed in the ravines are noteworthy.

The Kvitezis Khevi River

The Kvitezis Khevi River – right tributary of the Alazani River, flows in the territory of the village Birkiani. Morphologically the river gorge is a symmetric watershed. Its main riverbed has developed a deep eroded gorge with dry ravines and dingles on its sides. The Kvitezis Khevi River has its rise on the steep (35-40^0) south-west facing slope of the Sopro hill, at an absolute elevation of 1,300 m. The river flows into the Alazani River from the right side in the territory of village Birkiani. The length of the river is 3 km. The difference in height between its source and confluence with Alazani is 620 m. The area of the watershed is 3 km^2. The river is characterized by the occurrence of mudflows.

Pic. 8, 9. The Kvitezis Khevi River

The morphological characteristics of the gorge are determined by its geological structure and location within a zone of tectonic discordance, its engineering-geological and hydrogeological conditions, and its hydrological regime.

The study area is made up of heavily dislocated and cracked sediments of terrigenic-carbonate flisch from the Kimmeridgian-Titonian **(J31km+tt)** layer of the Upper Jurassic age. It consists of an alternation of clastic-limestones, rare sandstone-gravellite turbidites, quartzites, pelagite loamy limestones, marles and argillites, and oolite limestones at specific sites. At certain locations the mentioned sediments are covered by heavily weathered and cracked eluvial sediments of different thickness, by delluvial, delluvial-colluvial and colluvial sediments - on and beneath steep slopes and by prolluvial sediments of talus train – on the bottom of the riverbed. The riverbed is developed in these sediments. According to the tectonic zoning scheme of Georgia (E. Gamkrelidze, 2000) the study area is located within the Mestia-Tianeti zone of the Greater Caucasus folded system.

The morphological character (steep slopes having a high energy potential, the degree of erosion dissection of the gorge), geological structure and climate conditions of the watershed have created and still create favorable conditions for the development and activation of hazardous geological processes. In particular, landslide-erosion (vertical erosion) and mudflow processes are widespread within the villages and adjacent areas. In this context the most active is the left tributary (dry ravine) of the Kvitezis Khevi River – Pic. 10, 11.


Pic. 10, 11. The left tributary of the Kvitezis Khevi River – dry ravine

The maximum depth of the ravine is 7 m and the mean depth is 3-4 m. The sides of the ravine and the slope itself are made up of delluvial light brown loamy rocks, which are prone to erosion. The site of confluence with the Kvitezis Khevi River is made up of prolluvial sediments of the river – coarse pebble-shingle and gravel-cobble material. Currently, an active vertical erosion process is observed in the ravine, while shallow landslide processes occur on its sides (Pic 12, 13).


Pic 12, 13. Dry ravine – vertical erosion and landslide processes

The mentioned processes heavily damage the scarce agricultural lands, manly the pastures of the community. As animal breeding is the main source of income for the community, the damage to pastures will negatively affect the well-being of local farmers and the community in general.

During heavy rains the internal village road becomes unserviceable and impassable (Pic. 14).

Pic. 14. Pipe bridge at the crossing of the ravine and the motor road

A so-called pipe bridge, built at the crossing of the ravine and the motor road, hampers the transportation of materials and stone-muddy masses create a number of branches that cover and damage the road.

The Dzibatkhevi River

The Dzibatkhevi River – a right tributary of the Alazani River, flows north-west of village Birkiani (the Pankisi gorge). Its gorge is surrounded by the ranges of Kakhuris Gori and Sofaros Gori and borders the Batsara Reserve to the north.

The Dzibatkhevi River gorge is made up of heavily dislocated and cracked sediments of terrigenic-carbonate flisch of the Kimmeridgian-Titonian **(J31km+tt)** layer of the Upper Jurassic age, and consists of an alternation of clastic-limestones, rare sandstone-gravellite turbidites, quartzites, pelagite loamy limestones, marles and argillites, and oolite limestones at specific sites. At certain locations the mentioned sediments are covered by heavily weathered and cracked eluvial sediments of different thickness, by delluvial, delluvial-colluvial and colluvial sediments - on and beneath steep slopes and by prolluvial sediments of talus train – on the bottom of the riverbed. The riverbed in developed in these sediments. According to the scheme of tectonic zoning of Georgia the Dzibatkhevi river gorge is located within the Mestia-Tianeti zone of the Greater Caucasus folded system.

The morphological characteristics of the gorge are determined by its geological structure and location within the zone of tectonic discordance, its engineering-geological, and its hydrogeological conditions and hydrological regime.

Morphologically, the gorge of the Dzibatkhevi River is a symmetric watershed with steep slopes and a number of V-shaped deep gutters, periodical watercourses and dingles. The Dzibatkhevi River and its tributaries take their rise on the steep (30^0) east facing slope of the Kekhurisgora range at an absolute elevation of 1,340 m. The river flows into the Alazani River from the right side north of the village Birkiani. The length of the river is 3 km. The difference in height between its source and confluence with Alazani is 615 m. The mean inclination is 20.5%. The area of the watershed is 4,718 km^2. The total length of the river network is 15,981 km. The degree of erosion dissection of the watershed is 3.39 km/km^2.

The morphological character, geological structure and climate conditions of the watershed have created, and still create, favorable conditions for the development and activation of hazardous geological processes (mainly mudflows). As a result of the accumulation of solid sediments in the downstream and confluence areas a talus train has developed. This is currently a settled territory. Later the intensity of hazardous processes decreased considerably. The slopes of the gorge are covered by thick and aged deciduous forests, while the riverbeds of the river and its tributaries are covered by perennial vegetation, indicating that large scale mudflows have not occurred there for a long period of time. Therefore only small scale flows of mud-debris and mud of low density have accumulated in the middle reach areas. Intense felling of forests growing on the steep slopes of upstream areas and adjacent territories occurred during recent years and the exposed the slopes created favorable conditions for the development (initiation-development) of new hazardous geological processes. With regards to this, an event in 2007 is noteworthy; during heavy rainfall 3 villagers died in a flash mudflow that was generated as a result of the scouring of soils from exposed steep slopes.


Pic. 15, 16. The Dzibatkhevi River

Currently no large-scale geological processes are observed within this site and its adjacent areas, except erosion (scouring) occurring along a 15 m section of the right bank of the Dzibatkhevi River (coordinates of the site: X-524726; Y-4673131) – Pic. 17, 18.

Pic. 17, 18. Erosion process occurring on the Dzibatkhevi River / bank scouring – damaged motor road

This process results in damage to the internal village road and water pipeline.

A similar problem is observed in the area adjacent to the village, where bank scouring occurs at a 30 m long section located on the right side of the river (coordinates of the site: X-525167; Y-4673077) – Pic. 19, 20. This process threatens the pastures adjacent to the village.

Pic. 17, 18. Erosion process occurring on the Dzibatkhevi River / bank scouring – area adjacent to the village

Condition of forests

Forests and forest resources play an important role in the life of the community. On one hand forests provide heating resources for the local population and additional incomes from selling non-timber forest resources, on the other hand the forests and their condition determine the scale and intensity of hazardous processes occurring in the community.

At the working meetings with the local population it was revealed that the forests adjacent to the community have been intensively cut over the past few years and this has resulted in their degradation. Such a condition of forests led to the activation of hazardous natural processes. Disasters occur in areas where, according to the locals, they had never happened before. According to them, the event that occurred in the Dzibatkhevi River gorge in 2007 and led to the death of 3 people was associated with the degradation of forests on the slopes of the watershed. The experts' judgment confirms the opinion of locals. The field study confirmed that frequent mudflows occurring in the community are caused by intense felling of forests on the slopes of the watershed and adjacent areas over recent years.

Table 3, below, contains a summary of information on the problems and challenges identified in the Jokolo community on the basis of working meetings with local population, consultations with relevant experts, and the impacts of their units of analysis:

Table 3. Problems identified in the Jokolo community and corresponding units of analysis

Identified problems/impacts	**Corresponding units of analysis**
Shortage of irrigation water affecting productivity. The population uses drinking water for irrigation which leads to seasonal shortage of drinking water.	• Agricultural lands • Infrastructure (drinking water system)
Degraded agricultural lands – arable lands. Inadequate soil cultivation practices leading to low soil productivity.	• Agricultural lands
Degraded agricultural lands – pastures. Weeded (Ambrosia) pastures and unregulated grazing lead to reduction of carrying capacity of pastures.	• Agricultural lands
Shortage of pastures, especially winter pastures (pastures used by the community in previous years are now allocated under licenses) forces the population to reduce the quantity of livestock.	• Agricultural lands
The livestock driving routes are badly organized and narrow, leading to increased driving time and costs (expenses associated with the recovery costs of damage caused to crops along these routes). Increased costs makes livestock breeding ineffective.	• Agricultural lands
Floods and flash waters occurring as a result of river bank erosion cause serious damages to the community.	• Agricultural lands • Hydrographic network • Infrastructure – (drinking water system/intake, motor roads, electricity transmission lines, etc.)
Mudflow processes contribute to the reduction of harvests, drinking water and electricity supply systems of the community are under the threat. These processes led to human deaths.	• Agricultural lands • Hydrographic network • Infrastructure – (motor roads, water supply system, electricity transmission lines, residential houses)
Degraded forests determine the acceleration of hazardous natural processes.	• Agricultural lands • Hydrographic network • Forests • Infrastructure

5. Climate change and its consequences

After identification of the existing challenges in the community trends of climate change have been identified to determine its potential impacts in terms of emerging challenges and tge aggravation of existing problems in the community. Climate change trends have been 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 4 contains the trends of climate change with descriptions of the potential direct impacts and indications of those units of analysis that might be affected by the mentioned changes.

Table 4. Climate change and potential direct impacts

Climate change trends	Direct impacts	Corresponding units of analysis
Expected increase of all parameters of air temperature (mean annual, seasonal, etc.)	• Change of the agricultural calendar. • Increase in temperature will result in higher evapotranspiration rates and determine increased demands of plants on irrigation water on the background of expected increase of dry periods despite of the growth of total amount of rainfall.	• Agricultural lands • Hydrographic network • Infrastructure – drinking water system
Increased precipitation. Change of the seasonal distribution of precipitation. Increased probability of extreme precipitation – growth of the number of days when daily precipitation exceeds 10, 20, 50, 90 mm. Increase in the number of cases when annual precipitation exceeds its mean index by 200 mm and more. Increase of the duration of continuously rainy periods.	• Expected increase of occurrence and intensity of floods and the consequent increased risk of flooding and acceleration of erosion of riverside areas • Increased risk of accelerated landslide processes. Accumulation of alluvial-prolluvial coarse materials along the beds of ravines characterized by mudflows and filling the ravines with these materials. Sharp reduction of conveying capacity of ravines and the possible overtopping of mudflows onto the areas adjacent to the riverbed. Severe erosion and sanding-silting of these areas • The areas prone to mudflows, floods, flash waters and landslides will face increased risks • Increased risk of accelerated landslide processes.	• Agricultural lands • Hydrographic network • Infrastructure – drinking water system, motor roads, electricity transmission lines, utilities, residential houses, etc.

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

6. Combined impacts in the Jokolo community

The challenges faced by the community and the potential consequences of climate change have been combined to assess their impacts on the units of analysis. The assessment was made on the basis of the results of experts' work and participatory working meetings with the local population.

Impacts on agriculture

Under forecasted climate change scenarios an increased demand for irrigation water (mainly in case of vegetables) is expected in the Jokolo community. This is due to increases in the duration of continuously dry periods that will mitigate the forecasted increase in precipitation. Under such conditions qualitative degradation of already poor and low productive agricultural lands in the community is expected, this will negatively affect both qualitative and quantitative characteristics of agricultural yields and lead to increased expenses in agriculture.

Pastures and haylands of the community will be also affected by climate change. Under conditions of changed climatic parameters (temperature, precipitation) a shift in the hay cutting and grazing periods is expected. Moreover, aggravation of pre-existing problems in the background of pasture overgrazing is expected. In particular, weed infestation, degradation of haylands, and the acceleration of water and wind erosion are expected.

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

Negative natural phenomena

The analysis of the situation shows that the Jokolo community is being affected by negative natural phenomena such as river erosion that leads to flooding of the territory of the community and causes damage to the infrastructure during floods and flash floods. The frequency of occurrence of mudflows in the ravines of the community is high. Mudflows severely affect utilities, agricultural lands and residential houses in the community. Mudflows have also resulted in human deaths over recent years. The scale of natural processes occurring in the community is described in detail in Chapter 4.

According to the climate change scenarios an increased risk of the acceleration of mudflow processes is expected due to increased precipitation. Increased occurrence and intensity of floods and flash flood waters is also expected. These processes will lead to an acceleration of river erosion. Moreover, the forecast of rainfall distribution shows that the risk of development of landslide processes for the community, which is currently not critical, may increase in the future. Therefore, damage caused by negative natural phenomena to the Jokolo community will increase. The areas currently being threatened by these hazards will be most affected.

The analysis on the combined impacts of climate change shows that it will have a high impact on the development of hazardous natural processes in the Jokolo community.

Table 5, below, contains a summary of the information on combined impacts.

Table 5. Combined impacts identified in the Jokolo community

Combined impact	Corresponding units of analysis
Soil degradation (deterioration of quality), reduction in the volumes and deterioration in the quality of agricultural products.	• Agricultural lands
Degradation of pastures and haylands as a result of changed climate parameters. Resulted reduction of livestock and incomes from animal breeding.	• Agricultural lands - pastures
Reduction of the volumes of agricultural products due to increased demand on irrigation water and increased temperature, as well as changed agrotechnical terms.	• Agricultural lands
Accelerated floods, flash waters, river erosion and mudflows will lead to increased damages of agricultural lands and infrastructure of the community. Acceleration of landslide processes is also expected.	• Agricultural lands • Hydrographic network • Infrastructure

7. Adaptation and disaster risk reduction activities

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

Agriculture

As has been stated above (see Chapter 4) the main problem related to agriculture in the Jokolo community is weed infestation (*Ambrosia sp.*) in pastures and arable lands. As a result a considerable portion of agricultural lands have become useless. To solve this problem and prevent the spread of ambrosia permanent weed control is needed, especially during the period of their active growth and flowering. During the vegetation period weeds have to be sowed several times to limit their spread and initiate decline. However, removal of ambrosia from pastures using this method may need some years. Considering the above-mentioned improvement of the areas heavily infested with weeds may be required. This will imply plowing of the area and sowing of forage grasses (e.g. English ryegrass, white clover, meadow fescue, orchard grass, etc.). Weed control on arable lands can be carried out through timely tilling, distributing residuals of main crops, or plowing and sowing catch crops or winter cover plants. Selective herbicides can also be applied, however, herbicides should be selected for each individual crop and applied according to the relevant rules, to avoid damage to crops.

Along with the above-mentioned, implementation of measures oriented at solving the existing problems is important for adaptation of the community to future climate change. These measures include facilitating the growth of incomes from agriculture, building resilience, and reducing the vulnerability of the population to climate change and natural disasters. The suggested measures are also important for changing climactic conditions.

1 Under predicted climate change scenarios an increased demand on irrigation water is expected in case of further development of vegetable growing. Increase in mean annual (as well as summer) precipitation by 219-448 mm will allow cultivation of some agricultural crops under unwatered conditions. However, the increase in mean annual temperature by about 2.5-2.8 ^{0}C is expected to lead to increased evapotranspiration. Therefore, it is very important to implement activities that will ensure retention and increase of moisture content in soils, especially in the case of moisture-loving plants:

a) Increasing soil productivity on the basis of the study of existing productivity of arable lands and considering characteristics of agricultural crops will be required. The content of organic matter in soils should be increased, since the organic matter of soil is able to retain 10 times as much water as its weight. Therefore its content determines the ability of soils to retain moisture. This can be achieved through the application of organic fertilizers. Taking into account the current level of soil fertility, it is necessary to apply 25-30 tons of composted manure, compost manure or compost per 1 ha of land. The amount of fertilizers can be increased depending on the needs of crops, or if applied to soils low in organic matter.

The content of organic matter in soils can also be increased by sowing green manure (so-called green fertilizers). For this purpose mainly legumes (e.g., vetch, grass pea) are used. Green manure can be used under perennials (vine, fruits), as well as in case of annual crops. To prepare land plots for autumn cereals (wheat, barley) green manure showed be sowed in spring and ploughed into the soils during their flowering period, while in case of spring crops (corn, majority of vegetables and vine crops) they should be sowed in autumn (September-October) and ploughed into the soils prior to sowing main crops.

b) Mulching is an important activity to ensure retaining of moisture in soils. Mulching is effective in case of vine and other perennials. Mulching material should be made of locally available hay or crop remains. Hay used for mulching should not contain the seeds of weeds, therefore grass should be mowed during the flowering season. Mulching under perennials has to be done in spring before rains, in the case of vegetables – after transplanting or when sprouts reach a desirable height.

Along with the dead mulch so-called live mulch can be used between rows of perennials. For this purpose cover plants have to be sowed. Cover plants are comprised of legumes or a combination of legumes and grain grasses. Cover plants retain moisture in soils as well as revitalizing and improving their structure. The presence of legumes (vetch, grass pea, clover, etc.) in cover plants ensures the accumulation of biological nitrogen in soils and thus improves consumption of nitrogen by main crops.

The use of cover plants on arable lands is important in the case of spring crops, when soils are free from vegetation during autumn-winter and early spring. During this period cover plants can protect soils form erosion, retain moisture in soils, restrict the development of weeds, accumulate biological nitrogen and provide significant amounts of green mass that can be used as green fertilizers, forage and preparation of mulch and nourishing hay.

Construction of drainage ditches is important for agricultural lands located on slopes. Ditches have to be built across the upper or middle parts (if needed) of the slopes to collect and direct surface waters to natural water bodies (springs, rivers, ravines) or larger canals.

0.5-0.6 m wide buffer strips of perennial grasses are widely used for water erosion control. These strips retain loose-solid flows, contribute to the growth of crop productivity and increase soil humidity. The width of the duffer strip increases with the slope inclination. An anti-erosion effect is achieved when hoed plants and trees alternate with strips of grain crops or perennial grasses.

2 Cattle breeding and animal breeding in general are the main agricultural activities in the Jokolo community. To increase the productivity of cattle an improvement in the local breeding stock is required that will enable the doubling of milk yields. Selection of relevant breeds is needed for beef husbandry.

The Jokolo community does not have enough grazing areas to maintain the existing livestock herds only through pastures. Therefore the forage base has to be improved through effective use of arable lands and through feeding livestock with additional concentrated foodstuff (e.g. corn, barley, soya).

Mowing periods should be adequately selected and observed. On one hand late mowing leads to the deterioration of hay quality, while on the another hand, early mowing leads to the decline of pasture productivity. E.g. the following schedule can be used:

1) In the first year mowing shall take place during ripening period of main forage grain crops; 2) In the second year – when crops begin to ear; 3) In the third year – during flowering; 4) In the fourth year – after seed fall.

Grazing height considerably impacts the productivity and regeneration ability. The grazing height should not be lower than 4-5 cm, while the height of post grazing residual should not be at 10-15 cm. In this case the pasture will not be fully used.

Sowing of alfalfa is recommended on arable lands freed from main crops. This plant can be used during 5 years and can be sowed twice a year from the second year of sowing, meaning up 10 t high-quality annual yield (in the case of proper maintenance).

3 Maintenance of local breeds of sheep and moderate pasture loads is important for the development of sheep breeding in the Jokolo community. For this purpose plot rotation practices should be introduced to maintain the productivity of pastures and enable their improvement, which in turn will give local farmers the possibility to increase the number of sheep.

4 Natural conditions of the Jokolo community are favorable for beekeeping development. Both field and forest vegetation are available for bees and therefore beekeepers are able to produce diverse goods. To make beekeeping more profitable production of beekeeping products other than honey should be promoted. The role of bees in the growth of the pollination index for a major part of agricultural crops (leading to increased yields) should also be considered. To support the development of bee keeping nectariferous plants should be included in seed rotation, cover plants and pastures (sainfoin, alfalfa, clover, etc.).

Hazardous natural processes

River erosion

To mitigate river erosion and protect eroded river banks, which in turn will ensure the protection of road infrastructure and agricultural lands from floods and flash floods, bank protecting gabions have to be constructed at the identified hazardous sites.

The first site (between the coordinates - X-525886; Y-4673991 _ X-525710, Y-4672783 WGS 1984 UTM Zone 38N) – a 420 m long gabion wall should be constructed and a 100 m long section of the existing structure should be reinforced to protect the territory and the infrastructure (water intake facility) of the village.

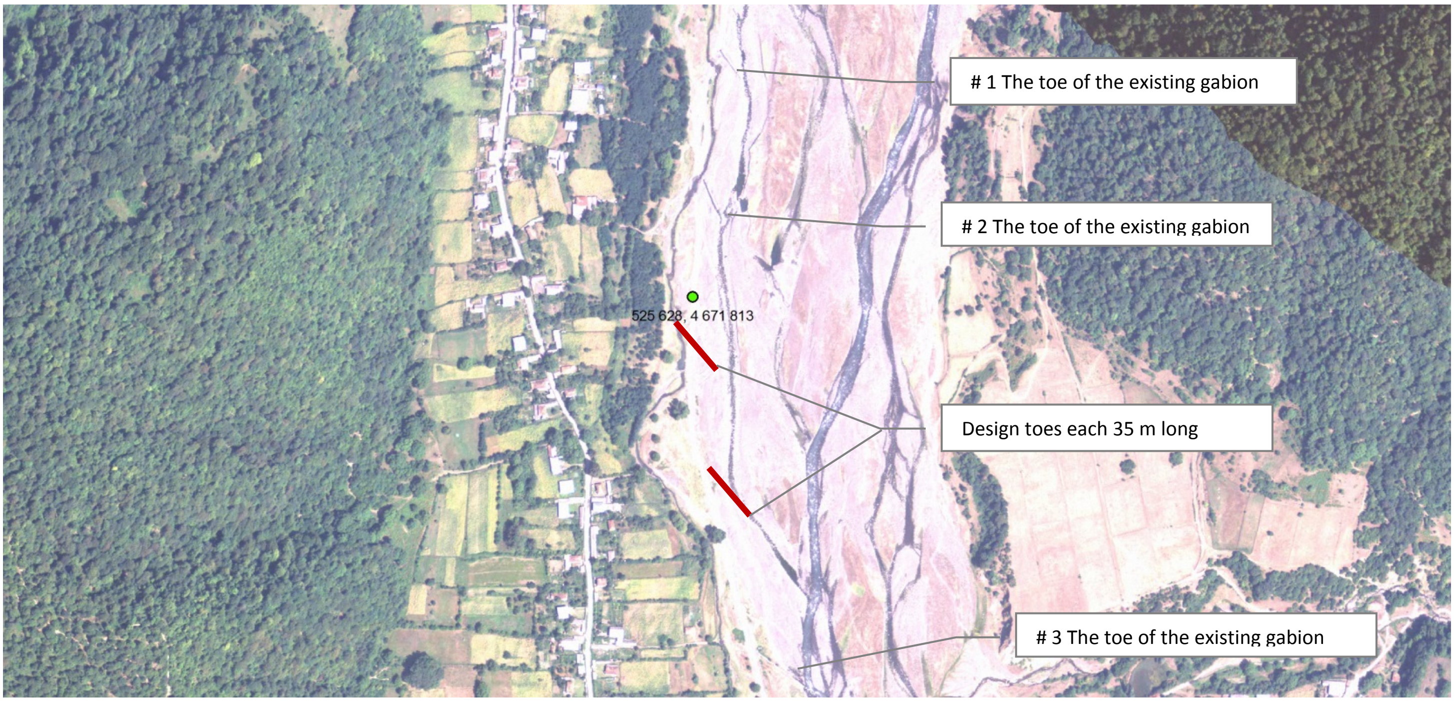
At this section the discharge of 1% probability is 500 m^3/sec. On the basis of the results of field works carried out with simple surveying instruments and the data obtained from topographic maps it has been found out that the maximum depth of the river during design floods, including scouring and flooding, is 4.8 m.

The estimated volume of the gabion wall is 2,710 m^3. To reinforce the foot of the existing wall a concrete toe (volume 180 m^3) should be constructed.

The estimated cost of the construction and installation of the gabion wall is 430,900 GEL, the cost of the construction of the toe is 38,000 GEL. The total cost of the rehabilitation of the first site is 470,000 GEL.

The second site (coordinates - X-525628, Y-4671813 WGS 1984 UTM Zone 38N) – as has been mentioned above scouring of the right bank of the river occurs at this site. A system of gabion toes should be constructed for the purpose of erosion control. The existing structures do not ensure abatement of erosion and protection of adjacent areas.

Based on the results of field surveys we deem it appropriate to construct two new toes at 100-120 m intervals between the second and the third toes indicated in Pic. 19, to abate erosion processes. The new toes will be located 100 m from the existing one. The length of the design toes should be 35 m. The angle of inclination of the toes against the bank should be 35-40^0.



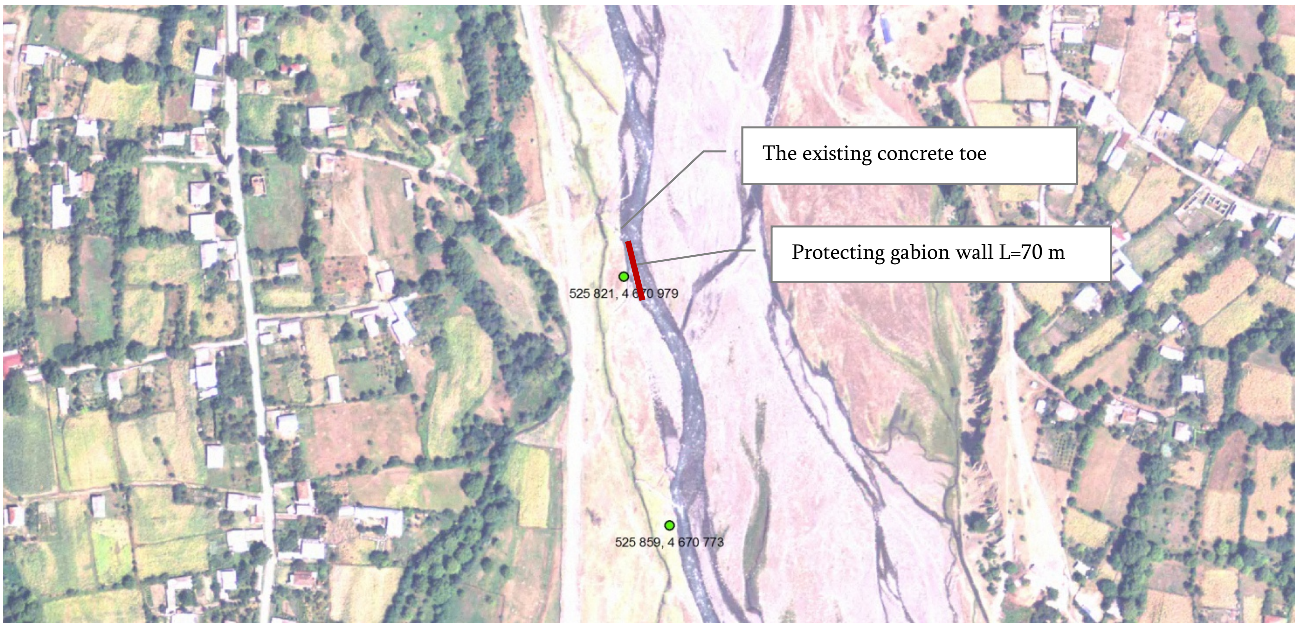
Pic. 19. Location of design toes on the right side of the river in the village Birkiani

The estimated volume of design gabion toes is 812 m^3.

The estimated cost of the construction and installation of the gabion toes is 130,000 GEL.

The third site (coordinates - X-525821, Y-4670979 WGS 1984 UTM Zone 38N) – a water distribution well (drinking water supply system of the community) located within the right floodplain of the Alazani River is under the risk of flooding-scouring. The elevation of the floodplain at this site is rather low (0.2-0.4 m above the river level). A concrete toe constructed at a distance of 40-50 m from the well does not ensure protection of the study area.

To protect the water distribution well of the drinking water supply system of the community it is recommended to construct a 60-70 m long gabion wall at the existing concrete toe (Pic. 20).



Pic. 20. The scheme of protection of the water distribution well on the right bank of the river in the village Birkiani

The estimated volume of the design gabion wall is 452 m^3.

The estimated cost of the construction and installation of the gabion wall is 72,000 GEL.

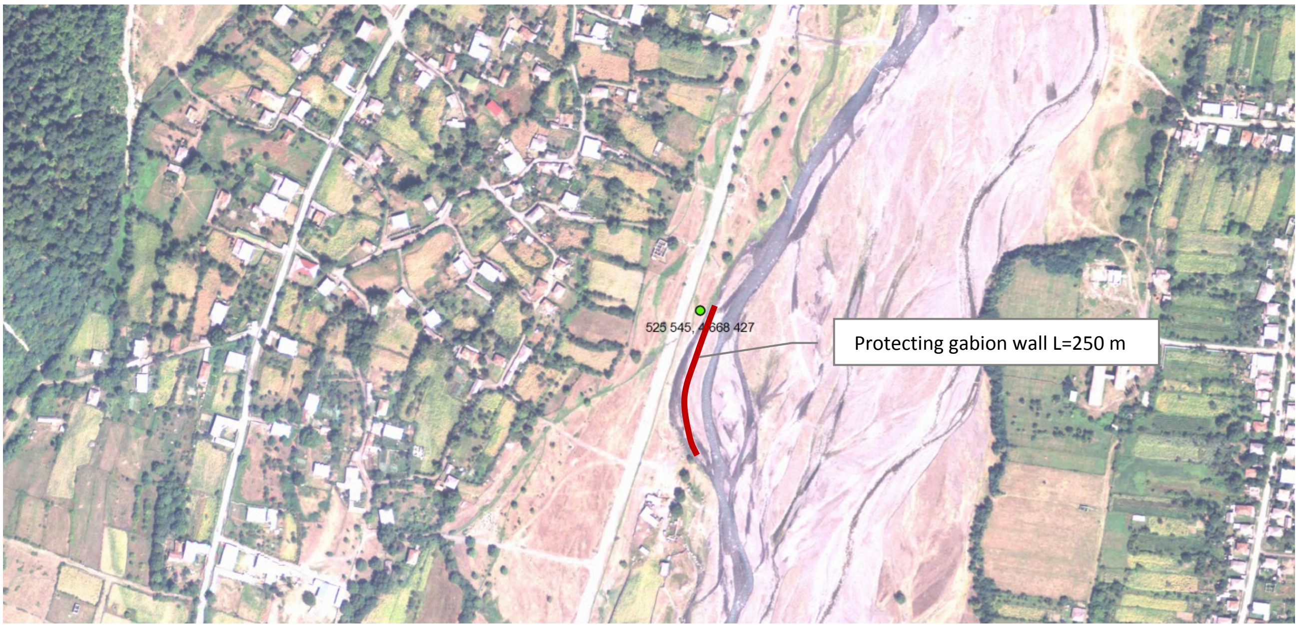
The fourth site (coordinates - X-525859, Y-4670773 WGS 1984 UTM Zone 38N) – as is the case at the third site, the distribution well found on this site is located within flood and erosion zone and therefore the water supply system of the community is under the risk of flooding-scouring. To protect the water distribution well of the drinking water supply system of the community it is recommended to construct a 40-50 m long gabion wall at the existing concrete toe (Pic. 21).

The estimated volume of the design gabion wall is 323 m^3.

The estimated cost of the construction and installation of the gabion wall is 51,500 GEL.

Pic. 21. The scheme of protection of the water distribution well on the right bank of the river in the village Birkiani

The fifth site (coordinates - X-525545, Y-4668427 WGS 1984 UTM Zone 38N) – a section of the Jokolo-Duisi motor road located in the village Jokolo, on the right bank of the Alazani River, is being scoured. To abate river erosion it is recommended to construct a 250 m long gabion wall (Pic. 22), the parameters of which shall be determined considering design scour and flood levels. Application of bioengineering methods is recommended upstream of the structure to protect the slope from the effect of surface flows.



Pic. 22. The scheme of protection of the road located on the right bank of the Alazani River in the village Jokolo

The estimated volume of the design gabion wall is 1,630 m^3.

The estimated cost of construction-installation of bank protection structures is 280,000 GEL.

Mudflow processes

Regarding mudflow processes two sites – the rivers Kvitizis Khevi and Dzibatkhevi – were identified on the territory of the Jokolo community where relevant risk reduction activities have been planned:

Site I – The Kvitizis Khevi River

The Kvitezis Khevi River is characterized by erosion and mudflow processes creating serious problems in the community (Chapter 4). The implementation of the following protection measures is recommended to mitigate impacts of hazardous natural phenomena at this section:

- A row of barrages should be installed in the riverbed of the dry ravine – the left tributary of the Kvirezis Khevi River - to decrease the rate of landslide processes on the slopes of the ravine.

- The riverbed should be deepened and cleaned in the motor road crossing zone of the dry ravine.

  The diameter of the so-called pipebridge should be increased, or another similar pipe should be added. The pipe(s) will be cleaned from debris (sediments) periodically.

- The riverbed of the Kvitezis Khevi River should be periodically cleaned of mudflow materials.

Site II – Dzibatkhevi River

The implementation of the following measures on the Dzibatkhevi River is important to mitigate the effects of erosion processes and prevent future damage:

- To mitigate erosion processes occurring on the right bank of the river along a 15 m section (coordinates: X-524726; Y-4673131) a ragged stone embankment or gabion wall should be constructed.

- A 30 m long section of the left bank of the river, adjacent to the Jokolo community, is being scoured (Chapter 4). In this case the construction of a ragged stone embankment or gabion wall is recommended (coordinates of the site: X-525167; Y-4673077).

Table 6, below, contains a summary of information on climate change adaptation and natural disaster risk reduction activities that should be implemented in the Jokolo community.

Table 6 Summary of climate change adaptation and disaster risk reduction activities to be implemented in the Jokolo community

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
Global aim of the activities: • Adaptation and increase the resilience of agriculture of the Jokolo community to climate change and natural disasters • Reduction of vulnerability of the Jokolo community					
Measures for improvement of weeded agricultural lands: • Plowing pastures and sowing forage grasses. • Timely tilling of arable lands, disturbing residuals of main crops or plowing. • Sowing catch crops or winter cover plants.	• Reduction of the degradation (weed infestation) of agricultural lands • Expansion of the agricultural areas through improvement of degraded agricultural lands	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Application of selective herbicides - herbicides shall be selected for each individual and applied according to the relevant rules.	• Reduction of the degradation (weed infestation) of agricultural lands • Expansion of the agricultural areas through improvement of degraded agricultural lands	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Application of organic fertilizers (manure, manure-compost, compost) to agricultural lands (25-30 tons per 1 ha) on a regular basis.	• Increase of soil fertility • Increase of the content of organic substances in soils • Increase of the moisture content and retention capacity of soils	< 50,000	**ST**	• Local farmers • Agricultural development services • Local self-governance	• 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
Sowing green manure (so-called green fertilizers) mainly legumes (e.g., vetch, grass pea) on agricultural lands. Education and awareness-raising of farmers on this issue.	• Increase of soil fertility • Increase of the content of organic substances in soils • Increase of the moisture content and retention capacity of soils	< 50,000	**ST**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Introduction of the practice of mulching on agricultural lands, under perennials and vegetables. Application of both dead mulch and cover plants. Education and awareness-raising of farmers on mulching.	• Increase of the productivity of perennials • Retention of moisture in soils • Improvement of soils structure • Accumulation of biological nitrogen in soils • Protection of soils from erosion • Ensuring additional forage basis for animal breeding	< 50,000	**ST**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Construction of drainage ditches on agricultural lands (arable lands) located on the slopes, across their upper or middle parts.	• Regulation of surface flows • Abatement of soil erosion/topsoil losses • Increase of soil fertility • Reduction of the degree of soil vulnerability to extreme precipitation	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
Application of bioengineering methods against water erosion on agricultural lands located on slopes: planting buffer strips (0.5-0.6 m wide, their width may increase with the growth of slope inclinations). Training and awareness raising of farmers on these issues.	• Regulation of surface flows • Abatement of water erosion • Abatement of soil erosion/topsoil losses • Increase of soil quality • Increase of soil humidity • Increase crop productivity	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Improvement of breeding stock of cattle.	• Increase of milk and meat yields in cattle breeding	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Improvement of the forage base of livestock through effective use of arable lands and feeding livestock with additional concentrated foodstuffs (e.g., corn, barley, soya).	• Expanding the forage base under condition of shortage of pastures	< 50,000	**MT**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • NGOs
Development of pasture and hayfield management plans: • Selection and observation of adequate mowing and grazing periods. Selection of relevant crops (Chapter 7). • Grazing height control (Chapter 7). • Awareness raising of the population on practices of sustainable use of pastures.	• Development of cattle and sheep breading in the community • Improvement of forage reserve for animal breeding • Maintenance and improvement of pasture productivity	< 50,000	**MT**	• Local farmers • Agricultural development 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
Inclusion of nectariferous plants in seed rotation, cover plants and pastures (sainfoin, alfalfa, clover, etc.). Awareness rising of the population on the importance of these plants.	• Facilitation of the development of bee keeping in the community • Increase the productivity of agricultural crops through increased pollination	< 50,000	**ST**	• Local farmers • Agricultural development services • Local self-governance	• Local farmers • Agricultural development service • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
Global aim of the activities: • Mitigation of hazards faced by the Jokolo community and reduction its vulnerability to natural disasters and climate change • Reduction of risks of natural disasters in the Jokolo community • Adaptation to climate change					
Construction of 420 m long bank protection gabions on the Alazani River and reinforcement of the 100 m long foundation of the existing structure (X-525886; Y-4673991 _ X-525710, Y-4672783) total volume - 2,890 m^3.	• Abatement of river erosion • Reduction of the risk of floods and flash waters	270,000	**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
Construction of two gabion toes on the Alazani River with the total length of 35 m - II site (X-525628, Y-4671813) total volume - 812 m^3.	• Abatement of river erosion • Reduction of the risk of floods and flash waters	75,000	**MT**	• Local self-governance • Municipal government • National Environmental Agency • Ministry of Regional	• Local budget • State budget • Development agencies (USAID, UNDP, EU, Dutch government, GIZ,

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
				Development and Infrastructure	Sida, etc.) • NGOs
Construction of 60-70 m long bank protection gabions on the Alazani River - III site (X-525821, Y-4670979) total volume - 452 m^3.	• Abatement of river erosion • Reduction of the risk of floods and flash waters • Protection of infrastructure (drinking water supply, roads) and agricultural lands of the community	42,000	**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
Construction of 40-50 m long bank protection gabions on the Alazani River - IV site (X-525859, Y-4670773) total volume - 323 m^3.	• Abatement of river erosion • Reduction of the risk of floods and flash waters • Protection of infrastructure (drinking water supply, roads) and agricultural lands of the community	30,000	**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
Construction of 250 m long bank protection gabions on the Alazani River. Reinforcement of the slopes above the gabions with bioengineering methods - V site (X-525545, Y-4668427) total volume of the gabion wall - 1,630 m^3.	• Abatement of river erosion • Reduction of the risk of floods and flash waters • Protection of infrastructure (drinking water supply, roads) and agricultural lands of the community	160,000	**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
Construction of a row of barrages in the	• Prevention of the	< 50,000	**ST**	• Local self-governance	• Local budget

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
riverbed the dry ravine - left tributary of the Kvitezis Khevi River.	development of large-scale mudflows • Abatement of vertical erosion occurring in the ravine • Stabilization of the slopes of the ravine • Stabilization of local landslide processes observed on the slopes of the ravine			• Municipal government • National Environmental Agency • Ministry of Regional Development and Infrastructure	• State budget • Development agencies (USAID, UNDP, EU, Dutch government, GIZ, Sida, etc.) • NGOs
Deepening and cleaning the riverbed at the crossing of the motor road and the dry ravine. Increasing the diameter of the pipebridge or adding another pipe. Periodical cleaning of the pipebridge from mudflow materials.	• Prevention of the development of large-scale mudflows • Protection of the road network of the community from damage Protection of the population from mudflow masses	< 50,000	**ST**	• 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
Periodical cleaning the riverbed of the Kviteis Khevi River from mudflow materials.	• Prevention of the development of large-scale mudflows • Protection of the population from mudflow processes • Protection of the road network of the community from damage	< 50,000	**ST**	• 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

Activity	Aim	Estimated budget	Duration[6] (ST; MT; LT)	Responsible institution	Potential Source of Funding
Protection of a 15 m long section on the right bank of the Dzibatkhevi River (X-524726; Y-4673131) – via an embankment built of ragged stone or a gabion.	• Protection of residential houses and agricultural lands from mudflow masses • Protection of utilities (road, electricity, water supply) of the community from damage	20,000	**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
Protection of the 30 m long section on the left bank of the Dzibatkhevi River (X-525167; Y-4673077) – via an embankment built of ragged stone or a gabion.	• Protection of residential houses and agricultural lands from mudflow masses • Protection of utilities (road, electricity, water supply) of the community from damage	30,000	**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

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