Assessment of Natural Disasters and Climate Change for Upper Alazani Pilot Watershed Area, Plan of Mitigation & Adaptation Measures

Republic of Georgia

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Abbreviations and Acronyms

ACF International	Action Against Hunger
ADB	Asian Development Bank
AID	Agency for International Development
APA	Agency for Protected Areas
CARE	Care International
CDM	Clean Development Mechanism
CENN	Caucasus Environmental NGO Network
CO_2	Carbon dioxide
DRR	Disaster Risk Reduction
EBRD	European Bank for Reconstruction and Development
ECHAM	Atmospheric General Circulation Model Developed at the Max Planck Institute for Meteorology
EIA	Environmental Impact Assessment
EU	European Union
FIU	Florida International University
GHG	Green House Gases
GIS	Geographical Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit, GmbH (German Society for International Cooperation, Ltd.)
GLOWS	Global Waters for Sustainability
GoG	Government of Georgia
UNDP	United Nations Development Programme
UNESCO	United Nations special agency
USAID	United States Agency for International Development
Ha	Hectare
HADCM	Hadley Centre Coupled Climate Model
HPP	Hydropower Plant
IHE	International Hydrological Education

INRM	Integrated Natural Resource Management
INRMP	Integrated Natural Resources Management Plan
INRMW	Integrated Natural Resources management in Watersheds of Georgia
KfW	Kreditanstalt Für Wiederaufbau (German Development Bank)
Km	Kilometer
km^2	Square Kilometer
MoE	Ministry of Environment
m	Meter
m^2	Square Meter
m^3	Cubic Meter
mm	Millimeter
NGO	Non-governmental organization
PA	Protected Area
PRECIS	Providing REgional Climates for Impacts Studies
Riv.	River
ROFIU-GE	Representative Office of FIU in Georgia
SHPP	Small Hydropower Plant
Sida	Swedish International Development Cooperation Agency
WB	World Bank
WI	Winrock International
WMO	World Meteorological Organization, special UN agency

Tables

Maps

Methodology of Reserch

The presented report outlines a methodological approach for the analysis of expected climate change, adaptation and natural disaster risk reduction. This includes an analysis of the risks of natural disaster processes (landslide-mudflow processes, floods, droughts, etc.) and their adaptation measures in project areas. The analysis considers the current climate (1996-2006, the baseline period) and the forecasted changes between 2020 and 2050.

To assess the hazards caused by climate change, high-precision forecasting of climate models and the development of corresponding scenarios for climate change are required. This allows forecasting of the probability of extreme phenomena (maximum temperature, droughts, abundant precipitation, floods, etc.).

The climate change scenario (that was used to analyze the expected changes in the meteorological elements of the target territories between 2020-2050, presented in this report) was processed using the PRECIS regional model. This model used the ECHAM4 global model and the A2 and B2 scenarios of worldwide socio-economic development. The PRECIS regional model was calibrated using the territories of the municipalities presented in this report, using the results of actual meteorological observations during the baseline period. This was the methodology used to develop scenarios of the modeled climate parameter (air temperature, atmospheric precipitation, wind, etc.) changes for the years 2020-2050 for the target municipalities.

Using the aforementioned scenarios, and taking into account forecast changes in the climate between 2020-2050, the probability of occurrence, frequency and magnitude of natural disaster processes has been estimated (mudflow, landslide, floods, droughts, uncomfortable temperatures). In order to understand the probable future effect of climate change on the target areas, it was necessary to prepare a short description of the components of the physical-geographic and socio-economic environment of these areas. Thus, the report briefly describes the geological composition, geo-morphological peculiarities, natural processes, soils, plant cover and the main fields of local economies for the target municipalities. Based on these components, of expected climate change effect analysis, the main problems and adaptation measures have been identified.

Risk Assessment

Risk assessment is a process that defines the qualities of a risk as well as its type; it is based on a combination of technical characteristics of hazards, population vulnerability and their exposure to risks. Therefore, disaster risk can be conceptually presented in the following way:

Disaster risk = hazard * vulnerability * quantity of elements exposed to the risk

When analyzing risks, three main components are usually identified:

- hazards;
- vulnerability; and
- elements exposed to the risk, which have spatial, as well as non-spatial characteristics.

Hazards are characterized by their temporal probability and intensity, which is derived from the frequency/magnitude analysis. In the formula, the hazard component relates to the probability of occurrence of hazardous processes over a concrete time period (in this case the baseline time period). During analysis, different types of hazards will be taken into account: floods, mudflows, erosion caused by rivers, landslides and rockfalls. For hazard assessments, historical information regarding occurred/recorded disasters and the scale of different disasters was used, as well as the information gathered by the fieldwork team within the scope of program. During the fieldwork, the natural hazards in the target areas were identified in detail using participatory methods. Subsequently, the spatial probability was calculated. The final hazard information was based on the data of recorded natural disasters.

To calculate the social, physical, ecological and economic vulnerability, a qualitative-spatial multi-criteria assessment technology was used. The following characteristics of the target areas were assessed – the demographic situation of the population, infrastructure, communications, economic and social characteristics of the community, ecological conditions of the target areas, ability to respond to natural disasters. Finally, a vulnerability result was formalized and the extent of vulnerability was quantified on a scale from 0 to 100.

At the last stage of assessment, a risk assessment was conducted, based on spatial analysis, for all types of hazard (high, moderate, low). This assessment also took into account the vulnerability of the elements exposed to risk, these risks were quantified on a scale from 0 to 1.

Additionally, we would like to mention that the field work conducted within the scope of the program included every community of the target river basins. Besides the vulnerability assessment, field visits included the first-hand inspection of territories containing hazards, taking GPS coordinates and photo documentation.

Greenhouse Gas Emissions

The greenhouse gas (GHG) emissions study aims to identify the transport, agricultural, industrial, waste, and stationary GHG emissions emitted by target municipalities over two watersheds of Georgia, Roni and Alazani-Iori. These GHG emission estimations will be used to develop municipality-specific recommendations and actions plans to reduce GHG emissions. Although the study focuses on data that relates to factors that can be impacted on by local government, such as municipal and public buildings and transport means, a baseline study will also be completed for each municipality.

The methodology of the study was developed primarily using Intergovernmental Panel on Climate Change (IPCC) 2006 and 1996 Tier 1 methodologies for estimating national GHG emissions. Due to the unavailability of some data, the baseline results of this study entail some degree of uncertainty.

Introduction

The present report was developed within the framework of the program “Integrated management of natural resources in watersheds of Georgia” (INRMW), implemented by a group of the following partners:

- Florida International University (FIU)
- UNESCO Instituted of Hydrological Education (UNESCO-IHE)
- CARE International
- Winrock International
- Caucasus Environmental NGO Network (CENN)

The geography of the program covers watersheds of Georgia: the Rioni River basin in West Georgia, and the Lori 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 areas - Municipalities of Khobi and Senaki.
- Upper Alazani pilot watershed area – Municipalities of Akhmeta and Telavi;
- Lower Alazani-Iori pilot watershed area - municipality of Dedoplistskaro.

Within the framework of the program, it’s envisaged to assess the pilot watershed areas/municipalities in respect of their vulnerability to climate change and natural disasters; also, to develop a plan of corresponding mitigation and adaptation measures.

This report provides the assessment of Upper Alazani pilot watershed area (Akhmeta and Telavi municiaplities) in terms of vulnerability and risks of natural disasters. The plan of activities that have to be implemented for climate change and natural disaster mitigation and adaptation is provided based on the performed assessment.

To simplify the matters, the discussion on the upper pilot watershed area is given by municipalities. Therefore, municipalities of Akhmeta and Telavi are discussed separately. This is justified by the fact that defining the target areas for the Program was based on the combination of natural (geographic) and administrative boundaries of the country. Furthermore, the Program has chosen Akhmeta and Telavi municipalities as target areas in the upper watershed of the Alazani River.

1. General Characterization

1.1. Akhmeta municipality

1.1.1 General Information

Location

Area – 2,248 km^2.

The Akhemta municipality is located in the upper part of the Riv. Alazani watershed and is bordered by the following features: to the north – the Caucasus watershed ridge consisting of Mesozoic clay-slates, sandstones, marls and partly of limestone, located between Didi Borbalo (3,292 m) and Shavi Klde (3,578 m); Kakheti ridge to the west and south-west; the Nakerala watershed of Riv. Alazani and Riv. Strori – to the east; the north-west part of the Alazani accumulative plain adjoins the municipality territory from the southern part.

Relief

The Akhmeta municipality is distinguished by a very high hypsometric development. The area is located at an altitude of 450-3,600 meters and serves as one of the important factors of the diversity of the terrain. Most of the territory is mountainous. The southern part of the main Caucasian watershed ridge slopes towards the Alazani Valley and is extensively fragmented by numerous deep erosive gorges. The following steep watersheds are erected between these valleys (offshoots of the Caucasus main watershed ridge): the Kakheti Ridge – a Riv. Alazani and Riv. Iori watershed, the Pankisi Ridge – a Riv. Alazani and Riv. Ilto watershed, the Nakerala Ridge – a Riv. Stori and Riv. Alazani watershed, and the Didgverdi Ridge – a Riv. Stori and Samkuristskali watershed. These are typical erosive ridges, which are crossed by deep and mostly narrow valleys of a number of small, rapid rivers. The erosive cut of the river valleys begins at 10-15 meters and goes as deep as 160-180 meters.

Along with the main Caucasian watershed ridge and its offshoots, important orographic units are the Ilto and Pankisi valleys, having erosive-accumulative features. The Ilto valley, starting from the eastern slope of the Kakheti ridge, is narrow from the beginning to the middle and is distinguished by steep slopes. It significantly broadens towards the base and creates an accumulative bottom comprised of alluvial-proluvial sediments of the Quaternary age. The bottom of the Ilto valley gradually enters the Alazani valley. The Pankisi valley is part of the moutn of the Alazani river. Its upper part is typically erosive, narrow and deeply segmented. The Pankisi valley broadens from the middle and the width of its bottom (comprised of alluvial sediments) sometimes reaches 3 km, and, like the Ilto valley, gradually adjoins the Alazani accumulative lowland.

Among the meso forms of the relief in the upper basin of the Riv. Alazani watershed, short glacial trogs, moraine sediments and kars are to be distinguished. Glacial relief forms are mainly featured in the vertex line of the main watershed ridge and the northern part of the Nakerala ridge. Erosive-accumulative terraces are developed as separate large fragments on the last sections of the river gorges; the first terrace is particularly well depicted. The relative height of this terrace is between 4 and 6 m.

The morphology of the flat, slightly sloped surface of the Alazani accumulative lowland within the municipality boundaries is complicated in its peripheral area (especially the eastern slopes of the Kakheti ridge) by alluvial fans created by temporary and permanent flows. The basins of the rivers Alazani, Ilto and some of their tributaries (Osiauri, Didrike, Orvili, etc.) are characterized by the intensive development of flax streams, landslides and floods.

Throughout a significant area of the Akhmeta municipality, the highly angled and deeply fragmented relief of the Caucasus main watershed ridge and other mountain ranges connected with it is characterized by adverse topography that significantly complicates the possibility of using it for agricultural purposes. Unlike the above-mentioned areas, the north-west part of the Alazani gorge and its adjacent Mtatsineti valley have less stiff and fragmented terrain, thus creating a geomorphologic environment for the development of agriculture.

1.1.2 Climate

Ongoing Changes in Climate

The Akhmeta municipality is located in the transitional district between the subtropical and maritime climates. The municipality territory up to the altitude of 600-800 meters (north-western part of the Alazani lowland and its adjacent Mtatsineti range) is characterized by a rather humid climate with moderately warm winters and long hot summers. The average annual temperature is 11.6^{0}C; in January, the average temperature amounts to 0.5^{0}C, and in July – 22^{0}C, the absolute maximum is 38^{0}C, the absolute minimum is -23^{0}C. Average annual precipitation is about 770-820 mm. At the altitude of 700-1,200 m, the climate is moderately humid with cool summers and moderately cold winters. Average temperature in January is -0.4 – -3^{0}C, and 18 – 22^{0}C in July. The absolute maximum temperature is 36^{0}C and the absolute minimum is -26^{0}C. The total annual atmospheric precipitation is 1,200-2,000 mm. At the altitude of 1,200-2,000 m, the climate is moderately humid and cold with long winters and cool, short summers. Average temperature in January is -3 – -6^{0}C; and in July – 14-19^{0}C. Total annual atmospheric precipitation is 1,500-1,700 mm. At the altitude of 2,000 m and above, the climate is cold with harsh winters.

The assessment of ongoing climate change in the Akhmeta Municipality was prepared based on observations made by the Akhmeta metrological station (at the altitude of 570 m) in 1957-2006. The observation period was divided into two sections, each section comprising a 25-year period (1957-1981 and 1982-2006). The meteorological parameters (temperature, precipitation, wind, etc.) were presented for each time period.

Average annual air temperature within the boundaries of the municipality has a tendency to increase. The average annual temperature difference between these periods is 0.4^{0}C. Maximum warming is observed in the summer (almost by 1^{0}C). The **absolute maximum temperature** is slightly elevated in the second period (by 0.1^{0}C). However, the **absolute minimum temperature** for the average annual value is noticeably decreasing (in 1957-1981 – 17.6^{0}C; in 1982-2006 – 13.6^{0}C). The steadiest warming with these parameters was observed in the summer (in 1957-1981– 6.50^{0}C; in 1982-2006 – 9.10^{0}C).

The total annual **atmospheric precipitation** is decreased during all seasons. The decrease of total annual precipitation is especially notable for the second 25-year period, and equals almost 30% (835 mm in 1957-1981, 557.6 mm in 1982-2006). All seasons are marked with a decrease of total precipitation. The number of daily rainfalls in the first period is significantly higher than in the second period (by 15 mm in spring, 38 mm in summer, 48 mm in fall, and 2 mm in winter). The decrease of the daily precipitation in the Municipality caused a reduction of the risk of flooding, but increased the number and severity of droughts in the summer.

The wind velocity was assessed based on data of observations during 1957-1992. The comparison of two 18-year periods showed that average wind speed in the second period has significantly reduced (by approximately 25-35%) during all seasons. In addition, the characteristics of maximum wind speed showed the tendency of reduction for the whole period (1966-1992) according to linear trends.

The analysis of the observations of the meteorological elements made at the Akhmeta meteorological station in 1957-2006 shows the following:

According to the data of the last 25 years, the **winter** temperature in the municipality has slightly increased in comparison with the first 25-year period (by 0.6^0C). The number of frosty days has reduced by 3 as a result of the decrease of the maximum temperature. During the same period, the total number of atmospheric precipitation in winter, as well as the maximum number of daily rainfalls has reduced (by 53% and 34%, respectively). The number of days with 10, 20, 50 mm rainfall are decreased by 50-60%. In general, winter in the Akhmeta municipality has become drier and a warmer during the last 25 years.

Average **spring** air temperature has increased ($+0.4^0$C). The number of frosty nights between the two periods has not changed, while the number of frosty days has slightly increased. The maximum temperature range has also increased. Almost all parameters for rainfall during this season have decreased in comparison with the previous 25-year period. The amount of total seasonal rainfall has reduced (by 12%). The average and maximum of total daily rainfall have decreased (the difference between the two periods is approximately 25%). The number of days with 10, 20 and 50 mm rainfall has significantly decreased. Based on the above, spring in the Akhmeta municipality has become warmer and drier, though there still is a risk of frost. The vegetation period has increased by approximately 4 days as a result of warming ($<5^0$C; $>5^0$C).

Summer, compared to other seasons, is projected to experience the highest degree of warming ($+0.8^0$C). The absolute maximum and minimum temperature has also augmented. Consequently, the number of hot summer days and tropical nights has increased by an average of 5-6 days. Like other seasons, daily temperature amplitude is almost unchanged. Total seasonal rainfall in the past 25 years, as well as the daily maximum and average is reduced (for mean values, the reduction is almost 30%). Therefore, in the Akhmeta municipality, which already has a background of elevated temperature and reduced rainfall in the summer, the risk of frequent droughts has increased.

Autumn air temperature has increased by 0.4^0C. Minimum temperatures and the number of frosty nights did not change between the two periods. Frosty nights have been observed only once in the first period and never in the second. The number of hot days has increased by approximately 3. The number of tropical nights has also increased threefold during this season. The risk of frost in autumn has not decreased. Rainfall has significantly reduced during this season (-40%). The number of days with more than 10, 20 and 50 mm of rainfall has also reduced. The decrease of precipitation during this season also indicates the reduction of the risk of floods and mudflows, which generally pose a serious risk to the Akhmeta municipality. Consequently, autumn, as well as the rest of the seasons, was warmer and drier in the Akhmeta municipality.

Extreme Phenomena

Mudflows and landslide processes. As the rainfall indices show, within territory of the municipality, the maximum amount of precipitation over 5 consequtive days, the number of days with heavy rain, as well as the number of days with more than 10, 20 and 50 mm of rainfall, have decreased in 1956-2006. Although, the number of periods with high consequtive levels of rainfall has not reduced at all. As for days with heavy rain, the number of days with more than 50 mm rainfall has been observed 21 times during last 50 years. Nineteen cases were observed in the first 25-year period, and only 2 cases occurred in the second. Although, it is noteworthy that the second period is observed with gaps, which that complicates the analysis of change. No cases with over 90 mm of rainfall have been observed. Cases with more than 50 and 90 mm are considered a risk for mudflows. This demonstrates a significant reduction of the risk of floods. Herewith, it should be noted that the total annual rainfall exceeding 200 mm or more, which is regarded as a risk factor for landslide processes, has been observed 8 times in the first period, while no cases were recorded the second period. This means that the risk of landslides has also reduced in the Akhmeta municipality, while this district is regarded as a zone with a high risk of landslides. Mudflows, however, remain as the main risk factor here.

Drought. Drought was assessed with a standardized precipitation index. The table below shows the change of the average number of recurring severe and extreme droughts between the two periods.

Table 1.1.1. Number of severe droughts in different periods according to time periods (Akhmeta Municipality)

Severe drought (SPI≤-1.5)	1-month	3-month	6-month	9-month	12-month
1957-1981	8	6	5	7	11
1982-2006	22	15	17	8	9
Difference	14	9	12	1	-2

Table 1.1.2. Number of extreme droughts in different periods according to time periods (Akhmeta Municipality)

Extreme drought (SPI≤-2.0)	1-month	3-month	6-month	9-month	12-month
1957-1981	5	4	4	3	1
1982-2006	8	6	2	0	0
Difference	3	2	-2	-3	-1

As the tables above show, for short time periods, the possibility of extreme droughts has increased during the period of observation. There were no long-lasting extreme droughts. The increased tendency of severe droughts is consistent with the trend of precipitation reduction discussed above, while the region is less characterized by extreme droughts.

Expected Change of Climate in Years 2020-2050

The parameters of climate change scenarios have been assessed by the PRECIS regional model developed according to the ECHAM4 global model and using two (A2, B2) scenarios of the global socio-economic development.

According to both models (ECHAM4, HaDCM3), a difference method has been chosen for the calibration of air temperature. Correlation between the model forecasts and observed data is quite high (≈0.9). Using the ratio method, the calibration of precipitation has been conducted, since the total amount of forecasted rainfall for future months is so low, that the difference method would be inappropriate. Consequently, in order to create the scenario for future climate change, the difference method will be used for temperature, and the method of relativity – for precipitation.

Modeled scenarios of climate change parameters for the years 2020-2050 are represented below.

According to both scenarios, **average annual air temperature** in the Akhmeta municipality will increase by about 2.2°C during 2020-2050 and thus continue the trend identified during the observation period (1956-2006). According to the B2 scenario, winter will be most affected by the warming (by 4^0C), and according to the A2 scenario, the season most affected will be autumn. These trends in temperature change during every season coincide with the trends for the last period (1982-2006). In 2020-2050, under both scenarios, the maximum value of the average air temperature is expected to increase further; the maximum temperature increases most in winter (by -4^0C under the B2 scenario). The minimum temperature warmer in winter is also warming and rises equally during n all other seasons (2.3^0C).

Total annual precipitation increases during 2020-2050 according to both scenarios (in the B2 scenario – by 40%, while in A2 – by twice as much). This contradicts the observed data for the last period. According to both scenarios, the temperature rises in winter the most and in spring the least. The daily maximum value of rainfall by 2020-2050 will be in autumn (as in 1956-1981). This parameter will increase about two times in all seasons. The rise of daily precipitation is expected less in spring (about 50%). Compared with the first period, total annual daily maximum precipitation will increase by 1.4 times. The average value of maximum daily rainfall, compared with the first period, shows the opposite trend. It will increase significantly in winter (80%) and the least rise will be in spring (12%). This parameter increases approximately by 57% annually.

According the scenarios, **average wind speed** stays within the average value of the last period of observation according to the seasons, as well as annually, and is less than in the first period of observation. The wind speed will again reduce during all seasons and continue the trends identified during the second period of observation. Though, this decline is much less pronounced than in the period of observation.

According to the data discussed, by 2020-2050 **winter** in the Akhmeta municipality will have warmed by an average of 4^0C. Average maximum temperature is expected to increase by 3.6-4.1^0C, while the minimum temperature is not likely to augment (3.4^0C). The number of frosty nights, compared to the second 25-year period, will reduce by about three times. According to the B2 scenario, total winter precipitation is expected to increase by 76%, while for the A2 scenario, the growth rate equals 2%. Average maximum daily rainfall will increase by about 80%. Daily, seasonal, and annual parameters for rainfall have decreased significantly in the recent period of observation, and according to the scenarios, these parameters will return to the values observed during the first period. The number of days with more than 10, 20, 50 and 90 mm of rainfall will increase in the last period after the decline. Accordingly, winter weather conditions are expected to ease. Winter will become twice as rainy. The number of daily rainfalls will be more frequent, so the probability of extreme rainfall and associated risks in the target area is high.

According to the A2 and B2 scenarios, the average temperature in **spring** will increase by 0.7-1.5^0C, while the average maximum and minimum temperatures will increase by about 1-2^0C. This is the most insignificant warming trend among the seasons. The number of cold nights reduces twice compared to the first 25-year period, while the number of frosty days (as well as the number of hot days) remains the same. The total amount of rainfall can increase by 5% according to the A2 scenario, while the B2 scenario predicts that this figure will amount to 30%. This season the lowest daily maximum norm is also expected. From the extreme rainfall indices, the number of days with more than 20 mm of rainfall is likely to increase (by 50%). Spring is expected to have daily rainfall of up to 50 mm, although the probability for this is very low. Consequently, according to the A2 scenario, spring in the municipality is expected to be relatively warm and rainy.

The average temperature in **summer** will rise by 0.7^{0}C according to the A2 scenario and by 2.1^{0}C according to the B2 scenario for 2020-2050. The number of hot days will decrease by 8% (6 days), though the number of tropical nights may increase by 3. All these parameters revealed a warming trend during the observation, which will likely remain and even intensify. Total amount of precipitation will increase by 52% according to the B2 scenario and by 78% in accordance with the A2 scenario, which opposes the downward trend during the last period of observation. The daily maximum of precipitation and its average value will increase 2-2.5 times, which also means that rainfall intensity will increase in the summer. The number of days with more than 10, 20, 50 and 90 mm of rainfall will also increase. The number of days with 20 and 50 mm of rainfall will increase twice. During this season, the distribution of total precipitation will occur at the expanse of days with heavy rains.

According to the A2 scenario, there is a possibility that the average, and the average maximum and minimum temperatures will rise more in **autumn** than in any other season – by 4^{0}C (according to the B2 scenario, this figure is around 2^{0}C). The number of cold nights will decrease by 60%, while the number of frosty nights will increase by 9 cases. The number of hot days and tropical nights will also increase (by 25 nights), which continues the recent trend of increase. Total seasonal precipitation increases by 68% according to the B2 scenario, and by 78% according to the A2 scenario, which contradicts the observed rainfall trends. The maximum daily precipitation, as well as its average value, increases by 76%. In the second period of observation compared with the first one, the number of days with more than 10, 20, 50 and 90 mm of rainfall may increase by an average of 2, 1.5, 0.4 and 0.15 days, respectively. According to these data, autumn may be warmer and more humid, but with a possibility of frost.

The number of **frosty nights** is expected to reduce during all seasons (by 60% annually). The number of **frosty days** may increase by an average of 1 day annually. The number of **tropical nights** in the summer may also increase 3 times; the number of such nights may significantly increase in autumn as well (the figure will increase from 2 observed cases to 74 within the 30-year period). **Hot days** are reduced slightly in summer, and approximately by 6 days per season.

Extreme Phenomena

According to climate indices, in the Akhmeta municipality, in 2020-2050, the amount of daily maximum precipitation will increase, as well as the maximum amount of precipitation over five consequtive days. The number of days with daily rainfall of 10, 20 and 25 mm will also increase. The length of periods with continuous rain and continuous drought will rise, together with the amount of daily precipitation. This means that in case of total annual precipitation of 200 mm, this serves as a precedent for an increased risk of landslides, which will increase twofold (50%), according to the scenarios.

Drought. Drought was assessed with a standardized precipitation index. The table below shows the change of the average number of recurring severe and extreme droughts between the three periods discussed.

Table 1.1.3. Total number of reccurent "severe droughts" of different length in the researched period (Akhmeta Municipality)

Severe drought (SPI>-1.5)	1-month	3-month	6-month	9-month	12-month
1957-1981	8	6	5	7	11

1982-2006	22	15	17	8	9
2020-2050	6	6	3	5	7

Table 1.1.4. Total number of reccurent "extreme droughts" of different length in the researched period (Akhmeta Municipality)

Extreme drought (SPI>-2.0)	1-month	3-month	6-month	9-month	12-month
1956-1980	5	4	4	3	1
1981-2005	8	6	2	0	0
2020-2050	4	4	0	0	0

It appears that the droughts of various duration and type, the number of which either decreases or increases during the baseline observation period, decline everywhere according to the scenarios.

1.1.3 Hydrographic Network

The main artery of the hydrographic network of the Akhmeta Municipality is the Riv. Alazani, the source of which is in the Caucasus main watershed ridge, on the eastern slopes of the peak of Didi Borbalo (3,925 m). Alazani is a typical mountain river within the boundaries of the municipality, eventually forming at the altitude of 825 m. Including its main tributaries, Tsiplovani and Samkura, the total length of Riv. Alazani within the municipality territory (from the source to the village of Kvemo Alvani) reaches about 42 km. The river's drop in this section is 840 m. Around the administrative center of the Akhmeta municipality (at the average altitude of 570-600 m), the river leaves the mountainous part of the watershed and reaches the accumulative lowland of Alazani. Within the Akhmeta municipality, Alazani is joined by a number of tributaries: Ilto (length - 43 km, the average height of the basin – 1,250 m, overall drop – 1,636 m, basin area – 337 km^2, river valley slope inclination – 10^0-30^0, water flow width – 3-15 m., depth – 0.3-0.7 m , flow rate – 1.9-1 m/sec); Riv. Samkuras Tskali (length – 18 km, overall drop – 2,155 m, basin area – 121 km^2, average height of the watershed basin – 2,555 m, water flow width – 7-12 m, depth of flow – 0.6-1.3 m, flow rate – 2.4 m/sec); Tsiplovani (length – 24 km, basin area – 92 km^2, width of flow – 5-10 m, flow depth – 0.4-0.7 m, flow rate – 1.3-1.6 m/sec, average height of the basin – 2,136 m, overall drop – 2,175 m). Within the municipality borders, the Alazani tributaries are characterized by deep gorges and frequent rapids, the height of which sometimes reaches 2-3 m; waterfalls of 3-5 meters are also observed at times. The slopes are often inclined steeply towards the river watercourses and are extensively fragmented with narrow and quite deep ravines.

The Riv. Alazani and its tributaries are fed by snow, rain and underground waters within the municipality territory. The river regime is characterized by floods caused by melting snow in spring, rain floods in summer and autumn, and a lack of water during winter.

In order to obtain the characteristics of the Riv. Alazani stream flows within the Akhmeta municipality borders, the data of a checkpoint for hydrological observation was used. The checkpoint is located on Riv. Samkura, near the village Birkiani (at the altitude of 800 m) and on Riv. Alazani, at the Shakriani Bridge (the checkpoints were in operation until 1991). Using the obtained data, the following information was obtained: average monthly and annual discharge of the river Alazani and its source in multi-annual terms and other recurrent maximum and minimum costs (See the tables 1.5 and 1.7).

Table 1.1.5. Average monthly and annual discharge of Riv. Alazani and its tributaries in multiannual terms

Riv.	Hydr. /stat.	F km^2	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Alazani	Birkiani	282	5.87	5.75	7.52	17.4	28.5	28.5	23.5	14.9	12.8	12.2	8.95	7.04	14.5
Alazani	Shakriani	2190	18.9	20.6	33.2	68.6	91.1	78.4	52.4	35.2	37.1	37.6	30.6	22.2	43.8
Samkura Tskali	Kadori	121	1.99	1.79	2.16	5.51	11.4	12.5	9.70	5.99	4.88	4.58	3.16	2.42	5.55

Table 1.1.6. Maximum discharge of various recurrency of Riv. Alazani and its tributaries near the hydrological checkpoints

River	Hydr/ checkpoint	F km^2	Reccurency τ year					
			1000	100	50	20	10	5

Alazani	Birkiani	282	700	500	420	310	265	205
Alazani	Shakriani	2,190	1,530	1,100	920	680	580	450
Samkura Tskali	Kadori	121	485	340	290	215	180	140

Table 1.1.7. Minimal discharge of varied maintenance of Riv. Alazani and its tributaries near the hydrological checkpoints

River	Hydr/ checkpoint	F km²	Maintenance *P* %						
			75	80	85	90	95	97	99
Alazani	Birkiani	282	2.60	2.37	2.20	1.95	1.67	1.45	1.16
Alazani	Shakriani	2,190	11.2	10.6	10.1	9.25	8.30	7.74	6.63
Samkura Tskali	Kadori	121	1.12	1.02	0.94	0.84	0.72	0.62	0.50

The observations on Riv. Alazani or its tributaries have not been renewed over the last 20 years. Because of unsystematic forest logging and climate change, the distribution of stream flows of Alazani and its tributaries has changed and caused an increase of the incedence of floods and flash floods. Summer streamflows have reduced, which has negatively affected water supply of the irrigation systems. Recent studies show that the average monthly and average annual discharges of Riv. Alazani at the Shakriani hydrological checkpoint have reduced in comparison to the data of 1932-1960. The table below shows these data.

Table 1.1.8. Riv. Alazani – Shakriani hydrological checkpoint. Average monthly and average annual discharge (m^3/sec) for two periods

Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
1932-1960	19.7	21.5	32.1	68.7	95.8	82.8	52.9	36.2	40.2	41.0	34.9	24.3	45.8
1961-1990	18.2	19.1	33.3	66.0	84.2	71.2	51.7	38.6	37.4	34.4	27.7	22.1	42.0

By 2020-2050, according to the climate change scenarios (assessed for Akhmeta municipality by the PRECIS, ECHAM4, and HaDCM3 global models using two (A2, B2) scenarios of global socio-economic development), on the territory of Akhmeta municipality in the coming decades it is expected that annual runoff will be decreased by 12% in the period of 2011-2040 according to the global models and decrease by 1% in the period of 2021-2050 according to the regional climate models. Also it is expected decrease of spring runoff (according to the regional climate models), that is the indicator of flooding risks reduction, including risk of spring floodings. However will be maintained and increased the risk of flash floods and development of subsequent landslides and mudflows; since according to the global and regional climate models in 2020-2050 is expected increase of average annual and seasonal amount of atmospheric precipitations about 40-50%, amount of maximal of daily precipitations in two times and maximal annual precipitations - by 1.4.

1.1.4 Soil

The territory of Akhmeta municipality is in the soil district, transitional forest-steppe, mountain-forest and mountain-meadow zone of eastern Georgia, where the following basic types of soil are developed according to FAO classification:

- PRIMITIVE MOUNTAIN MEADOW
- MOUNTAIN MEADOW SODDY
- MOUNTAIN MEADOW SODDY PEAT
- MOUNTAIN MEADOW BOG
- BROWN FOREST
- SINNAMONIC
- MEADOW SINNAMONIC
- RAW HUMUS CALCAREOUS
- ALLUVIAL CALCAREOUS

Mountain-meadow soils are developed in subalpine and alpine zones on the main watershed of the Caucasus mountain range and its junctions – Kakheti, Nakerala, Pankisi, and Didgverdi ranges, where they are mostly represented by mountain-meadow soddy and soddy-peat soils. Mountain-meadow soils are gray or brownish-gray; they are characterized by thick, strong, exhausted, rocky covers and high quality of cords. The more exhausted rocky covers, and less thickness is observed in alpine soddy and peat soils. The soddy soil is mainly observed under a thick grass cover of mountain-meadow soddy and peat soils, and less so in mountain-meadow soil of secondary origin developed under a thick herbaceous cover. These soils used for herbal cover are damaged, which contributes to the degradation of the underlying soil through surface water and soil erosion.

Brown forest soils. This type of soil is represented on the main watershed of the Caucasus mountain range and its junctions - Kakheti, Nakerala, Pankisi and Didgverdi ranges at the average altitude of 1,800 meters. Brown forest soils are of a dark brown color, have a medium and heavy clay composition, a high level of exhausted rocky covers, a well-defined humus horizon, and a loose, grainy structure. They are used for the cultivation of crops (barley, spring wheat, corn, fruits and vegetables). Steep slopes are easily susceptible to the impact of erosion processes.

Raw humus calcareous soils. This type of soil is developed under an herbaceous cover in mountain forests. These soils are of a blackish-brown color and a grainy structure, mainly characterized by a heavy clay composition. On slightly inclined slopes and lowlands, humus-calcareous soils are characterized by large and medium thicknesses. On more inclined or steep slopes this type of soil is easily susceptible to erosion and, thus, is not as thick. On the territory of the Akhmeta municipality, humus-calcareous soils are used for crop-cultivation (barley, spring wheat, corn, fruits and vegetables).

Sinamonic soils. Sinamonic soils are widely distributed on loams developed at the altitude of 1,000-1,100 meters, or on sandstones and the cortex of exhausted conglomerates. They are mostly distributed under the forest cover. These types of soils are generally dark gray or brownish in color. They are characterized by a grainy structure, and heavy mechanical composition containing clay and gravel. Sinamonic soils contain considerable amounts of humus. On inclined slopes, they are vulnerable to water and sand erosion. On forest-free areas, where meadows or meadow shrubs are featured, sinamonic soils of mainly secondary origin are represented. Meadow sinamonic soil is distinguished by large thickness, a gray-brown or dark brown color, medium or heavy clay composition, and average humus. This type of soil in the municipality is used for cultivating vineyards, orchards, grain, and vegetables.

Alluvial and alluvial meadow (with and without carbonate) soils. Calcareous alluvial soils are mainly developed along the right bank of the Riv. Alazani. This type of soil is characterized by a brownish gray color, very high level of carbonates (15-25%), a dust-like structure, a less differentiated profile and a relatively small humus horizon (amount of humus not exceeding 2.5%), this type of soil is poor in plant food elements. Together with calcareous alluvial soils, one may periodically come across alluvial soil without carbonate, which is very different from calcareous alluvial soil. It contains a greater amount of humus, is of relatively light mechanical structure, and has a lower rate of podzols. At an elevated area of the left side of Riv. Alazani – alluvial fans built up by the rivers feature a thin layer of generally strongly skeletal alluvial soil.

In the Akhmeta municipality, the alluvial type of soil is used for planting vineyards and orchards, and for production purposes of vegetables and fruits.

1.1.5 Landscapes

In the Akhmeta municipality, as a result of interconnection between relief, climate and vegetation, the following main landscape types can be found:

1. At the bottom of river valleys, at the altitude of 800-1,100 meters, natural vegetation is strongly degraded and cultural landscape (local settlements, infrastructure and other facilities, rural-agricultural lands, gardens, vineyards, etc.) is found on a sizeable part of the territory; the landscape features alluvial and sinnamonic soils.

2. In the peripheral segment of the zone described above, a landscape of secondary meadow and meadow-shrub woods is featured.

3. At the altitude of 1,900-2,000 meters, on the brown forest and humus carbonate soils of the slopes of the mountain range, a mixed landscape of broadleaf forests (oak, hornbeam-oak, oak-chestnut and beech) is featured.

The hypsometric zone above 2,000-2,100 meters is characterized by sub-alpine meadow-shrubs and alpine meadows.

1.1.6 Natural Vegetation

The Akhmeta municipality territory is diverse in terms of vegetation. There are extensive areas of almost all types of the deciduous forest formations.

The biodiversity of the municipality is demonsrated by the fact, that, within its boundaries, at the upper part of the Riv. Alazani, there is a number of protected areas, such as Batsara, Babaneuri reserves and Ilto Reserve.

The vegetation of heavily populated areas is extensively transformed. Territories, where once oak-hornbeam forests and riparian forests were featured, are now used for agricultural purposes (vineyards, agricultural lands, mowing-pasture lands, etc.). Only in some parts in the populated area, oak-hornbeam (*Quercus iberica, Carpinus betulus*) forests, fragments of hazel (*Corylus avellana*), European cornel (*Cornus mas*), hawthorn (*Crataegus kyrtostyla, C. pentagyna*), rosehip (*Rosa canina*), blackberry (*Rubus spp.*) are featured. Only in some areas, in the river groves, floodplain forests (*Populus canescens*) still remain, and separate derivates of black poplar (*Populus nigra*) and willow (*Salix excelsa*, *Salix alba*) are still preserved.

The dominant phytocenoses in the upper foothill zone are oak-hornbeam forests of secondary origin (*Quercus iberica*, *Carpinus betulus*). Other associations are: Oak-oriental hornbeam groves (*Quercus iberica*, *Carpinus orientalis*), Georgian oak-hazel (*Quercus iberica*, *Corylus avellana*), Georgian oak-European cornel (*Quercus iberica*, *Cornus mas*), Georgian oak-Jerusalem thorn-European cornel (*Quercus iberica*, *Paliurus spina-christi*, *Cornus mas*), Georgian oak-Caucasian hornbeam-roadside fescue (*Quercus iberica*, *Carpinus caucasica*, *Festuca drymeja*), European ash-common lime tree-Georgian oak (*Fraxinus excelsior*, *Tilia begonifolia*, *Quercus iberica*) and others.

Hornbeam forests are spread at the altitude of 1,800-2,000 m and are mainly of secondary origin. Hornbeam forests create different associations. Among them are the following: hornbeam-Georgian oak (*Carpinus betulus*, *Quercus iberica*), hornbeam-common hazel-roadside fescue (*Carpinus betulus*, *Corylus avellana*, *Festuca drymeja*), European hornbeam-oriental beech-roadside fescue (*Carpinus betulus*, *Fagus orientalis*, *Festuca drymeja*), European hornbeam-European cornel-roadside fescue (*Carpinus betulus*, *Cornus mas*, *Festuca drymeja*), oriental beech-common lime tree, hornbeam-blackberry-roadside fescue (*Fagus orientalis*, *Tilia begoniifolia*, *Carpinus betulus*, *Rubus caucasicus*, *Festuca drymeja*), Caucasian Zelkova-European hornbeam-oriental beech-roadside fescue groves (*Zelkova carpinifolia*, *Carpinus betulus*, *Carpinus orientalis*, *Festuca drymeja*).

Chestnut orchards are distributed on a limited area. They are mainly found in the Pankisi Gorge at the altitude of 600-1,300 m. where the following chestnut varieties are featured: chestnut with Pastuchov's ivy (*Castanea sativa*, *Hedera pastuchovii*), linden-hornbeam-chestnut-Pastuchov's ivy (*Castanea sativa*, *Tilia begoniifolia*, *Carpinus betulus*, *Hedera pastuchovii*), hornbeam-chestnut-yellow azalea (*Castanea sativa*, *Carpinus betulus*, *Azalea pontica*), blackberry-chestnut (*Castanea sativa*, *Rubus caucasica*), Georgian oak-hornbeam-mountain chestnut-roadside fescue (*Castanea sativa*, *Quercus iberica*, *Carpinus betulus*, *Festuca drymeja*) and others.

Among the forest creating formations, the leading role in the phyto-landscape belongs to beech forests; they are featured in almost every medium and high mountainous gorges (Ilto, Pankisi, etc.). The following associations are developed: yellow azalea-oriental beech (*Fagus orientalis*, *Azalea pontica*), European hornbeam-oriental beech (*Fagus orientalis*, *Carpinus betulus*), European hornbeam-linden-Pastukhov's ivy-oriental beech (*Fagus orientalis*, *Carpinus betulus*, *Tilia begoniifolia*, *Hedera pastuchovii*), oriental beech-European yew-Pastukhov's ivy (*Fagus orientalis*, *Taxus baccata*, *Hedera pastuchovii*), oriental beech-woodruff (*Fagus orientalis*, *Asperula odorata*), Oriental beech-Pachyphragma (*Fagus orientalis*, *Pachyphragma macrophyllum*), Oriental beech-slender toothwort (*Fagus orientalis*, *Dentaria quinquefolia*), oriental beech-yellow azalea with roadside fescue (*Fagus orientalis*, *Azalea pontica*, *Festuca drymeja*), oriental beech-blackberry-European yew with roadside fescue (*Fagus orientalis*, *Taxus baccata*, *Rubus caucasicus*, *Festuca drymeja*), Oriental beech-false brome (*Fagus orientalis*, *Brachypodium sylvaticum*), Oriental beech-wood bluegrass (*Fagus orientalis*, *Poa nemoralis*), high grass–fern-beech (*Fagus orientalis*, *Athyrium filix femina*, *Dryopteris filix mas*, *Cicerbita petiolata*, *Senecio rhombifolius*), Oriental beech-fern (Fagus orientalis, Dryopteris filix-mas), black fern-beech (*Fagus orientalis*, *Matteucia struthiopteris*), hornbeam-beech and others. In addition to the above-mentioned wood species, there also are high mountain oak (*Quercus macranthera*), mountain maple (*Acer trautvetteri*), birch (*Betula litwinowii*), poplar (*Populus tremula*), Caucasion Zelkova (*Zelkova carpinifolia*) forests and forest fragments in the Akhmeta Municipality.

Protected territories of the Akhmeta municipality are characterized by different and varied vegetation. The Babanauri Reserve is known for more than 200 species of vascular plants, and there are 670 species from the Batsara Reserve and Ilto Reserve. Of particular importance are Zelkova (*Zelkova carpinifolia*) and European yew (*Taxus baccata*) forests. The former can be found in Babaneuri Reserve with an optimal distribution at the altitude of 600-800 m. The following associations are featured: Zelkova-hornbeam-roadside fescue groves (*Zelkova carpinifolia*, *Carpinus betulus*, *Festuca drymeja*), Zelkova-European hornbeam-Oriental hornbeam with roadside fescue (*Zelkova carpinifolia*, *Carpinus betulus*, *Carpinus orientalis*, *Festuca drymeja*), Zelkova-false brome (*Zelkova carpinifolia*, *Brachypodium sylvaticum*), Zelkova-sedge *(Zelkova carpinifolia*, *Carex buschiorum*), Zelkova-false brome-Cock's foot-sedge-Purple Gromwell (*Zelkova carpinifolia*, *Brachypodium sylvaticum*, *Dactylis glomerata*, *Carex divulsa*, *Lithospermum purpureo-coeruleum*).

In the Batsara reserve, there are European yew (Taxus baccata) and Oriental beech (Fagus orientalis) forests. These forests are unique in their age and scale. They are widely distributed at the altitude of 1,000-1,500 m. Their age exceeds 800-900 years; the height of the trees is approximately 20-22 m. There are also surviving plants - Colchian box tree (*Buxus colchica*) and cherry-laurel (*Laurocerasus officinalis*).

The territory of the Ilto Reserve features beech, hornbeam, alder forests, subalpine meadows and tall herbaceous vegetation. The local phytocenoses are similar to the Batsara valley, but there are certain differences, such as Caucasian beech (*Fagus orientalis*, *Vaccinium arctostaphylus*), beech-azalea undergrowth (*Fagus orientalis*, *Azalea pontica-Rhododendron ponticum*), and beech-cherry-laurel undergrowth (*Fagus orientalis*, *Laurocerasus officinalis*).

On the territory of the Akhmeta municipality, there also are subalpine and alpine meadows, subalpine tall herbaceous and forest and rock complexes. The forest and rock complexes are situated in the Pankisi Gorge and is diffiult to access. The leading role here belongs to Caucasian pine (*Pinus sosnowskyi*) and birch (*Betula litwinowii*), European rowan (*Sorbus aucuparia*) and goat willow (*Salix caprea*). In the underbrush there are currant (*Ribes biebersteinii*), Caucasian honeysuckle (*Lonicera caucasica*), wayfaring tree (*Viburnum lantana*) and others.

Subalpine and alpine meadows with granular, various herbal and granular-herbal plants are featured at large. At certain points, the meadows fweature abundant matgrass (*Nardus stricta*), alpine sorrel (*Rumex alpinum*) and thistle (*Cirsium spp.*).

The following phenomena have a negative ecological impact on vegetation in the municipality of Akhmeta:

1. Intensive cultivation of agricultural land;
2. Unsystemic grazing;
3. Unsystemic forest logging;
4. Forest fires.

Forests are still being felled for firewood or other purposes. In much of the cases, the cleared area is used for grazing.

According to the data of the expected climate change study for 2020-2050, a significant increase in air temperature and atmospheric precipitation is expected in the Akhmeta municipality. As a result, the plant vegetation period can increase by a month, which should have a positive impact on the development of thermophilic and mesophilic plants.

1.1.7 Agricultural Activities

The main agricultural trends in the Akhmeta municipality are: viticulture-gardening; field-crop cultivation-horticulture and livestock.

Of perennial crops, vine is of great importance to the municipality. In the recent past, the area covered by vineyards was more than 5,000 acres until recently, and the grape harvest reached 40 thousand tons. Currently, due to meteorological conditions (drought, hail), the grape harvest ranges within 1,200-8,000 tons. One of the main reasons for such a significant difference, according to the local population, is the falsified, outdated means of protection from harmful insects, as well as their high cost and, in many cases, inaccessibility. At the same time, the population mentions an increased frequency of droughts, extended periods of irrigation water shortage, and problems caused by irrigation systems that are out of order.

As for gardening, fruit (mostly apples and peaches) is mainly grown to meet the household needs of the local population. Depending on meteorological conditions, from 240 to 3,300 tons of fruit are annually gathered throghout the municipality. Such a considerable difference in annual yield is mostly due to natural meteorological processes (especially an increase of drought). Furthermore, obsolete varieties of plants, uncompetitive in the market, and obsolete, less effective technologies of fruit processing are of great importance. The cultivation of nuts also has some significance. Nut yield in the municipality ranges from 100 to 300 tons and attracts considerable attention, primarily for canning purposes.

It should be noted that in the Akhmeta municipality, fruit and vine planting is generally frowned upon by the population. Recently, an increased number of disease-carrying insects deteriorated the quality of saplings. A more serious problem is the purchase of high-quality grafted saplings without viruses for viticulture as well as horticulture purposes. In horticulture, the local residents have expressed willingness to pocure low saplings grafted on weak rootstock and a variety of equipment.

Field-crop cultivation-horticulture

In the villages of the Akhmeta municipality, the area of annual crops is more than 6,000 ha. The average annual yield per hectare ranges from 2.1 to 2.3 tons. Wheat occupies most of the area (over 5,000 ha). Corn harvest ranges from 3.2 to 2.5 t/ha. The area for the cultivation of sunflower crops ranges from 2,100 - to 2,500 hectares, while its yield is between 0.7-0.8 tons per hectare, which is quite a low result. The population has expressed a willingness to purchase new sunflower hybrids, production equipment, and edible oil production facilities. The aforementioned varieties are sown during the planting of wheat in autumn and, as a rule, yield a harvest prior to the hail season. In winter, the same species cover the soil with leaves and protect it from wind and water erosion. The oil obtained from the distillation of the seeds has high nutritional value, which is of great importance for the development of livestock.

The area of barley crop fields ranges from 600 to 1,100 ha, while its yield per hectare is about 1.5 tons. Barley is mainly used in cattle-breeding and feeding purposes for poultry. At present, outdated barley seed varieties with a low protein content are used in the Akhmeta municipality.

Potato crops occupy approximately 350 ha. Its yield is no more than 9 tons per acre. Locals generally grow potatoes for internal use. Recently, the irrigation areas along the Riv. Alazani are being used for cultivating early varieties of potato.

Bean Crops occupy about 200 ha, while the yield per hectare of is 600-700 kg.

Vegetables occupy about 400 ha (approximately 9 tons are harvested). Melons (cucumber, watermelon, melon) occupy about 90 ha, and the average yield reaches 20 tons (which is a low result). Such a low yield negatively affects the income of local farmers.

The population of the municipality is interested in purchasing winter-autumn garlic varieties and contemporary production technologies.

In terms of agriculture and in light of recent frequent droughts, irrigation water shortage is a problem in the municipality, and thus increases the farmers' dependence on weather. In addition, due to a high cost of fertilizers, only an insignificant part of the population can manage to fertilize the soil. According to information received from the local population, cultivation and harvesting mainly employs physical power. The lack of modern technology poses an additional challenge to the local farmers.

Seed quality is also a serious problem. Generally, domestic seeds manufactured without any selection are used. In some cases, the seeds are purchased in Tbilisi and other populated areas (Akhmeta, Gurjaani, etc.). There is also a practice of seed barter or credit. Mainly due to a lack of financial resources, farmers cannot afford to purchase seed in advance and must resort to aquiring seeds immediately prior to the planting season. This creates additional problems for the farmers, since, at this time, the seed is more expensive.

According to surveys of local residents, the soil is cultivated to a depth of 18-20 cm. Deeper cultivation has not been carried out for more two decades. As a result, at the depth of 3-5 cm, an insulated layer can be observed. It is compacted layer or a so-called “barrier” created as a result of systematic cultivation at the same depth, which prevents water from deep penetration and even distribution towards the plant root system, thus violating the regime of plant irrigation. In addition, the "barrier" contributes to the intensification of water, wind and irrigation erosion, drought and withdrawal of agricultural areas from circulation. In order to avoid these negative consequences, it is important to destroy the " barrier" using a contemporary deep cultivator and soil-loosening means and cultivate the soil to the depth of 25-35 cm. Along with the soil preparation, it is necessary to establish techniques and equipment for no-till planting, which will reduce the cost of crops and ensure soil protection from water and wind erosion.

As a rule, organic fertilizers, in many cases, excessive amounts of nitric fertilizers, are used for soil fertilization. It is observed that local farmers prefer not to purchase complex fertilizers (NPK), as they believe manure and nitric fertilization are sufficient. Such an approach leads to partial nutrition of the soil, which contributes to its exhaustion and yield reduction. Sideration and composting are also ignored; thus, crop yield is negatively affected.

The deficit of agricultural equipment and the high cost of fuel are major problems in the chain of crop production. In addition, it should be noted that in the villages, which located on inclined terrain, the use of agricultural machinery (tractors, combines, etc.) is associated with certain problems (due to the inclination). In such conditions, it is recommended to use hand-powered motor cultivators or mini-tractors.

Livestock

In the Akhmeta municipality, the number of livestock heads ranges from 22 to 24 thousand. Among them, the number of cows reaches 13 thousand, while the number of sheep and goats does not exceed a few thousand. Mainly, natural grasslands are used for grazing cattle, since the population does not plant annual and perennial grasses. It should also be noted that plot-rotation is ignored and there are no special facilities for cattle watering purposes. Financial support and veterinary services are at a low level.

As in other municipalities, in Akhmeta there is a possibility of the deviation of the mowing and grazing periods from usual terms as a result of global warming. In addition, there is a danger of the gradual domination of inedible weed plants, deterioration of the quality of hay lands, and the activation of water and wind erosion.

According to interviews with local farmers, the majority agrees with the need to improve livestock breeds, restore breeding, implement new technologies for processing dairy and meat products, and to improve veterinary services.

The majority of respondents expressed a desire to implement new technologies, which would facilitate the production process, increase production volume, and allow farmers to produce more diverse products.

1.1.8 Tusheti

In the Akhmeta municipality, one of the historical provinces of Georgia – Tusheti – is located. Although Tusheti belongs to the municipality in administrative terms, it is clearly demarcated from the rest of the natural conditions of the municipality, which is due to the location of Tusheti to the north of the main Caucasus watershed. For this reason, it is recommended to consider the natural conditions of Tusheti separately from the rest of the municipality.

Location

Area - 796 km^2.

Despite being within the administrative borders of the Akhmeta municipality, Tusheti, one of the historical provinces of Georgia, is strictly demarcated from the rest of the municipality by the orographic boundary of the main Caucasus watershed range. Tusheti is located to the north of the main watershed of the Caucasus mountain range, in the upper part of the Riv. Andis Koisu, which, along with the Caucasus mountain range, is bordered by the Piriketa and Atsunti hills.

Relief

The relief in Tusheti is characterized by high contrast and deep fragmentation. Its lowest point (the riverbed of the Riv. Andis Koisu at the Georgia-Dagestan border) is located at the altitude of 1,650 meters. The height of the highest peak of Tebulosmta reaches 4,493 m. Accordingly, the relief fragmentation exceeds the maximum depth of 2,800 meters. In terms of geomorphological structure, Tusheti is divided into two orographic regions: the Tusheti cave and the ridges around it. The Tusheti cave is further divided into two gorges - Pirikiti Alazani and Tusheti (Gometsri) Alazani. These gorges are separated by the Makratela ridge. Tusheti is constructed entirely of clays of the Jurassic period. The terrain is of mountain-ravine type, the morphological character of which is defined by river erosion. Mountain slopes, over a large area, are rather steep and fragmented by the tributaries of rivers Pirikita Alazani and Tusheti Alazani. Because of deforestation and overgrazing on the inclined slopes, flat and partially linear erosion is intensified. In the eastern part of Tusheti – at the junction of rivers Pirikiti Alazani and Tusheti Alazani – features the Omalo, Shenako and Diklo erosive lowlands, which are situated at the altitude of 2,000-2,100 meters. Pirikiti Alazani and Tusheti Alazani gorges cut the surface of these lowlands to the depth of 150-200 meters. Old glacier relief with short trog gorges and morains at their bottoms still remain at the sources of the mentioned rivers at the altitude of 2,700-2,800 meters.

Climate

Tusheti is located in a district with a moderately humid climate and is distinguished by a high-altitude zone because of the high hypsometric fragmentation of terrain. Generally, the Tusheti climate, in contrast with that of the southern slope of the main Caucasus watershed ridge, is relatively dry and more continental. Average annual temperature fluctuates between 4^0-6^0C at the altitude of 1,800-2,000 meters. In January it is -9^0 – -10^0C, and in July it is 14^0-15^0C. Total annual precipitation is 700-800 mm. Annual average air temperature in subalpine and alpine zones is -3^0– -6^0C, it ranges between 5^0-10^0C by July.

Hydrographic Network

The Riv. Andis Koisu takes its source in Tusheti and joins the Caspian Sea via Dagestan. Riv. Andis Koisu is a combination of two rivers Pirikita (Kvdistskali) Alazani and Tusheti (Gometsri) Alazani. The Riv. Pirikita Alazani (length of 49 m.) takes its source from the Pirikita ridge at the altitude of 3,200 m, while the Riv. Tusheti Alazani (length 59 km) starts from the Atsunta range at about the same altitude. Both rivers go through the Makratela ridge through a narrow and deeply erosive gorge and connect with each other at the southern edge of the Omalo lowland at the altitude of 1,640 m. Both rivers and their numerous tributaries (Tusheti Alazani tributaries: Bikurta, Ortskali, Khiso Alazani, Tsovatistskali, Cherostskali; Pirikita Alazani tributaries: Parsmistskali, Cheshostskali, Didkhevi, Chigostskali), are nourished by snow, rain, underground and glacial waters. Flooding on these rivers takes place in spring.

The average annual discharge of the river Tusheti Alazani at its estuary is 24 m^3/s, while at the estuary of Pirikita Alazani - 10.2 m^3/s. Small, modern glaciers should be highlighted among the Tusheti inland waters; their number reaches 36 and their area is 9.7 km^2.

Soils

In the Tusheti mountain-forest zone, at the altitude of 1,800-2,000 meters, mostly sinnamonic and and light sinnamonic soils are featured. Far above, in sub-alpine and alpine zones, mountain meadow cords and cord-peat soils can be found.

Vegetation

Natural vegetation is significantly degraded as a result of human activity. In preserved forests, the basic background is provided by pine and birch-pine associations. The upper forest border in Tusheti is at the altitude of 2,200-2,500 meters. Further above, subalpine and alpine zones are developed. Secondary meadows and meadow shrubs occupy a wide area in the zone; their vegetation is highly degraded as a result of intensive grazing.

Population

In the 1989 census, 10 villages were registered in Tusheti (5 of which were abandoned in the winter) with 101 inhabitants. According to the 2005 data, the population included 25 households (10 in Omalo; 5 in Shenako; 4

in Diklo; 3 in Dartlo; 1 in Dano). Tusheti is rich with summer grazing areas; consequently, it has quite good conditions for both sheep and cattle breeding. For winter grazing, farmers from Tusheti use lands adjacent to Riv. Iori (Eldar, Pantishara, Vashlovani, Shiraki and others).

Of small grain crops, barley, spring wheat, oats, potatoes, cabbage and onions are grown here.

1.2 Telavi municipality

1.2.1 General Information

Location

Area – 1.095 km^2.

Telavi Municipality is located in the midst of the Alazani watershed at the confluence of its left (Stori and Lopota) and right (Turdo and Vartiskhevi) tributaries. The territory of the municipality borderes: from the North – by the Great Caucasus Dividing Range (here some sections of the municipality border coincide with the state border between Georgia and Russia); from the South – by the Gombory Range. The East and West borders of the municipality are not geographically distinctive. From the East it is bordered by Kvareli and Gurjaani municipalities and from the west by Akmeta.

Relief

Telavi Municipality is to be divided into 3 parts. The North-East part is formed by Paleozoic and Mesozoic clay-shale/clay-slate, crystalline-shale, Sandstone, marl, limestone, marble and diabase. The South-West slopes of the Great Caucasus Dividing Range are situated between the Nakerala and Sajikhve-Girgala sub-ranges. This part of the Municipality features intense fractions caused by meridian-direction eroded ranges and gorges in-between them. Together with the ridged line of the Great Caucasus Dividing Range and its South-East slopes, here the main Orographic elements are Sajikhve-Girgala, Sajikhvistavi, Andarazani and Naqerala sub-ranges and erosive-accumulative gorges of the Stori, didkhevi and Lopota rivers.

The Municipality is located at an altitude of 250-3,300 m. above sea level. Due to extensive hypsometric development and the erosive-accumulative impacts of the rivers, its terrain is characterized by average and high mountains and gorges. Many of the mountains have crests of cliffs. Their slopes are extremely steep and are parted by eroded gorges with steep hills. Some sections of the Great Caucasus Dividing Range and its ridges have traces of Quaternary Glaciations exposed by U-shaped valleys or glacial troughs, circuses and doors. Toward the Alazani River Plain the slopes of the Caucasus Range decrease and the northern peripheral ridge of the above-mentioned plain begins in the fashion of separate monocline hillocks.

The relief of South-West Telavi Municipality is represented by the North-East slopes of the younger (Pliocene age) wrinkle-structured Gombori Range, which are located between the river gorges of Shavkodaskhevi and Mgvriekhevi. The gorges of the rivers coming down the abovementioned slopes (Turdo, Kisiskhevi, VAntkhevi, Shromiskhevi, etc.) are filled with cobble-stone have the shape of cubes, they settle deep within the the Gombori Range, which is formed by conglomerates, sandstones and clay. The slopes of the Gombori Range lower sharply towards the Alazani Plain. The loose rocks of these steep slopes, not resistant to exogenic processes, promote the development of badland and landslide relief. Mudflow debris originating on the Gombori Range slopes that pass through the abovementioned river gorges are worthy of special consideration.

The central part of Telavi Municipality across the River Alazani is occupied by an accumulative plain, the surface of which consists of the alluvial and alluvian-proluvian debris brought by the rivers of Caucasus and Gombori Ranges. Within the Municipality borders the Alazani Plain is located at an altitude of 300-500 m.

above sea level. Its surface is inclined twofold (toward the River Alazani channel and across its own course). Relief of the plain adjacent to the Alazani River on both banks is flat and less fragmented. The length of this plain segment varies from 2 to 5 km. Toward the Caucasus and Gombori Ranges the plain elevates and develops a steep surface. It eventually merges with the hill line, which consists of Talus cones formed by runoff, sediment and alluvian-prolluvian layers.

The relief of the Alazani Plain and its adjacent hill line create advantageous conditions for agricultural developments in the Telavi Municipality.

Due to its abundance of precipitation, sufficient inclination and its diversity, the mountainous part of Telavi municipality hosts an extensive hydrographic network. Together with permanent rivers, moderately dry ravines, which get waters only after intensive rains or snowmelt, play a considerable role in the hydrographic network.

1.2.2 Climate

Ongoing Changes in Climate

Telavi Municipality is located in a transitional area, from subtropical continental to sea climate and is distinguished by climate zones that vary by height. At approximately 700-800 meters above sea level (the municipality borders include a part of the Alazani Plain together with a hill line) the climate is relatively humid, with moderately warm winters and long hot summers. At approximately 700-1,200 meters above sea level the climate is moderately humid, with moderately cold winters and relatively cool summers. The climates of territories up to 1,220-2,000 meters above sea level are cold and moderately humid, with long winters and short, moderately cool summers. Territories higher than 2,000 meters are characterized by mountainous cold climates, severe winters and short, cool summers. Current climate changes were calculated according to data from the Telavi Meteorological station (568 meters above sea level) over a time period of 1956-2005. For the comparison of characteristics of meteorological elements, the abovementioned period was divided into two 25-year spans (1956-1980 and 1981-2005). According to the analyzed data, the annual average terrestrial air temperature is 11.8^0C, Absolute maximal temperature is 38^0C, while the absolute minimal is 23^0C. The total annual precipitation is 860 mm. Mean wind velocity is 2.4 m/s, rising to a maximum of 32 m/s.

In basic periods **annual average terrestrial air temperature** has increased slightly ($+0.3^0$C). Warming has been detected in all seasons, especially in summer ($+0.4^0$C). An increase in the absolute maximum was detected, during the last 25-year span, for all seasons but mostly for summers ($+3^0$C). **Absolute minimum** air temperature for the entire time-span is ascending. The difference between two 25-year spans is highest in winter ($+4.2^0$C). **Average maximum** air temperature has increased for all seasons and as a yearly average as well ($0+5^0$C). The demonstrated increase in air temperature is due to an increase in the upper limit. The warmest temperatures are detected in spring and summer ($+0.3^0$C). **Average minimum** air temperature (as well as average maximum) is slightly warmer (0.2^0C). Summer minimums are ascending sustainably (0.5^0C).

Total annual precipitation in the territory of the municipality descend slightly (-4.4 mm) over the period (1956-2005). The tendency of decreasing precipitation is most stable in winter (-5.2 mm) and in summer (-8.2). However, the sum of summer and winter precipitations increases in total (16.6 mm and 10.7 mm).

Daily precipitation in the second 25-year time-span descended relatively slightly compared to the previous period (-2.4 mm in winter and -19 mm in summer). A comparatively slight increase in maximal precipitation was detected in spring (+3.1 mm) and in autumn (+3.3 mm). In annual statistics this parameter descends (-20). The consequence of this information is that the decrease of daily summer precipitations, as well as of their seasonal sum, resulted in drought increase. Precipitation ascends slightly in spring, resulting in a comparatively slight increase of floods.

Mean wind velocity is decreased in all seasons. The most significant decrease was reported in spring (-0.9 m/s) and annual decrease equals to -0.8 m/s. The maximal wind velocity decreased in colder seasons, while it increased slightly in springs and summers of the second 25-year time-span. The mean values of maximal velocity were marked by an increase.

Winters of the last 25-year time-span were comparatively warmer (mostly due to the ascending maximal temperature). Variation of mean and absolute temperatures was slightly negative. The number of freezing nights increased by 3 days, while the number of freezing days decreased by 4. Also, total precipitation and daily precipitation indexes decreased (-5%). The number of days with more than 10 mm per day was increased, while the number of days with abundant precipitation decreased.

In the second time-span, compared to other seasons, a slight increase in the average **spring** temperature was detected (+0.1^{0}C). Daily temperature amplitude also ascended (+0.4^{0}C). The last 25-year period featured an overlap of the absolute values of minimal temperature. The nights are warmer in spring: a number of those nights when T_{min}<0 is decreased, while a number of freezing nights when T_{max}<0 – is increased. The index of hotter days increased as well. In the second time-span seasonal precipitation increased mostly in spring (+7%). Meanwhile, the maximal daily precipitation overlapped. Notable increases in days with more than 10 and 20 mm of rainfall were detected. Over the observation period, springs were warmer and more humid, with less danger of freezing and the duration of the vegetation period was unchanged.

Summer seasons, in comparison with other seasons, were characterized by an annual temperature increase. The number of hot days was increased by 5, while the number of tropical nights was increased by 4. Total precipitation as well as night maximums decreased (by 3%). The number of shower precipitation days (with more than 50 mm of precipitation) was slightly increased (by two days over the two time-spans). Therefore, summertime features an increased risk of drought due to an increase in temperatures and a decrease in the precipitation index.

Autumns, according to all abovementioned temperature parameters, were warmer. However, the warming is less significant than in summertimes. The number of hotter days increased, while the sum of colder nights lessened. The last 25-year time-span was marked by more frequent tropical nights, while freezing nights, when the day maximum is negative, were not reported at all. Consequently, the danger of autumn chilling is reduced. Total precipitation, unlike in the summer, showed an increase (+7%). Multiannual trends of Daily maximal precipitation are ascending as well. Likewise this increase may result in enhanced risks of flooding and mudflows. All climate extreme indexes related to precipitation were raised (10, 20, 50 mm).

Extreme Phenomena

Mudflows and landslides. During the observation period the precipitation index demonstrates that In Telavi Municipality maximal precipitation over 5 consecutive days, the number of abundant precipitation days (when daily precipitation is higher than 20 and 50 mm) and the duration of consecutively rainy days all increased. The municipality is characterized by abundant precipitation – more than 50 mm precipitation was reported just 42 times during the last 50 year period. Eighteen cases were reported in the first 25-year time-span and another twenty four – in the second time-span. Precipitation of more than 90 mm was reported just twice in the first 25-year span. This is considered to be a hazardous amount of precipitation, resulting in mudflows. This shows that the risk of mudflows increased in the municipality. Moreover, total annual precipitation days of 200 mm or more, which is a criterion of landslide processes, were reported thrice in the first time-span and twice in the second one.

Table 1.2.1. The change in the amount of precipitation posing risks of mudflows and landslides (Akhmeta Municipality)

Mudflow and Landslide processes	Total daily precipitation >50 mm	Total daily precipitation >90 mm	Total annual precipitation – when it exceeds 200 mm and more
Changes of occurrence number	+6	-2	-1

Droughts were assessed according to the Standardized Precipitation Index for the period of observation. The table below shows the variance of severe and extreme droughts recurrence between two time-spans and the average number of extreme droughts in different periods (according to the two time-spans).

Table 1.2.2. Average number of extreme draughts in different periods according to time periods (Akhmeta Municipality)

Extreme droughts (SPI>-2.0)	1-month	3 months	6 month	9 month	12 month
1956-1980	8	5	2	0	4
1981-2005	8	11	15	8	5
Difference	0	6	13	8	1

Table 1.2.3. Average Number of severe draughts in different seasons according to time periods (Akhmeta Municipality)

Severe drought (SPI>-1.5)	1-month	3 months	6 month	9 month	12 month
1956-1980	23	20	16	18	24
1981-2005	23	20	24	14	13
Difference	0	0	8	-4	-11

The probability of drought occurrence becomes more frequent for 6-month droughts. Probability occurance for longer droughts is decreased. Besides, the number of extreme droughts increased, which is caused by the precipitation reduction tendencies in the summer and winter seasons.

Expected Change of Climate in Years 2020-2050

The future scenario of climate change was elaborated according to PRECIS model, which reflects the ECHAM4 global model and two other models of the world's socio-economic development (A2, A3). The model was calibrated according to the data of the Telavi Meteorological Station. Means of average temperatures and total precipitations (30 years long observations) for each month and the significance of the same parameters were calculated by ECHAM4 and HADCM3 models.

For air temperature, a method of difference was considered to be the best for calibrating according to both models (ECHAM4 and HADCM3). Correlation between Model forecasts and observation data is quite high (≈0.9). Calibration of precipitations was conducted using a ratio method because the forecast (according to the scenario) total precipitation for some months in future is so little that the application of the method of difference seems impossible. When designing a future climate scenario a method of difference for air temperature and a ratio method for precipitation will be applied.

Both seasonal and annual average air temperature indices will be raised for Telavi Municipality in years 2020-2050. According to Scenario B2 these parameters rise by 2.5^{0}C (most of all in winter, by 3.6^{0}C). It is noteworthy that this tendency is in agreement with the temperature rise reported for all seasons during the last 25 years. Average maximum temperatures are also increased both seasonally and annually, and are in agreement with warming revealed over the last 25 years.

According to Scenario B2, **Average maximum temperature** gets warmer in winter (4^{0}C). For other seasons, as well as annually, this parameter rises by 1.6^{0}C-2^{0}C.

Rise of **average minimal temperature** is anticipated for summer (according to Scenario B2 by 2.3^{0}C). For other seasons, as well as annually, average minimal temperature increases by 1.5^{0}C-2.5^{0}C (according to Scenarios A2 and B2).

According to the scenarios, total annual precipitation rises by 8% and 9 %. Change in precipitation by seasons, forecasted by the scenarios, is opposite to the tendency detected in the last 25-year span. According to Scenario B2, increases, revealed in winter, over the observation period will decrease slightly. Increases, revealed in last period, will be shifted by decreases. According to Scenario B2, total seasonal precipitation is unchanged in autumn. An increase in the total summer precipitation by 22% and 15% is the most important occurrence (according to Scenarios B2 and A2).

According to the scenario, daily maximum precipitation is forecast for spring. This is the only season where daily maximal precipitation is raised by 11%. Among other seasons summer is the one when this parameter is reduced (by approximately 50%). Annual maximum precipitation also decreases and continues the decrease detected in last period. Also, mean values of daily maximum precipitation descend and, together with maximums in this parameter, become most acute in summer (by 40%) and least significant in winter (by 4%). The mean of daily maximum precipitation decreases by 30% in other seasons.

The annual wind velocity in years 2020-2050, according to the future climate scenario, will remain largely within the limits of the average values observed over the last 25-year span.

According to Future scenarios, Climate analysis for the seasons is mostly based on the results of Scenario A2. For this season, extreme indices are also calculated that make the changes in meteorological parameters more precise (For Scenario B2 extreme indices could not be calculated, as there is no calculation of daily extremes for this scenario).

Winters in 2020-2050 will be approximately 3^{0}C warmer. Avarage Maximal temperature will be raised by 2-3^{0}C, while the minimal air temperature will be less (by 1^{0}C). The number of freezing nights will decrease by approximately by 24% compared to the second 25-year time-span. In 2020-2050 the number of freezing days will also decrease by approximately by 10 times. Scenario B2 shows that total winter precipitation is expected to rise by 1%, and, according to Scenario A2, total precipitation for this season will be 2% lower. Daily maximum precipitation and its mean value will decrease slightly (4% in the scenario). The number of rainy days with less than 20mm precipitation will not change, and there will not be any days with less than 10mm of precipitation. The consequence of this data are that in 2020-2050 winter will be milder compared to the observation time-span in Telavi Municipality.

As expected, average, average maximal and average minimal air temperatures will rise by approximately 1.6^{0}C **in spring**. Furthermore, the number of cold days will increase by 64 days (compared to the first 25-year span). There are expected to be no freezing days. The number of hot days will increase (to approximately 15 days per season). Tropical nights are anticipated to start in spring (their number is around 3 in the previous 30-year period). As anticipated, the reported tendency of decline in precipitation sums will be replaced by an increase (of 5% according to the Scenario B2). In this season the daily maximum precipitation will exceed the spring maximum, reported in all observed spring maximum. The mean value of the daily maximums will decrease with the values of extreme precipitation indexes. In spring, total precipitation will be distributed over fewer rainy days. Consequently, spring season is forecasted to become warmer with more days of less precipitation.

According to both scenarios, average air temperature, as well as its average maximum and minimum, will raise approximately by 2-2.5^{0}C **in summer**. As supposed, maximal and minimal temperatures will increase equally (according to the Scenario B2 by 2.5^{0}C and the Scenario A2 presumes 2^{0}C). The number of hot days will lessen by 7%, while the number of tropical days will increase 3.5 times. According to scenario B2 total precipitation will increase by 22%, scenario A2 supposes an increase of 15% (that contradicts the reduction tendency detected in the second observation period). Therefore, daily maximum precipitation and its mean value will decrease by 50% and 40%. As estimated, the number of rainy days when total precipitation is more than 10 mm will increase, while the number of days with more than 20 mm and 50 mm will lessen.

According to scenarios B2 and A2, average air temperature, as well as its average maximum and minimum, will rise by approximately 1-2.2^{0}C **in autumn.** There are no cold days forecasted, while the number of freezing nights will increase by 40%. The number of hot days will increase either (approximately by 5 days per season and in total, by 600 days for the following 30-year period). This tendency will continue the increase revealed in the last observation period. Total seasonal precipitation will not be changed in scenario A2, while according to scenario B2 it increases by 11%, which sustains the tendency of precipitation changes for this season seen in last observation period. Daily maximum precipitation and its mean values descend by 30% and 19%. As estimated, compared to the first observation period, the number of rainy days with more than a total of 10mm precipitation will increase by around 3 days. Besides, the number of days with more than 20 mm of precipitation will reduce by 35%. Days with more than 50% precipitation intensity are not expected in autumn. According to this data, autumn season in Telavi municipality is forecasted to be warmer but with chilling risks maintained.

Extreme climate indexes were calculated on the basis of total precipitation and of data about minimal and maximal daily temperature for the years from 2020 to 2050. As anticipated, according to the climate indexes, the number of freezing days will increase by 4 cases in autumn and by 2 in spring in the territory of Telavi Municipality. In winter, the number of freezing nights will decrease compared to the observed period. The number of freezing days will lessen by ten times compared to the second observed 25-year span.

The number of tropical nights will increase significantly in summer and autumn (2 cases were reported in the observation period, with approximately 74 occurrences expected in the coming 30-year period). Besides, the number of days when total daily precipitation exceeds 10 mm will increase annually. However, the number of days with more than 20 mm and 50 mm total daily precipitation is anticipated to lessen, while the days with more than 90 mm precipitation will remain the same. Occurrences of 200 mm and upper total annual precipitation that are criterions of landslide hazards are expected to increase by two incidents.

According to the aforementioned data, and compared to the previous observed period, mudflow risks will diminish slightly, although risks of landslide re-activation will increase.

Droughts. In Telavi Municipality drought occurrence was assessed using the standardized precipitation index. According to the future scenario for years 2020-2050, droughts of different types and durations (their length varies from period to period) will diminish in the territory of Telavi municipality. Besides, compared to the first observation period, enhancement of 3, 6 and 9-month long droughts are anticipated.

Table 1.2.4. Dynamics of severe 3, 6 and 9-month long droughts (Akhmeta Municipality)

Severe drought (SPI>-2.0)	1 month	3 month	6 month	9 month	12 month

1956-1980	8	5	2	0	4
1981-2005	8	11	15	8	5
2020-2050	7	8	9	7	4

1.2.3 Hydrographical Network

The main artery of the hydrographic network in Telavi Municipality is the Alazani River. The Alazani River originates from the municipality borders in the Greater Caucasus, south of the main ridge, on the Southern slopes of the Mount Borbalo (3,295 m above sea level). The Alazani flows in Telavi Municipality through the village of Qvemo Alvani at 450 m above the sea level and levels in the municipality territory at 260 m above the sea level. Following the aforementioned information, the Alazani River fall hight does not exceed 190 m through the Municipality territory. The following tributaries of the Alazani River are noteworthy: left tributaries – Stori and Lopota, right tributaries – Turdo, Kisiskhevi, Vantkhevi, Akuriskhevi, etc. There are irregular creeks streaming down the Gombori slopes, which have their their channels filled by intense rainfall and snow melt.

The Alazani River and its tributaries gather their waters from rains, snow melt and groundwater. The water regiment of these rivers is featured by floods, caused by spring snow melt, as well as by freshets, caused by summer and autumn showers, and by significantly swallowed waters in winter. In all territory of the municipality, as well as across the whole of the River Alazani, the majority of the river discharge (approximately 60-65%) flows in spring and in the first part of summer.

The width of the Alazani River channel within the Telavi municipality boundaries varies from 40 m to 60 m., its approximate depth reaches 2-4 meters, while its stream discharge reaches 0.8-1.2 m^3/s.

The Lopota River originates in the Greater Caucasus at 2,380 m above sea level and merges the Alazani River in the south of Saniore village (on the left bank, 3 km away). The length of the river is 33 km, total fall reaches 2,000 m, total watershed area equals to 263 km^2 and its average basin height is 1,400 meters. The river channel up from Lapankhure village varies moderately and makes delta. Rifts and slower streams exchange positions. The width of the stream in the riverbed varies btween 2 m - 12 m, its depth reaches 0.2 - 0.7 meters and stream speed varies from 2.5 mps to 0.8 mps. The Lopota River is the main water reservoir and irrigation basin for Napareuli village. There is a Lopota canal for irrigational purposes that waters 1,100 ha of lands.

Approximately once every 5 years (especially in dry periods of summer) middle and lower courses of the Lopota River pass mudflow streams, which are caused by showers.

The Stori River originates on the south slope of Mount Didgverdi, at 2,950 m above sea level and merges with the Alazani River at Saniore village. The length of the river is 38 km, its total fall reaches 2,577 m, its total watershed area equals to 281 km^2 and its average basin height is 1,610 meters. The main tributaries of the River are the Usakhelo River (total length: 14 km) and the Tchitchakhvi Khevi (20 km). From Pshaveli village to the confluence point the River Stori passes the Alazani accumulative plain. The river gorge, from its source to Pshaveli village, makes a V-shape. Its lower gorge does not have any tributaries and has a less sharp shape. The upper course of the river is crisscrossed. Rifts and slower streams exchange positions. There are sections with rapids, with a length of 200-800 m, width reaches 7-8 m, and fall equals to 30-40 meters. The width of the river channel is 6 m at the river source and 20-22 m at Lechura village. Stream depth is around 1 m, and stream speed varies from 2-2.5 mps to 0.6-1.5 mps.

Discharges of the Alazani River were observed from 1912-1991. On the basis of the observations average monthly, annual, and other maximal and minimal discharges of recurrence and various provisions were identified for the Alazani River and its tributaries over this period. Characteristics of these parameters within the boundaries of Telavi municipality are given in the tables below:

1.2.5. Average monthly and annual discharges of the rivers

River	Hydrological checkpoint	*F* km²	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Alazani	Shakriani	2190	18.9	20.6	33.2	68.6	91.1	78.4	52.4	35.2	37.1	37.6	30.6	22.2	43.8
Stori	Lechuri	203	3.02	3.22	5.00	10.7	15.1	14.9	11.4	7.35	7.06	6.46	4.72	3.60	7.71

Table 1.2.6. Maximal discharges of various recurrences of the rivers

Rivers	Hydrological checkpoint	F km²	recurrence τ year					
			1000	100	50	20	10	5
Alazani	Shakriani	2,190	1,530	1,100	920	680	580	450
Stori	Lechuri	203	600	430	360	270	230	180

Table 1.2.7. Minimal discharges with various provisions of the rivers and its tributaries within the boundaries of Telavi Municipality

River	Hydrological checkpoint	F km²	Provision *P* %						
			75	80	85	90	95	97	99
Alazani	Shakriani	2,190	11.2	10.6	10.1	9.25	8.30	7.74	6.63
Stori	Lechuri	203	1.86	1.79	1.72	1.62	1.52	1.43	1.27

As mentioned above, for the past two decades observations on Alazani River and its tributaries have been discontinued. During this period in-year distribution of river discharges has changed, which is mainly expressed in an increase of the maximal levels of floods and freshets. Simultaneously, summer discharges decreased, and impacted negatively on the provision of irrigation systems. According to recent observations, amounts of average monthly and average annual discharges of the Alazani River (Shakriani confluence hydrological station) in 1961-1990, compared to earlier period from 1932 to 1960, were diminished (the conclusions were based on existing materials). This can be explained by climactic changes.

Table 1.2.8. Average monthly and annual discharges (m^3/s) of the Alazani river for two periods

Periods	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
1932-1960	19.7	21.5	32.1	68.7	95.8	82.8	52.9	36.2	40.2	41.0	34.9	24.3	45.8
1961-1990	18.2	19.1	33.3	66.0	84.2	71.2	51.7	38.6	37.4	34.4	27.7	22.1	42.0

In 1930-1933 Upper Alazani Canal was exploited in the territory of Telavi Municipality. Like other comparatively dry climate municipalities of Georgia, the irrigation of agricultural lands was practiced in the past as well (in the period of King Tamar's reign, tens of kilometers of irrigation canal were built). Currently, the technical conditions of the irrigation system in Telvai municipality, as well as in other parts and municipalities of Georgia, are not satisfactory. Certain sectors of the canal need cleaning and repair. The second and third distributors of the canal are out of order, which interrupts the provision of agricultural lands with water from the main canal.

Table 1.2.9. Main Irrigation systems on the territory of Telavi Municipality

Names of feeding rivers	Irrigation System	Distance from river source to the waterhead of the irrigation system	Irrigation area (ha)	andwidth at canal (m^3/s)	Annual waterfeed volume ($mln.m^3$)	Note
Alazani	Upper Alazani[1]	337	15,772	24.0	56.0	
Alazani	Lower Alazani	279	191	16.0	255.445	212.4 HP
Alazani	Bakhtrioni	315	–	1.50	6.0	
Stori	Naurdauli	12.0	3,686	6.0	26.0	
Stori	Saniore	–	1,632	1.5	–	
Lopota	Lopota	–	1,253	1.0	–	

[1] Project bandwidth of the Upper Alazani Canal was planned to be regulated from the Birkiani Reservoir to be constructed on the Alazani River. Currently, the main Upper Alazani Canal is supplied by 6 m^3/s amount of water.

1.2.4 Soil

The territory of Telavi Municipality belongs to the soil area of Georgia, which is a transitional forest-valley, mountain forest and mountain meadow zones, where, according to the FAO classification, the following soil types are present:

- PRIMITIVE MOUNTAIN MEADOW
- MOUNTAIN MEADOW SODDY
- MOUNTAIN MEADOW SODDY PEAT
- MOUNTAIN MEADOW BOG
- BROWN FOREST ACID
- SINNAMONIC
- MEADOW SINNAMONIC
- RAW HUMUS CALCAREOUS
- ALLUVIAL CALCAREOUS (carbonated and non-carbonated)

Mountain Meadow soils are common mostly on the south-west slopes of the Great Caucasus Dividing Range – in the subalpine and alpine zones of Nakerala, Sajikhve-Gorgial, Andarazani and Kakheti sub-ranges. Here they are present as mountain meadow soddy, mountain meadow soddy peat, and primitive mountain meadow soils. Mountain meadow soils are dark or dark-sinnamonic in color. They feature thickness and a higher degree of sod. Soddy and soddy-peat soils of the alpine subzone are characterized by less thickness. Sodness is characteristic of mountain meadow and mountain meadow soddy peat soils, which develop under a thick cover of grass. It is less present in soils formed under tall herbaceous and secondary mountain meadow soils. The abovementioned soils host summer pastures, and here intensive grazing damages sodness of grass cover. On the other hand, this promotes the intensification of soil degradation through surface waters and wind erosions.

Brown forest soils are more widespread on the terrain of the Municipality. These types of soils are common on the south-west slopes of the Great Caucasus Dividing Range, on the slopes of Nakerala, Sajikhve-Gorgial, Andarazani and Kakheti sub-ranges, and are developed under broadleaf forests at about 1,800 m above sea level. Brown forest soils are distinguished by their dark brown color, average and heavy clay constitution, and well-expressed humus horizon and a grain-loose structure. They are exploited for cultivation of crops (barley, spring wheat, and corn), fruits and vegetables. When developed on steep slopes these soils are at risk of erosive processes.

Raw humus calcareous soils are developed under mountain forests. They are black-brown in color and have granular and crumb structure with heavy clay compounds. These types of soils exist on steep slopes and plain areas, and feature a high to average thickness. When existing on steeper or inclined slopes they are subject to erosive processes and, consequently, are less thick. Raw humus calcareous soils are useful for cultivation of crops (barley, spring wheat, and corn), fruits and vegetables.

Sinnamonic soils are common for the lower part of the front hills and mountain-forest zones, at 1,000-1,100 m above sea level, on loams or erosive layers of sandstones and conglomerates. The soils belonging to this type are generally dark or dark-brown in color and have a granular and crumb structure. They are composed ofa heavy clay mechanical shingle, and contain a large amount of humus. On steep slopes, especially in the forest-free territories, sinnamonic soils are subject to water and wind erosion.

In places where meadows and meadow-shrub landscape has developed, meadow sinnamonic soil replaces typical sinnamonic soil. Meadow sinnamonic soil is of secondary origin and is common to post-forest terrains. This type of soil is thick and dark sinnamonic or grey sinnamonic in color. It has average or heavy clay composition and average levels of humus in it. In the boundaries of the municipality this soil is employed for cultivation of crops and vegetables, vineyards and fruit gardens.

Alluvial and meadow alluvial (carbonated or non-carbonated) soils. Alluvial carbonated soils are developed along the Alazani River banks. This type of soil features a grey brown color, a high content of carbonates, a dusty crumb structure, a less differentiated profile and moderately little humus (the amount of humus does not exceed 2.5%). It lacks significant quantities of plant feeding elements. Together with alluvial carbonated soils there are alluvial non-carbonated soils all over the territories of Telavi Municipality. This type of soil contains more humus, has a relatively light mechanical composition and a lower index of podzolization. Across the elevated line on the left side of the Alazani River less thick and, in general, stronger alluvial soils have developed on Talus cones generated by rivers. Alluvial soils are advantageous for growing vineyards and fruit gardens, for melon and vegetable farming.

1.2.5 Landscapes

In the boundaries of the mountainous territories of Telavi Municipality when ther is an interconnection between relief, climate, soil and natural vegetation, the following types of geographic landscapes are present:

1. On brown forest and raw humus calcareous soils of low and average gorges, at 1,200-1,400 m above the sea level – Oak, Hornbeam-oak and Oak-chestnut-beech forest landscape.

2. At 1,400-2,100 m above sea level - Beech forest landscape.

3. At 2,100 m above sea level – subalpine meadow shrub wood, subalpine and alpine meadow landscape.

4. Across the Alazani River channel there is a small district of floodplain forest landscape.

On the most part of the Alazani Plain and the adjacent hill line a developed landscape has developed (populated communities, roads, agricultural lands including vineyards, grains and cornfields, fruit and vegetable gardens). Therefore, in this territory the natural landscape is highly modified, thorny shrub fields and shrub woods are present.

1.2.6 Natural Vegetation

Natural vegetation in Telavi Municipality and, consequently, its current ecological condition is diverse due to the fact that the municipal territory, on the one hand, includes a lower mountain zone (500-800 m above sea level) and on the other hand, middle, uphill and sub-alpine belts. The front hill and plain vegetation is highly degraded. Here, the terrain previously occupied by Oak and Hornbeam woods and floodplain forests is occupied by villages and agricultural lands (pastures, fruit and vegetable gardens, and cornfields). Currently, territories adjacent to the villages and towns are represented by degraded fragments of Oak-hornbeam (Quercus iberica and Carpinus betulus) and Oak-elm (Ulmus foliaceae) relict forests. Phytocenosis of the aforementioned relict forests, the sub-forest of which is presented by Hazel nut (Corylus avellana) and species of hawthorn (Crataegus kyrtostyla, C. pentagyna). The floodplain forest landscape is also highly degraded. The only exception is an upper course of Turdo Gorge, where Poplar (Populus hybrida), Willow (Salix alba, S. excelsa), Silk Vine (Periploca graeca), Old man's beard/Traveller's Joy (Clematis vitalba, C. orientalis), Smilax excelsa, Elderberry (Sambucus nigra), Hop (Humulus lupulus), Blackberry (Rubus sp.), Wild wine (Vitis sylvestris), Common Ivy (Hedera helix), Dog-strangling vine (Cynanchum acutum), Wild privet (Ligustrum vulgare), Eglantine (Rosa canina), and Common sea-buckthorn (Hippophaë rhamnoides) are found. Small fragments of floodplain forests are present in the floodplains of the Alazani River and its tributaries (Didgula, Eniseli, Lapankhuri, Pshaveli, Shakriani and others).

In some places (Eniseli, Pshavela, Napareuli and other villages) Christ's thorn (Paliurus spina christi), Oak-shrub-hornbean (Quercus iberica, Carpinus orientalis), and Oak-hornbeam (Quercus iberica, Carpinus betulus) woods are widespread. In other places thorn shrubs are of more recent origin and Christ's thorn together with Georgian oak (Quercus iberica), Thorn hornbeam (Paliurus spina-christi), and Common maple participate in its spread. Single Christ's thorn is often intruded by Oak-shrub-hornbeam woods (likewise phytocenosis is reported in the Shaqriani neighborhoods). The derivates (Quercus iberica, Carpinus betulus, Populus canescens, Salix alba, S. excelsa) populated in similar districts indicate that they were widely spread in the territory of the municipality. Along with abovementioned species, Acer laetum, Common maple, Common ash-tree (Fraxinus excelsior), Floodplain elm (Ulmus suberosa), Floodplain oak (Quercus pedunculiflora) and others were widely present.

The Caucasus Mountains of Kakheti, and the Tetritsklebi-Kobadzeebi segement of Gombori range and upper forest belt are dramatically different from the forests of the plain territories. Humidity in these areas is quite high, which promotes the development of mezophilic phytocenosis of forests and meadows.

In the lower belt of Sak forests, at 600-1,100 m above sea level and across the south-east slopes Oak-hornbean and mixed deciduous forests (Quercus iberica, Carpinus betulus, Acer campestre, A. laetum, Fagus orientalis, Tilia begoniifolia) have developed. Eglantine (Rosa canina), Cornel (Cornus mas), Medlar (Mespilus germanica), Hazel nut (Corylus avellana), Hawthorn (Crataegus kyrtostyla), Blackberry (Rubus sp.) are also common in these sub-forests. Also, Oakwood Quercus iberica, Festuca drymeja, and Carex buschiorum are found here. There are fragments of surviving floodplain forests here and there (on river floodplains and on the first terrace) in the belt.

At 1,000-1,600 m above sea level a Beech forest sub-belt is mixed with widespread monodominant beeches, as well as Hornbeam (Carpinus betulus), Hornbeam-beech (Carpinus betulus, Fagus orientalis) woods, Acer laetum of mixed broadleaf forest, Common maple and Linden (Tilia begoniifolia) exist on the steep slopes.

Sub-alpine forests are very different. At the sub-alpine belt Birch (Betula litwinowii), Goat/Pussy willow (Salix caprea), Rowan/Mountain ash (Sorbus aucuparia) exist. Their residence is used for pasturing. The same belt is presented amply by sub-alpine tall herbaceous, such as Sosnowsky's Hogweed (Heracleum sosnowskyi), Rough comfrey (Symphytum asperum), Oriental monkshood/Queen of poisons (Aconitum orientale), Giant Bellflower

(Campanula latifolia), Tatarian Cephalaria (Cephalaria gigantea), Rough Chervil (Chaerophyllum aureum), Cutleaf teasel (Dipsacus laciniatus), Small Teasel (Dipsacus pilosus), Hogweed (Heracleum asperum), Telekia (Telekia speciosa), Elecampane/Horse-heal (Inula helenium), Ligusticum (Ligusticum alatum), Magnoliophyta (Senecio rhombifolius), Docks (Rumex alpinum), Gadelia lactiflora and others.

Sub-alpine meadows are quite diverse. Mezophilic sub-alpine meadows are predominant, with polidominant cereal-Herbaceous (Anthoxanthum odoratum, Calamagrostis arundinacea, Betonica macrantha, Trifolium pratense, T. canescens, T. caucasicum, Astragalus spaerocephalus, A. glycyphyllus, Astrantia maxima, Gentiana septemfida, Daphne glomerata, Lotus caucasicus, Melilotus officinalis, Vicia variabilis, Fragaria vesca, Rubus saxatilis, Pastinaca armena, Sedim caucasicum, Bunias orientalis, Silene walichiana, Asyneum campanuloides, etc.), Monodominant cereal (Festuca varia), Reed grass (Calamagrostis arundinacea), Agrostis planifolia and Monodominant Inula grandiflora, Geranium sylvaticum, Anemone fasciculate, and Clover (Trifolium caucasicum) meadows.

Ecological state of natural vegetation in Telavi municipality is negatively impacted by the following factors:

- Intensive cultivation of agricultural lands.
- Irregular grazing.
- Unmethodical logging.
- Forest wildfires.

Forests are still felled unsystematically with the intention of obtaining wood as well as materials for different purposes. Most of deforested territories are used for pasturing.

According to the research data on expected climate changes, air temperature is anticipated to increase considerably in Telavi municipality for the period of 2020-2050 this may impact the duration plants vegetation period. In particular, it concerns plants of spring flora. Their vegetation period may be prolonged by one month.

1.2.7 Agricultural Activities

The main agricultural directions developed in Telavi municipality are: viticulture and horticulture, field-crop cultivation and livestock-breeding. The most important direction is viticulture. The total area of vineyards exceed 5,800 ha, as for the grape harvest, it often reaches 17 thousand tons. According to the local farmers, one of the factors interrupting viticulture developments is falsified and aging pesticides, as well as their high prices and inaccessibility. In addition, regarding prolonged and more frequent droughts, deficiency in irrigation water is also problematic.

As for developments of horticulture in municipality, fruits (peach, apple, cherry and others) are produced for subsistance requirements. Because of the meteorological conditions, the volume of fruit production varies from 580 to 3,000 tons annually. The difference between total annual harvests of different years is caused by natural meteorological processes (especially frequent droughts). Besides, aged and low-harvest species with difficulties in gathering are less competitive on the market. In addition, the presence of aged, less effective technologies of fruit production worsen the situation. The cultivation of nuts is very important as the annual harvest reaches 120-300 tons and therefore, the population gives much importance to it (primarily due to its canning purposes). The population pick out wine and fruit seedlings themselves. Recently, propagation of virus-transferring insects has casued a worsening in seedling quality. Also, the purchase of certified virus-free grafted seedlings (both for horticultural and viticulture purposes) is a serious problem. The population expresses the desire to purchase young seedlings grafted on weak rootstock, and appropriate technologies.

Total municipality land area equals to 48,246 ha. Agricultural land area is 35,084 ha, while arable lands occupy 13,146 ha.

From crop cultures corn is cultivated on an area of 1,200-2,000 ha. Total annual productivity varies from 3.0 to 3.8 tons.

Sunflower fields are extended over an area of 1,420 to 1,650 ha. Its productivity reaches 0.7-0.8 tons , which is a quite low index. The population expresses its wish to purchase new sunflower hybrids and production technologies, as well as a special species for producing food oil of autumn rafse. In Telavi municipality the abovementioned species are planted in autumn, when wheat is planted. Usually they ripen before the hail season. The same species cover the soil with their broad leaves in winter and protect it against wind and water erosions. Remains of oil distillation out of rafse have a useful feeding value and are important for farming purposes.

The total area of Barley crops varies from 500 to 800 ha and its harvest reaches 1.5 tons per ha. Barley is used predominantly for cattle breeding and poultry farming.

Potato crops occupy 600-800 ha of total area and its average harvest equals 9 tons per ha. The municipality population produce potatoes for their own purposes.

Bean crops occupy total area of 200-250 ha and its harvest reaches 600-700 kg per ha.

Vegetables are planted over an area of 500 ha and produce approximately 9 tons of harvest. Gourds (cucumber, water-melon, melon) are planted over 100-200 ha area and their total harvest reaches 25-30 tons.

The population in the municipality is interested in purchasing winter and autumn garlic species and modern technologies of cultivation and production.

Lately, as drought frequency escalates, the shortage in irrigation water supply becomes a considerable problem. Consequently, due to high market prices of fertilizers, only a very modest part of population can afford themselves to fertilize their lands. According to information received from the population, due to aged and insufficient agricultural machines land plowing and harvesting (partially) is completed using human force (especially in mountainous villages). This factor creates additional difficulties for the farmers of mountainous villages in the Municipality.

The quality of seed is a serious problem. Mostly local, non-selective seeds used. Farmers from all over the Telavi municipality villages buy plant seeds in Telavi or other cities. Seed exchange of borrowing is practiced as well. Often, due to financial needs, local farmers are not able to purchase seed products in advance. Therefore, they buy seeds right before sowing. This factor creates additional problems for farmers, as seed prices are increased at that time.

In most of the municipality villages plowing depth reaches 18-20 cm. Plowing deeper than that has not practiced during last 2 decades. As a result of mentioned practice, hardening of soil in depth (3-5 cm layer) is detected. It is a “heel” that generates when plowing for a long period of time does not exceed one and the same depth. This interrupts the process of water penetration of root systems, its equal distribution through lower layers of the soil and creation of a supply there. In this fashon the water supply regime of plants can collapse. Moreover, the aforementioned “heel” promotes the enhancement of water, wind and irrigation erosions and drought impacts, leaving arable lands out of circulation.

In order to avoid these impacts, the derangement of the soil “heel” is recommended via deep-plowing and loosening tractors down to 25-35 cm. Besides, in parallel to soil cultivation preparations, a technique and technology of planting without plowing should be introduced that lessens the harvest cost prices and protects the soil from water and wind erosions.

Primarily, organic fertilizers and an excessive amount of nitrogen-based fertilizers are applied for fertilization. It is noticed that local farmers do not express much interest in purchasing more complex fertilizer (NPK), as they think fertilization with manure is sufficiently enough. Likewise, this approach results in one-sided feeding that effects soil depletion and harvest decrease. Moreover, soil mulching, sidering and composting are neglected, which negatively impacts on productivity.

Deficiency of agricultural machinery and fuel expenses are the two most important problems In the chain of agricultural cultivation processes. Besides, it is worth mentioning that the application of agricultural machinery (tractors, combines, etc.) in those villages of the municipality that are located on a steep relief is problematic as well. Therefore, usage of hand motoblocks and mini tractors are more reasonable in these conditions.

Livestock-breeding. The number of domestic animals exceed twenty thousand across the municipality, half of which are cows. The number of goats and sheep is limited. As the population is not occupied with sowing one-year and perennial grass, natural hayfields and pastures are typically used for cattle feeding purposes.

On the pastures and hayfields of the municipality, like other municipalities across the country, and because of global warming, a decrease in hygrophilous cereals and leguminous grasses, earlier emergence of grass growing and maturity phases and a shortening and shift of mowing and grazing periods are anticipated. Besides, invasion risks, domination of non-edible weeds, deterioration of hayfields, re-activation of wind and water erosions on the soil surface, caused by overgrazing, are also expected. It is noteworthy that land-shifting grazing and water placements for cattle are ignored. Financial assistance and veterinary services are not available.

2. Vulnerability to Climate Change and Natural Disasters in Upper Alazani Pilot Watershed Area

2.1 Akhmeta municipality

2.1.1 Possible activation of Hazardous natural processes

According to the analysis of the meteorological data of 1956-2005, the comparative analysis of the changes of meteorological conditions and the PRECIS regional, ECHAM4, HaDCM3 models, and the socio-economic development by the A2, B2 scenarios, compared with the baseline period, the following changes should be anticipated on the municipality territory by 2020-2050:

Average annual terrestrial air temperature will increase by 2.4^{0}C. This parameter will increase in winter and autumn the most (approx. +4^{0}C). The average maximum temperature (especially in winter and autumn) is also projected to increase (+3^0-4^{0}C). This parameter increases in summer the least. Average minimum temperature decreases. Winter is expected to warm the most. During all other seasons, minimum air temperature is likely to increase by 1.8^0-2.5^{0}C. Therefore, in the Akhmeta municipality, all parameters of air temperature will have increased significantly compared to the observation period (1956-2005).

Also, the increase of the total average annual and seasonal atmospheric precipitation is expected to increase, by an average of 40-50% (mostly in winter and less in spring). The maximum value of daily rainfall will increase at least twice. The average value of this parameter increases in winter the most (by almost 80%) and in spring the least (12%). Taking into account total atmospheric precipitation and data for maximum and minimum temperature, the analysis of calculated extreme climate indices shows that by 2020-2050, the number of days with more than 10, 20, 50 mm of rainfall is also expected to increase. Cases with annual precipitation of 200 mm will also rise by two figures, which may enhance the possibility of landslide. At the same time, future climate scenarios predict a partial increase in the duration of continuous dry periods.

Based on the aforementioned, as a result of current (1956-2005) climate changes, the risk of landslides, floods and mudflows is expected to remain or even increase in the Akhmeta Municipality by 2020-2050.

In light of climate change, the following territories were particularly distinguished by intense development of debris flows: Gombori and Kakheti ranges crossed by steep, heavily angled valleys of the tributaries of rivers Alazani and Ilto (Osiauri, Didrike, Kistauri ravine, Orvili, Khodasheni ravine). As a result of strong anthropogenic degradation (that began increasing in the middle of XIX century), mudflows formed a strong source in these valleys. During heavy rains, the mudflows bring rocky and muddy debris to the slightly sloped and flat bottom of valleys of rivers Alazani and Ilto, causing extensive damage to the settlements and agricultural lands.

A clear example of the aforementioned is the Riv. Kistauri ravine; its bed is completely filled with alluvial-proluvial materials after leaving the mountainous part of the watershed; periodically, it is elevated by 0.5-1 m from the surface. During heavy rain periods, and these morphodynamic conditions, floods cover adjacent territories and threaten the population of the village Kistauri and their agricultural lands. The situation is particularly alarming around the ravine of the river Khodashni. Its river bed is also filled with coarse debris and a significant part of its surface is elevated above the surrounding area. This kind of morphodynamic situation threatens to wash away, silt and sometimes destroy various buildings and agricultural lands (Badagoni winery complex, homes of the population of the village Zemo Khodasheni, etc.). In the recent period, during torrential rains, the flow of mudflows emerging from the Riv. Khodasheni valley into the Riv. Shavkaba ravine has increased. The latter is located near the Alaverdi monastery complex; consequently, episodic floods damage the walls of the temple and household objects (bee-hives, etc.) in its vicinity.

During flash floods on Riv. Alazani and its tributaries, intense erosion can be observed on a number of riverbanks on the territory of the municipality, which poses a threat to some residential areas and agricultural lands. In particular, within the territory of Akhmeta city, Riv. Alazani keeps extensively washing away about 500-600 m length of the right bank. As a result of the above, the agricultural lands are under risk of flooding. Because of the erosive action of Riv. Ilto, its right bank is extensively washed, which is why the road connecting Akhmeta and the village Chartala is practically out of order. In addition, infrastructural facilities are placed under high risk: the main water supply station of Akhmeta city, and the main water supply line connected with it, high voltage power transmission line towers, etc. Riv. Ilto, below the dam built on it, keeps washing away and damaging about 150 meters of the highway. In the Pankisi gorge, at the junction of Riv. Batsara and Riv. Alazani, around the territory of villages Dzibakhevi and Kutsakhta, Riv. Alazani keeps extensively washing away certain parts of its right bank during floods, amounting to a total length of 1.2 kilometers. As a result of the above, agricultural lands and pastures located on the right bank of the river are at high risk of flooding. The territories of the village Kvemo Alvani are also to be mentioned, as during medium and heavy floods of the Riv. Alazani, its left bank is intensively flooded. Because of this, pastures and lands located on the high floodplains of the river are heavily damaged.

As noted above, according the climate change scenarios, by 2020-2050 (compared to the observation period), on the territory of the Akhmeta municipality a significant increase of annual and seasonal precipitations, as well as the maximum values of daily rainfall and the growth of number of days with more than 10, 20, 50, 90 mm rainfall is forecasted. Therefore, debris flows, floods, landslides, and rock slides on steeply inclined rocky slopes are expected to intensify and their potential risk may increase. According to the climate change scenarios, the increase of the annual sum of atmospheric precipitation by 200 mm will be more frequent and increase twice by 2020-2050. This will enhance the activation of landslide processes, or the emergence of new centers. From the point of view of the intensification of landslides, the most sensitive territories are parts of Gombori and Kahkheti ridges that are located within the boundaries of the municipality and are covered with loose or weakly cemented sediments of the Quaternary age. Anthropogenic pressure on ecosystems is likely to increase in the future, and first of all - on the forest cover. Deforestation during the significant increase of atmospheric precipitation further enhances the intensity of natural hazards and their risks. Most of all, mudflows, floods and the landslide hazard risk appears to be enhanced in areas that were most negatively affected by these natural phenomena during the observation period (1956-2006).

The increasing development tendencies of natural processes, under the growth of the influence of anthropological factors, will definitely contribute to the enhancement of degradation of the forests and developed soil under them located on territories adjacent to river beds; different agricultural lands will also be damaged, and in some cases, destroyed completely; engineering and public utility facilities, roads and other communications will be destroyed or will break down. All this will hurt the local economy, especially in agriculture.

According to the future climate change scenarios, a significant increase in total annual and seasonal atmospheric precipitation deserves primary attention. The annual, as well as the seasonal total sums of liquid runoffs of Riv. Alazani and its tributaries are expected to increase within the Akhmeta municipality boundaries. In addition, it is noteworthy that because of the increase in the total volume of surface water arising from atmospheric precipitation, the total recurrence of droughts of all types ("severe" and "extreme") and duration will be reduced.

2.1.2 Problems related to possible changes of climate in 2020-2050

As it was already mentioned above, according to the forecasted climate scenarios, in 2020-2050, a further strengthening of already existing very high risks of debris landslide processes and intensified flooding are expected within the Akhmeta municipality borders. Together with significant climate change (mostly the increase in atmospheric precipitation), intensified hazardous natural phenomena will be also be aggravated by a rather high energy potential of the relief (deeply and intensely segregated steep and angled slopes, weakly cemented slope sediments, depleted to various degrees, constructing the rocky surface of the terrain,) and the growth of the intensity of agricultural activities of the population. Along with the climatic factors, the trends for the activation and enhancement of hazardous exogenous processes in 2020-2050 will be highly dependent on the geological and geomorphologic factors and the scope of human impact.

In general, the vulnerability of infrastructural objects and ecosystems of the municipality towards climate change will depend on the changes of average values of parameters of meteorological elements, and particularly on the strength of extreme meteorological events and the frequency of their recurrence. Furthermore, it should also be noted that the dynamics of occurrence of extreme meteorological phenomena are hardly predictable; as it was stated earlier, the scope of the development of hazardous natural processes is highly dependent on their occurrence.

The possible main problems that might emerge due to the changes of meteorological elements, according to the climate scenarios on the territory of Akhmeta municipality, are discussed below.

2.1.2.1 River Run-off

Within the Akhmeta Municipality borders, according to the PRECIS, ECHAM 4, and HaDCM3 regional and global climate and socio-economic development models and the respective scenarios A2 and B2, in the years 2020 through 2050, a significant increase of annual and seasonal sums of atmospheric precipitation are expected to increase (compared to the baseline period) by an average of 40-50%; the total amount of daily rainfall is also expected to increase twice. The annual and seasonal parameters of the air temperature are expected to rise as well. The comparative analysis of the quantitative characteristics of the changes of the meteorological elements mentioned above demonstrates that on the territory of the Akhmeta Municipality, compared with the baseline period, the total annual volume of river runoffs may increase over the next few decades.

2.1.2.2 Landslide Processes

Compared to the baseline period, in 2020-2050 as a result of an almost doubled index of total annual atmospheric precipitation, as well as an increase of cases of total annual precipitation exceeding 200 mm, unexpected activation of creeping, creeping visco-plastic or blockish landslides of different depth, shape and width, is expected on the territory of the Akhmeta Municipality. Besides, the formation of new landslide bodies is also expected. The landslides will be formed in the sedimentary areas less capable to resist erosive-denudation processes on the slopes of Riv. Alazani and Ilto valleys, as a result of intense cutting of forests, extended rains, or periodically occurring earthquakes.

2.1.2.3 Floods

In 2020-2050, in case of a significant increase of total sums of annual and seasonal atmospheric precipitation, as well as intensive snow-melting and heavy rainfall in the watershed basins of Riv. Alazani, Ilto and their tributaries, the possibility of an increase in the strength and frequency of floods may rise. This will create a high risk of flooding of riparian territories and intensive increase of erosion.

2.1.2.4 Mudflows

Compared to the baseline period (1956-2005), there is a growth of risk of debris amplification (first of all, the slopes of the Kakheti and Gombori ranges): accumulation of alluvial-proluvial coarse material and filling of debris valleys with this material, a sharp decline of possible filling capacity of these valleys, possible extension of mudflows over the watercourse territory; strong surface erosion and filling with rough debris material of the latter.

2.1.2.5 Drought

It is known that the two principal problems for agricultural development in the regions of Kakheti and the Akhmeta Municipality (especially in the lowland areas near Alazani River) are drought and lack of irrigation water. The Upper Alazani irrigation system and several types of non-engineering and half-engineering canals are used for irrigation. The Upper Alazani irrigation system is located at the upper part of Riv. Alazani - in Pankisi gorge near the village Duisi. Projected capacity of the irrigation system is $24m^3$/sec. Observation data (over the period of 1946-1986) from the hydrological station near the village Shakriani were used to estimate stream flow and distribution runoff of Riv. Alazani in 2020-2050. Observation periods of 1946-1965 and 1966-1986 were selected for calculations. The calculations were performed during the vegetation period (V-IX months). Point analysis of the Shakriani hydrological information, considering the future expected changes in climate, makes it possible to define the hydrological regime of Riv. Alazani and its tributaries in the coming decades (first of all, in order to consider providing water for irrigation of lands). Content analysis of the results shows that the flow of Riv. Alazani and its tributaries will increase in the coming decades due to of a significant increase in rainfall during all seasons, compared with the baseline period. As a result, there will be a rise in runoff volume of Riv. Alazani and its tributaries. In such conditions, the water resources supplied by Riv. Alazani and its tributaries will be sufficient to meet the needs for the irrigation of lands in the Akhmeta Municipality during 2020-2050.

2.1.2.6 Forest

According to climate forecasts, annual and seasonal air temperatures within the Akhmeta Municipality will significantly increase, which may lead to the xerophilization of forest vegetation, reduction of forest distribution area, pauperization of dendroflora, strengthening of the distribution of drought-resistant species in the forest, etc. Although, by the same climate forecasts, total annual and seasonal atmospheric precipitation is expected to double in the coming decades. Therefore, the forecasted weather conditions will serve as a favorable background for the development of forest ecosystems in the municipality.

2.1.2.7 Sub-alpine and Alpine Meadows

Subalpine and alpine zone vegetation is quite sensitive to temperature and dryness. The main reason for this is that quite a large part of their development through the year is dependent on the snow cover. It is known that the subalpine and alpine ecosystems (alpine shrub, various-grassy meadows, subalpine bush, etc.) and associated pastures distinguish themselves with a low yield herbage due tolocal climatic conditions (long winters, the snow cover). Herbage growth mainly depends on the external layer of sediments and on air temperature. In eastern Caucasus, where Akhmeta municipality is located, drought starts in the second half of July, which leads to a decrease of moisture transpiration and photosynthesis intensity in sub alpine and alpine zone vegetation. This leads to a weakening of the vegetation, which reduces their yield. According to climate forecasts for the Municipality's territory in 2020-2050, the annual and seasonal sum of rainfalls is expected to rise, (compared with the baseline period). Despite the temperature increasing in upcoming decades, the significant increase of atmospheric precipitations should support the creation of favorable conditions for the development of the subalpine and alpine plants and, therefore, increase the productivity of mountain pastures, if all grazing norms will be considered.

2.1.2.8 Impact of Future Climate Conditions on the Health of the Population

It is proven that global climate change affects human health significantly.

Over recent decades, various countries, authoritative international organizations and regional programs have conducted many studies on the effects of climate change on humans' health and well-being.

Climate change does not exert any new type of influence on human health; however, it may significantly increase the burden of diseases that are sensitive to climate changes. Therefore, implementing effective and timely interventions on global, national as well as regional levels is extremely important.

For valid assessment of the results associated with climate change and fluctuations, it is necessary to form an understanding of the extent of sensitivity of the population to new conditions, and its potential of reacting adequately to them. Interconnection between sensitivity, adaptation potential, and possible results is determined through use of fairly standardized schemas. Sensitivity of human health to climate changes is determined by:

- perceptibility, which includes the degree of sensibility of health, natural and social systems (on which results for the impact on population health depend) to climate and weather changes, and, also, characteristics of the population, such as the level of development and demographic structure;
- subjection to the impact of weather and hazardous climate conditions (including character of climate variations, degree, and frequency);
- Measures and interventions implemented for adaptation, which are intended for lessening particular burdens of unfavorable impacts on human health (initial level of adaptation) and the efficiency of which partly determines the relationship "exposition-reaction".

Those groups and subgroups, of the population and systems that are unable or unwilling to adapt, are considered to be particularly sensitive, as well as to possess a high perceptibility of weather and climate changes. On the whole, the sensitivity of population to any kinds of health hazards depends on the local environment, the level of material resources, effective management (both at higher and local levels), the quality of the infrastructure of public health, and the accessibility of information.

For the purposes of the present report, indicators of incidence and prevalence both for contagious as well as non-contagious diseases were studied, as well as the frequency of referral to medical services of the population of Akhmeta municipality.

Population health in the municipality was studied according to the following groups of diseases:

- Cancers;
- Blood and marrow diseases;
- Diseases caused by endocrine system, nutrition and metabolic dysfunctions;
- Neurological diseases;
- Diseases of cardiovascular system;
- Diseases of respiratory system;
- Diseases of digestive system;
- Diseases of genital-urinary system;
- Diseases of bone, muscle, joint and connective tissues;
- Accidents and traumas;
- Congenital anomalies and developmental disabilities.

To study the disease incidence structure and disease prevalence tendencies of the Akhmeta municipality population, official statistical data on disease prevalence in Akhmeta municipality, Kakheti Region and in whole Georgia in 200-2012 were analyzed. For analysis, indicators of incidence and prevalence were used. In Akhmeta municipality, indicators of prevalence and incidence are significantly higher, which is mainly accounted for by the small size of the population, which changes indicators of incidence and prevalence considerably.

General morbidity and increase in the incidence of illness. Data analysis from 2000-2010 showed that the requests per capita for the Municipality’s ambulatory- policlinic emergency services were 1.4 time less than country average. Respectively, there were significantly lower rates of general morbidity among the population. However, this is mainly linked to an uneasy access to medical services and may therefore not reflect the real picture. Indeed, till 2009, Akhmeta municipality’s population mainly used the medical services from Telavi district. Consequently, illness incidents are registered in Telavi municipality instead of Akmetha municipality. Thus, in light of the expected climate changes, general illness rates of the population will not increase significantly in Akhmeta municipality, but will burden the Telavi municipality, as the regional center for medical services.

Contagious diseases. The 10 - year-long dynamic analysis of contagious diseases at Akhmeta Municipality failed due to a lack of statistical information. There are only indicators for 2009-2010, which show growing trends of contagious diseases in the population of Akhmeta Municipality. However, in light of the expected climate changes, when temperature and humidity level rise, combined with poor sanitary conditions, it is expected that this group of pathologies rise. As a reuslt of the violations to water supply and sewerage systems, floodings emerge and create niches for mosquitoes that transport diseases. This may lead to epidemic explosions. Furthermore, the rise of temperatures pathogenic micro-organisms to develop faster, which increases the chances of disease transmission to humans. Whilst temperature is ensures the viability of disease-causing bacterias; extreme atmospheric precipitation may also cause a number of pathogenic bacteria to get to the water supply system. In light of all the above, the significant increase in diseases is mainly due to the growth in acute intestinal infections and respiratory infections. Therefore, Akhmeta municipality will need additional interventions to extend and expand access to health care services.

An analysis of **endocrine system** diseases between 2000 and 2010 indicates that in Akhmeta municipality the cases of endocrine system diseases are in some cases higher than national overall figures, though, still significantly lower than the regional figures. In addition, no increase nor decrease of the trend cant be observed. Diabetes and iodine deficiency (found in mountainous regions of Georgia) is an important issue in the municipality. Accordingly, in light of climate changes, an increase in this group of pathology is detailed.

Cardiovascular disease morbidity indicators in 2000-2010 due to the ten-year trend data showed that an increase of blood circulation system diseases is spreading in Georgia. An increase in ischemic heart diseases and inhypertension is visible in Akhmeta Municipality as well as in the whole of the Kakheti region. Although, the municipality's indicators are significantly lower than the region indicators, 2009-2010 reflects a sharp increase in morbidity, a trend which is expected to continue with the expected climate changes.As it is well known, global warming and related climate changes contribute to the exacerbation and complications of chronic diseases. Therefore, with the increase of cardiovascular pathologies, morbidity and mortality in the population, as well as related complications (myocardial infarction, stroke) will also increase.

Respiratory disease prevalence data showed that between 2000 and 2010, the increase in respiratory diseases in Georgia as well as in the region was observed. In municipality's population, pathologies morbidity figures for 2009-2010 are equalising with regional and national levels that indicates an increasing trend. The influence of factors related to climate change is more pronounced, because weather has a major influence on the development of allergens, their distribution and seasonality. In addition, the concentrations of pollutants (nitric oxide, ozone, CO gas, etc.) has increased in the atmosphere andimpacts on human health at different scales. At the local scale, solid admixtures which are produced by cars and other vehicles impact human health. At the regional scale, nitrogen and sulfur transition cause acid rains. At the global scale, a wide range of factors that are related to the interaction between climate changes and environmental factors, are harmful to human health. These factors will cause respiratory tract irritation, allergic reactions (e.g. rhinitis) as well as an aggravation of asthma and an increase inrespiratory illnesses is expected.

A 10-year data tren on **digestive system diseases** showed increasing rates of these diseases in Akhmeta municipality, which is consistent with the observed rise in the country and regional levels. This is mainly related to poor nutrition and food quality. Possible changes in climate may lead to a reduction in food resources (e.g. harvest, cattle livestock reduction) or impair access to food and micronutrients shortages. This has a direct impact on digestive system diseases. This group of pathologies is expected to increase within the municipality territory, which is likely to correlate with national and regional data.

Between 2000 and 2010, a ten-year trend analysis of data related to injuries, accidents and poisoning indicates that fixed rates in Akhmeta municipality are significantly lower than those of regional and national level. However, since 2009 an upward trend in these cases can be observed. As a result of floods caused by the climate changes, as well as of environmental factors changes, this will be more noticeable. However, it should be noted that the majority of accidents and injuries will be shared by Telavi and Tbilisi's regional referral centers.

2.1.3 Assessment of Vulnerability and Disaster Risks by Communities

This section presents the analysis of the data collected during the field research program (Integrated Natural Resources Management in Watersheds of Georgia – INRMW), which aimed at identifying the vulnerability of Akhmeta municipality communities to climate change and natural disasters. The risk level faced by communities was assessed in terms of natural disasters. This information was used to prepare risk and vulnerability maps. Below we present a detailed description of the communities within Akhmeta municipality, mainly based on the analysis of CENN's field research data within the program. The analysis also takes into account data from the National Environment Agency (materials of the years 2006, 2007, 2008, 2009, 2010 are used[2]).

2.1.3.1 Jokolo Community

Jokolo Community is located in the extreme northern part of Akhmeta municipality (only Tusheti is further north). At the north, the community is bordered with the Main Caucasus Watershed Range, while at the south it is bordered with the territory of Duisi Community.

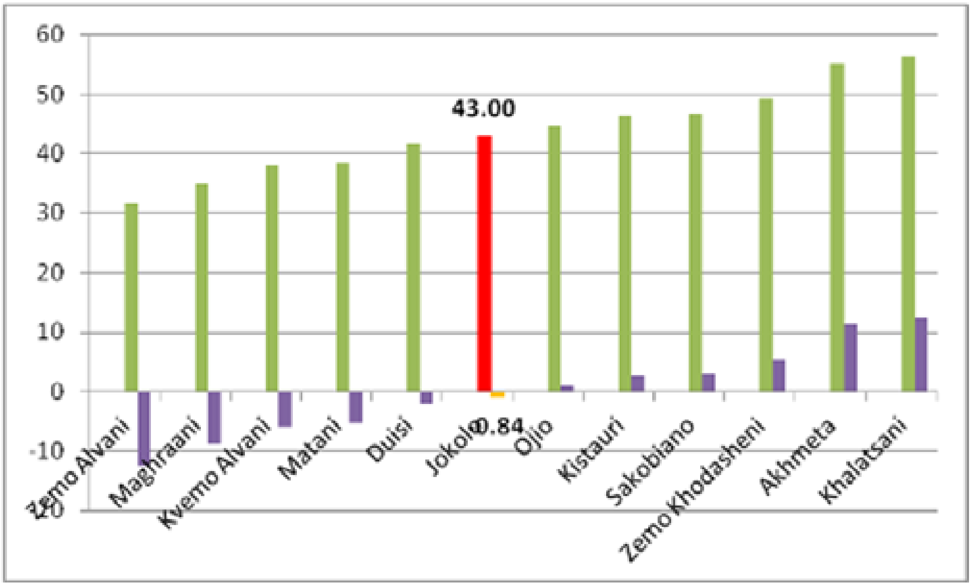
The communal territory is crossed by the Alazani River from north to south, which flows along the meridian lines. Practically, the entire community is located along the Alazani River and both villages of the community – Birkiani and Jokolo are located in the Alazani Valley. Birkiani village occupies the upper northern part of the Alazani River basin, whilst Jokolo village the southern part. In this respect, Birkiani village is the most populated point of the Alazani River basin on the territory of Akhmeta Municipality. Each village is located at an average distance of 22 km from the municipal center.

In addition to Alazani River, the communal territory is crossed by the gorges of right and left tributaries of Alazani River, the basins of which cover the entire territory of the community. Amongst these rivers, the Dzibaskhevistskali distinguishes itself as a main cause of dangerous natural processes for the community.

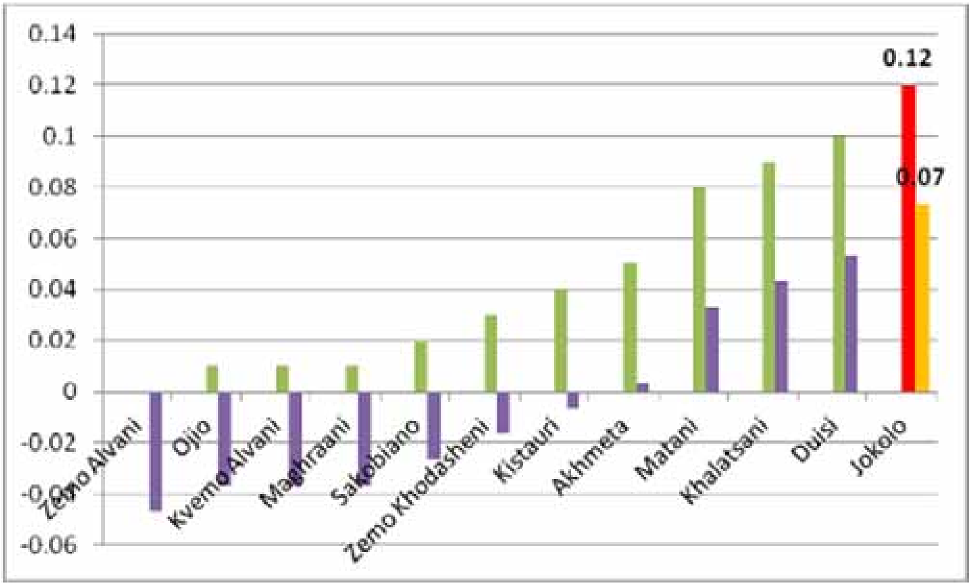
During the field research, mudflows were detected as the community's main issue, alongside the erosive actions of the river, which causes an intensive washing of slopes.

In course of the research, Jokolo community's vulnerability to natural disasters and climate change was assessed at 43 points. With this index, the community is slightly above the average of the municipality index which is 43.84 points. The deviation from the average is -0.84 (see diagram). Accordingly, in terms of general vulnerability on the scale of the target scope of the program (target basins), the vulnerability of this community is assessed as of average level (see the map – Assessment of the Vulnerability of Akhmeta Municipality).

[2] Ministry of Environmental Protection of Georgia. National Environmental Agency. Department for Geological Hazards and Geological Environment Management. Bureau of Natural Disasters, Engineering Geology and Geo-ecology. Information Bulletin – Results and Prognoses of the Development of Hazardous Geological Processes in Georgia.



During the field research the level of risk for Jokolo community was detected as representing the municipality's maximum. Indeed, it equals 0.12 while the average municipal index for Akhmeta approximates 0.05. The deviation from the municipal average is 0.07 (see Diagram). In terms of risk level, Jokolo community is assessed as having the highest risk in Akhmeta municipality. Regarding the general level of vulnerability, on the scale of the target scope (target basins) of the program, it is assessed as a higher than the average vulnerability (see the map – Assessment of the Risk of Akhmeta Municipality).



Likewise, the high indicator of risk despite the fact that the community's vulnerability index is rather low (lower than average municipal) is due to the scale and power of the hazardous natural occurrences present on the community territory. Consequently, Jokolo community is exposed as one of the highest risk communities. Therefore, it may be estimated to be one of the "hot spots" in terms of risks related to natrual disasters and climate changes in Akhmeta municipality. Besides, it should be noted that in the community there are human accidents reported as a result of natural disasters that are quite rare incident both within Akhmeta municipality and within the general research area. This fact emphasizes and reaffirms the high risk index of Jokolo community.

A detailed presentation of the hazardous natural occurrences for both villages seperatly is not necessary because, as mentioned earlier,both villages face the same problems, which are conditioned by the occurrences on the Alazani and the Dzibatkhevi Rivers. Consequently, this reports gives an overall revision of the problem for both village. Moreover, the problem is thoroughly discussed in the annual reports of the National Environmental Agency, thus the situation can further be assessed on the basis of these reports (which represent a qualified expert assessment).

The Dzibatkhevi River gorge of the right short tributary of the Alazani River is located in the north-west part of Birkiani village territory, surrounded by the ranges of Kekhuri Gori and Soparo Gori, which are bordered by Batsari Reservation on the North side.

Geologically, the gorge is built of terigenic-carbonate flysch, upper Jurassic sediments which have been considerably dislocated and clefted. In terms of tectonic divisions, the Dzibatkhevistskali River Gorge belongs to the Mestia - Tianeti zone of the Greater Caucasus fold system.

The morphological characteristics of the gorge are a result of its geological constitution and location within a tectonic zone prone to strong disorders, its hydrological regime and geotechnical and hydrogeological conditions.

Morphologically, the Dzibatkhevi River gorge is a symmetric watershed drainage basin, which is characterized by stiffly inclined slopes and V-shapes deep water-channels, with periodically activated ravines and expansion of the dingles. The Dzibatkhevistsqali and its tributaries originate from the the Kekhurisgori range , where it flows down an eastern slope presenting 30^0 inclinastionat at an altitude of 1,340 meters, before flowing into the Alazani River from the right side, near Birkiani village. Here, the length of the river reaches 3 km. The altitude difference between the junction and origin is 615 meters. The average inclination is 20.5%. The area of basin drainage is 4,718 km^2 and the total length of the river network equals to 15,981 km.

The morphological nature of the drainage basin (high energy potential of steep angled slopes combined with the very erosive nature of the gorge), geological structure and climate conditions contributed to the development and further re-activations of geohazard foci in the past. These resulted in the formation of a Talus cone through the accumulation of solid sediments in the lower course of the gorge. The territory of the Talus cone is now populated. The intensity of hazardous processes was significantly decreased, whereas the gorge slopes were covered by century old dense deciduous forests and the perennial tree-plants grew on the river bed and its tributaries, which shows that there have not been large-scale and high-density mudflows for a long time in the gorge. Accordingly, the accumulation of only a small volume of muddy output in the middle course of the gorge has occurred.

During the last decade, the intense forest felling and denudation of steep inclined slopes at the origins of the drainage basins created favorable conditions for the formation of new foci (origination and development) for dangerous geological processes as well as for their transformation into a high-hazardous spontaneous natural process.

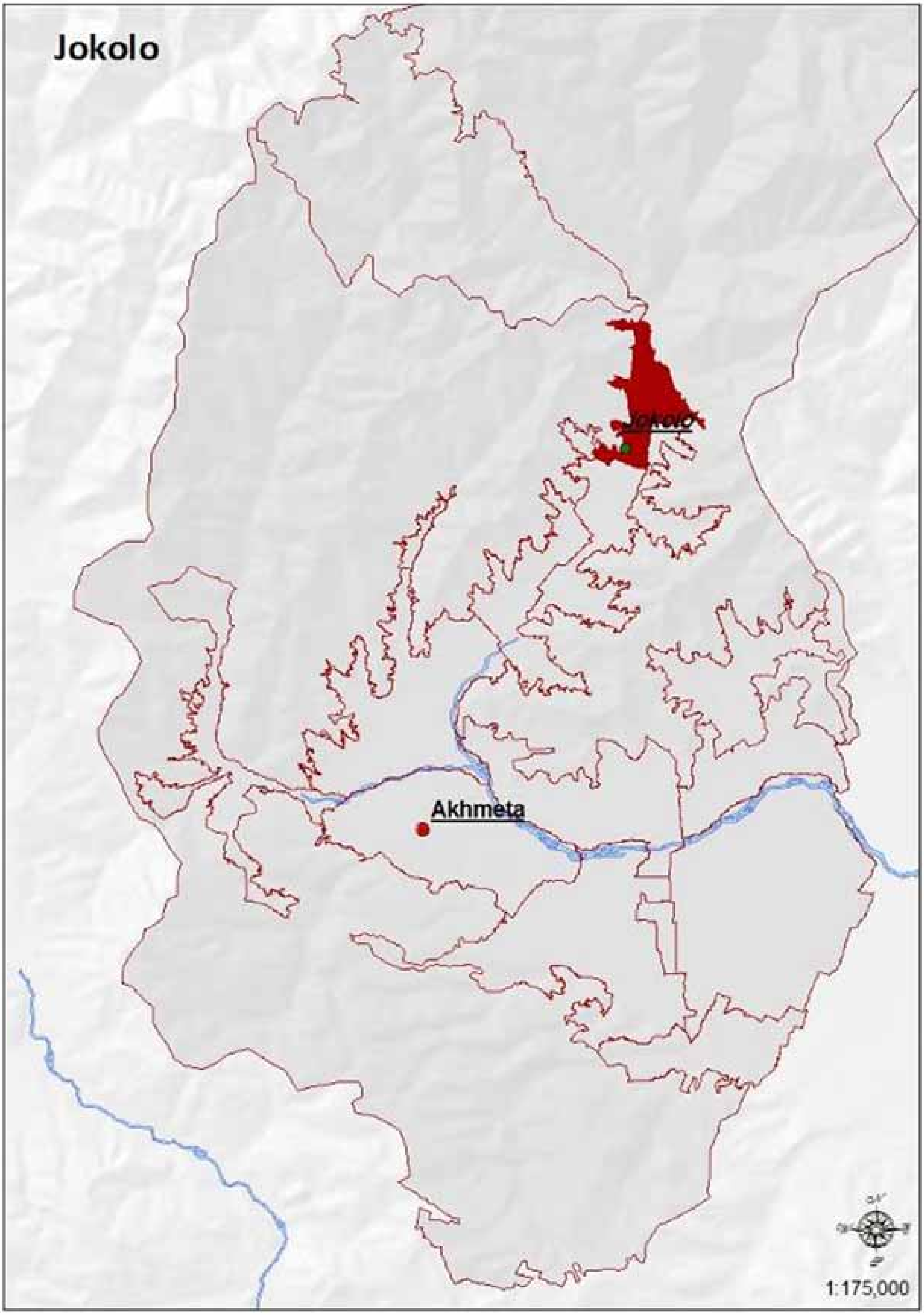
The trend of increasing risks is demonstrates in the tragic accident that took place in 2007, when after 1.5 hour-long rheavy rain, the water-mud flows collected on the surface ground washed the denuded steep inclined slopes andthree local people were killed.

Birkiani and Jokolo villages are also significantly exposed to the problems generated by the intense erosive actions of Alazani River. The Alazani River erodes its right bank at the level of Dzibakhevi village territory. The bottom of the existing gabions are washed through, partially damaged and detached.

Birkiani villager is located on the first upper floodplain terrace on the right of the Alazani River. The 350 to 400 meters wide terrace surface is straightened. In the east of the village, on the right side of the river, stream-directing gabions are now heavily damaged.

Eventually the Alazani River actions (floods, mudflow occurrences, extensive washing of the banks) threaten the entire population of Jokolo and Birkiani villages, their houses, crofts and agricultural lands (as the local inhabitants claim 320 ha of the territory is under risk) as well as the infrastructure responsible for village roads, drinking water and electrical wiring.

Finally, we should note that according to the local population the problem is intensified by the extensive timber felling, which, as described above, fully correlate with the findings and conclusions prepared by the agency experts.

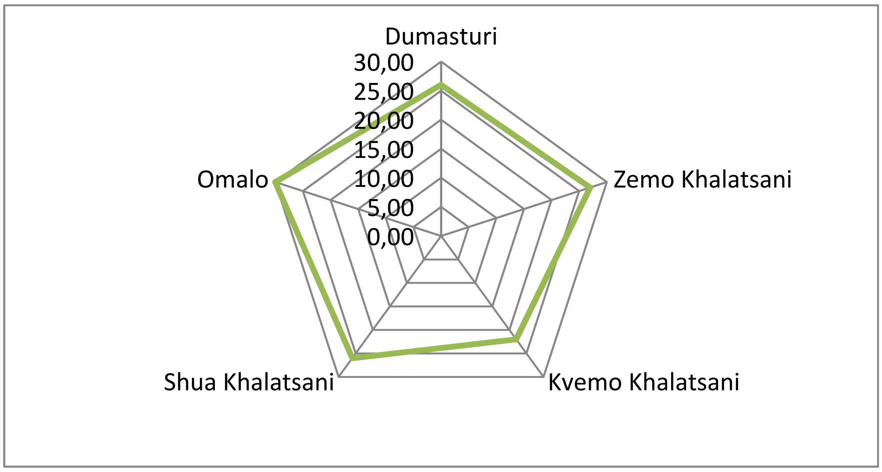

Jokolo
Jokolo
Akhmeta
1:175,000

2.1.3.2 Khalatsani Community

Khalatsani community is located in the northern part of Akhmeta municipality at the south-east of Jokolo community. The communal territory is stretched on the left side of the Alazani River. Besides, it includes the Khalatsani River gorge (left tributary of the Alazani River).

Khalatsani community is comprised of five villages – Dumasturi, Zemo, Qvemo and Shua Khalatsani and Omalo. Moreover, Dumasturi and Omalo villages are situated at the left side of the Alazani River, while the villages of Zemo, Qvemo and Shua Khalatsani occupy the basin of the Khalatsniskhevi River. Lower Khalatsani village overlaps with the confluence of the Alazani and Khalatsniskhevi Rivers.

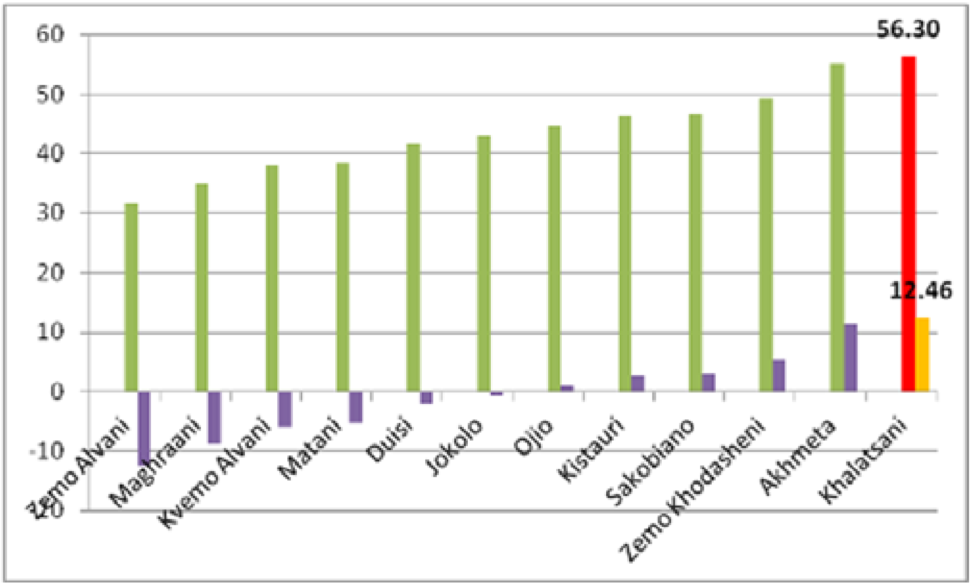
The average distance of the community villages from the municipal center is 26 km.



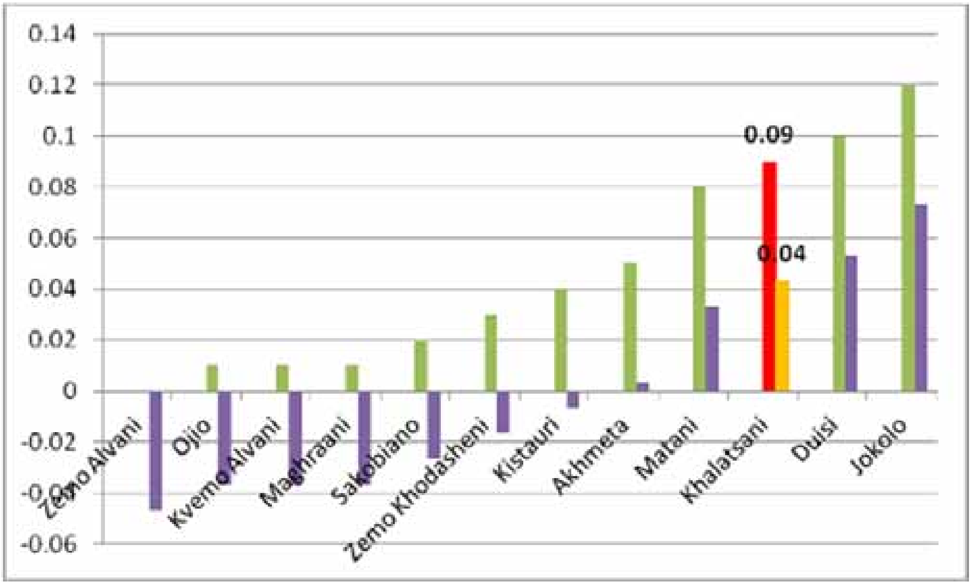
The field research detected diverse natural hazards on the territory of the community that are related to the erosive activities of the Alazani and Khaltsniskhevi Rivers. The following hazards were observed in the community:

- Landslides
- Floods
- Washing of banks

During the research, the vulnerability of Khalatsani community to natural disasters and climate change was determined as the highest in the municipality and equals to 56.30 points. The deviation from the average is 12.46 (see a diagram). This high level of vulnerability is determined amongst others by the absence of communication and relatively poor environmental conditions (particularly that of the neighbouring forest), a lack of drinking water infrastructure and the expansion of hazardous zones across the populated and agricultural territories. Regarding the general level of vulnerability, on the scale of the target scope of the program (target basins), it is assessed as a very high level of vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



According to the researche accomplished during the program, the level of risk for Khalatsani community is 0.09. The index is rather high compared to the municipal indices. It exceeds the average for the municipality and the deviation from the average is 0.04 (see a diagram). Regarding the general risk level, on scale of the target scope of the program (target basins), Khalatsani community is assessed as a higher than average level of risk (see the map – Assessment of Disaster Risks of Akhmeta Municipality). Such a high level of risk is determined both by the high vulnerability of the community as well as the scale of natural hazards registered on the territory of the municipality.



Likewise this high index of risk is determined by the scale and power of hazardous natural occurrences represented at the municipal territory. According to the risk index, Khalatsani community is exposed as one of the highest risk communities. Therefore, it may be estimated to be one of the “hot spots” in terms of risks related to disasters and climate changes in Akhmeta municipality.

A detailed picture of the situation in the villages of the community is as follows:

Omalo Village

Omalo village is located to the very north of Khalatsani community and occupies the left side of the Alazani River. The major problems of the village are ***floods*** and ***erosions***.

The left bank of the Alazani River is quite precipice and reaches 10 to 20 meters in height. Above the precipice there are houses and crofts of the Omalo village population. The Alazani washes a left board and in consequence the precipice surface gets narrow ravines and collapses that threaten the crofts. The process approaches the houses. The further activation of the process will threaten the school, the kindergarten and the dispensary.




Floods are more characteristic to the little river of Omaloskhevi passing through the village. Usually, in spring when snow melts intensively, or precipitation is increased, the ravine rises and damages residential houses and crofts of the local population. 15 residential houses and their crofts, in total, approximately 3 ha get damages.


Dumasturi Village

Dumasturi village on Alazani Valley occupies its left bank. When the Alazani River rises it damages residential houses of the population (5 families) and crofts (2 ha). The local school and sport playground are under danger as well.


Zemo Khalatsani Village

Zemo Khalatsani village occupies the upper course of the Khalatsniskhevi River basin (left trubutary of the Alazani River). The main problems of the village are related to ***floods***. Usually, in spring when snow melts intensively and precipitation increases, the Khalatsniskhevi River rises and damages residential houses, crofts and agricultural lands of the local population. 15 residential houses and their crofts, in total, approximately 3 ha get damages. Also, internal roads of the village and footbridge on the Khalatsniskhevi River connecting two neighborehood get damaged.


Shua Khalatsani Village

This village also is impacted negatively by floods. When the Khalatsniskhevi River rises it damages residential houses (5 families) and crofts of the local population. A shop, internal village roads and a footbridge on the river, as well as village cemetery are vulnerable to damage either. In 2011 the ***flood*** destroyed the footbridge on the Khalatsani River, which connects the two neighborhoods. In same year the flood harmed crofts of two local families (1 ha).

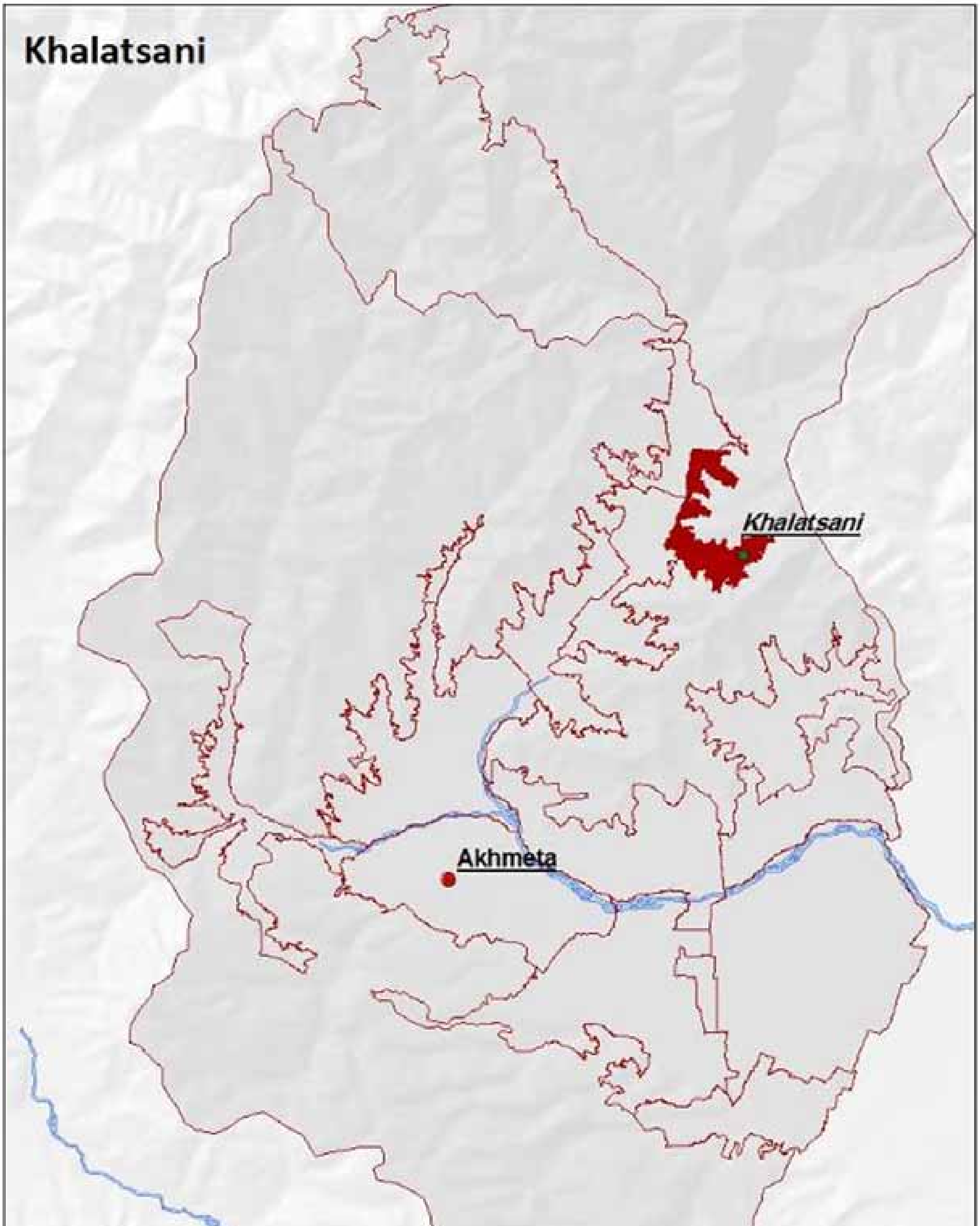



Kvemo Khalatsani Village

Kvemo Khalatsani Village is located at the lower course of the Khalatsniskhevi Rivee basin and occupies the territory at its confluence to the Alazani River. The village is impacted negatively by ***floods***, as well as by ***mudflow*** processes.

Usually, in spring, in the conditions of snow melts or heavy rainfalls the Alazani River rises and damages residential houses (10 families), crofts and agricultural lands (5 ha).

The Alazani River washes extensively its left bank bordering the road, which connects khalatsani community villages to each other that result in developing ***landslides*** in several different places. Some places are exposed to rockslides. Landslides also harm the central road, connecting the communal villages to other ones. As the local population reports, 3.5 km of the road is damaged in total.


Khalatsani
Khalatsani
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2.1.3.3 Duisi Community

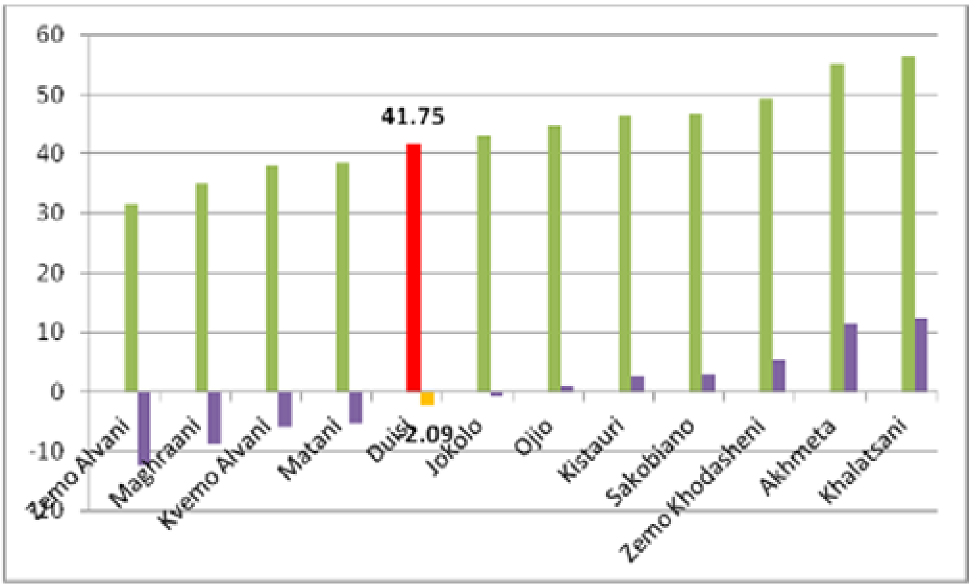
Duisi Community is located along both sides of the Alazani River, in the north part of the Akhmeta Municipality.

The community is comprised of two villages – Duisi and Tsinubani. Accordingly, Duisi village is located at the right side and Tsinubani village – at the left side of the Alazani River.

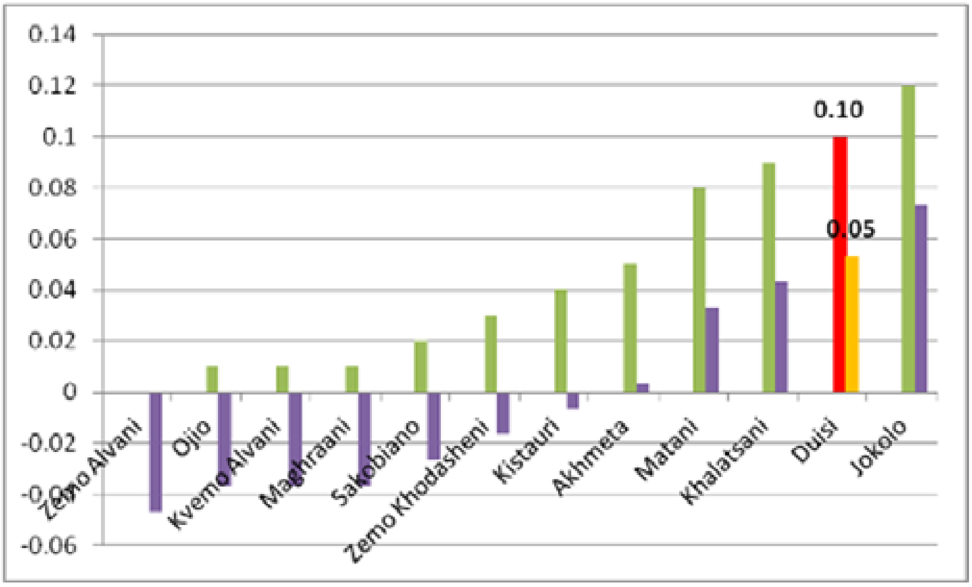
Average distance of the community villages from the municipal center is 20 km.

In the course of field research the population named landslides and river erosions as major natural hazards.

In terms of the program the vulnerability of Duisi community to natural disasters and climate change was assessed as 41.75 points. This index is lower compared to the average municipal index and the deviation from the average is -2.09 (see a diagram). Accordingly, vulnerability of Duisi community, compared to other communities of Akhmeta municipality is lower. As regards the general level of vulnerability, on the scale of the target scope of the program (target basins), it is assessed as of average vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The level of risk for Duisi community is rather high and equals to 0.09 so that it is the second one in the municipality (the first one is Jokolo). The deviation from the average is 0.05 (see a diagram). Accordingly, Duisi community is one of the high risk communities in the entire municipality. As regards the general risk level, on scale of the target scope of the program (target basins), Duisi community is assessed as a higher than average level of risk (see the map – Assessment of Disaster Risks of Akhmeta Municipality).



According to the risk index Duisi community is distinguished with one of the high index in the municipality. Therefore, it may be estimated as one of the "hot spots" in respect of risks of disasters and climate changes in Akhmeta municipality.

If discussed more comprehensively the situation in the villages of the community is as follows:

Duisi Village

The Alazani River embarked protective concrete dams and keeps washing away the right bank. Accordingly, during the ***floods*** large part of the village gets waterlogged. Usually, electrical wires are also damaged. If the process keeps the same pace residential neighborhoods of the village are under threat.

The so-called Mglisubani ravine joins Dedisperuli and Tchobioskhevi ravines. In case of abundant precipitation the abovementioned ravines rise from their channels and damage the foremost part of the village, including residential houses, crofts, agricultural lands (100 ha - present) and rural infrastructure. The cemetery also gets damages. The last and largest of such cases were reported in 2011.

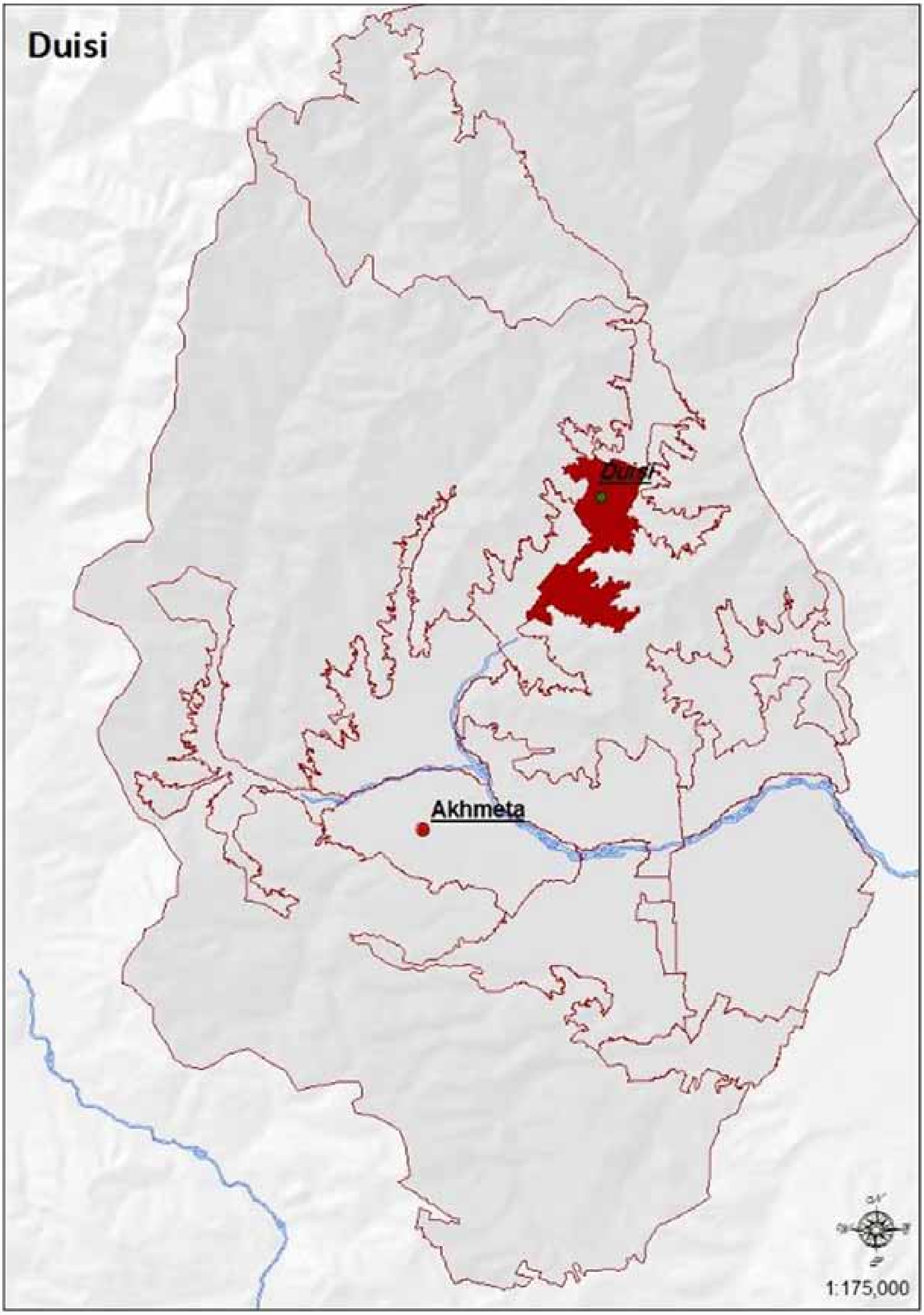
Tsinubani Village

The ***floods*** developed by the Alazani River, as well as the huge masses of water coming down from the adjacent mountains during the abundant precipitation create solid problems for the village and cause the swamping of almost entire village that includes residential houses, crofts and agricultural lands (30 ha) of approximately 60 families. It also damages village neighborhood roads, school and electric wiring. The problem is sharpened by the unsettlement of the drainage channels. However, it should be noted that the main cause of the problem is a hard conditions of the village adjacent forests, which have been felled intensively during last years.

Except of the abovementioned negative impacts, stream passing is related to surface, areal erosions that harms the significant territory of the village and promotes a ravine development process.




In the west part of the village, near the Alazani River itself, residential houses, crofts and agricultural lands (3 ha) of 3 families get damages due to floods developed on the Alazani River. Besides, the Alazani River washes its banks intensively that threatens the population in this neighborhood.



Duisi
Duisi
Akhmeta
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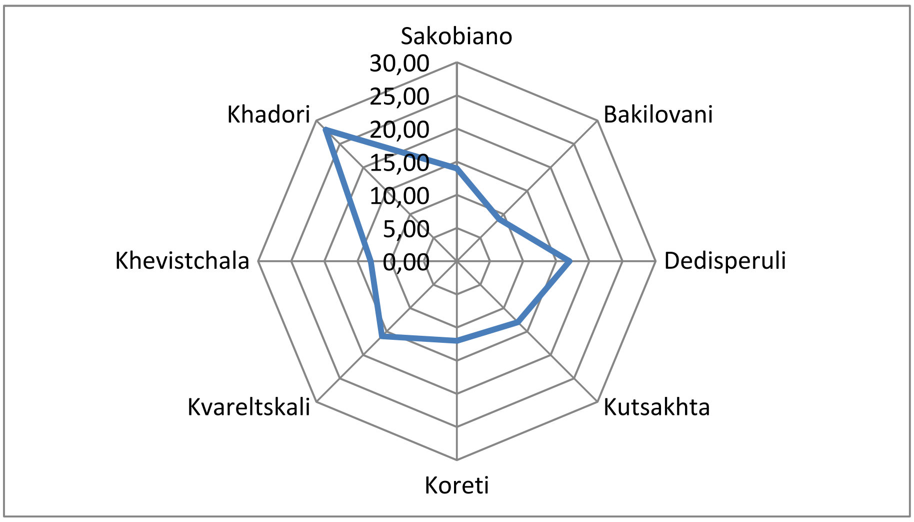
2.1.3.4 Sakobiano Community

Sakobiano community is located at the north part of Akhmeta municipality, along the Alazani River. The most part of the community occupies a left bank of the Alazani. Only small territory (Qoreti Village and its adjacent areas) is stretched on the left side of the River.

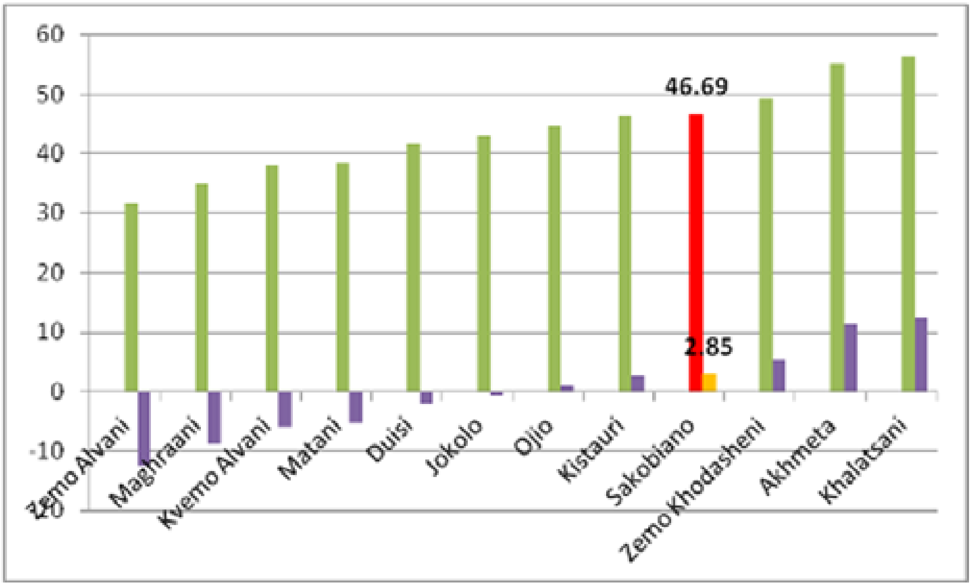
The community is comprised of eight villages – Sakobiano, Bakilovani, Dedisperuli, Kutsakhta, Koreti, Kvareltskhali, Khevistchala and Khadori.



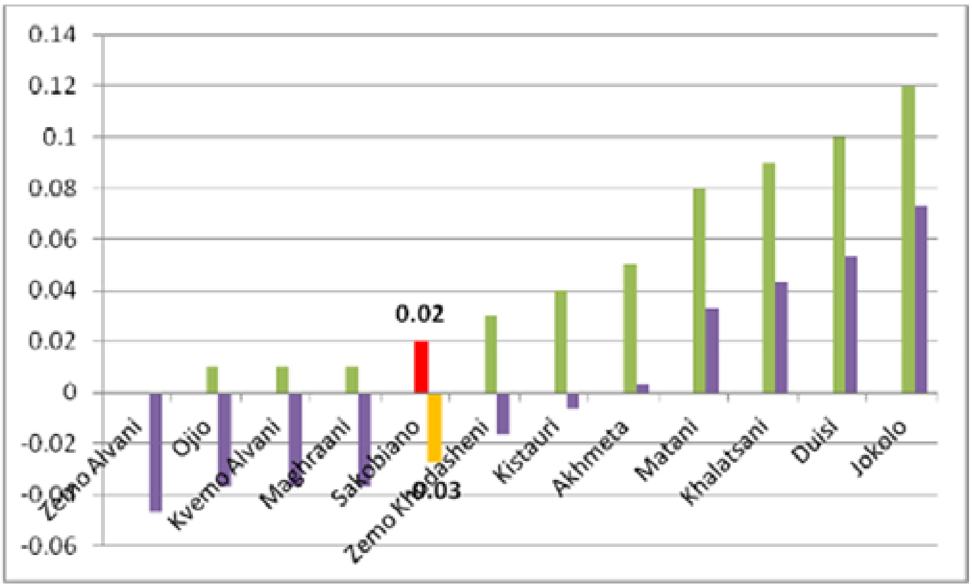
Average distance of the community villages from the municipal center does not exceed 16 km (as the diagram shows the most distant village is Khadori).

In course of the field research, it was detected that floods and stream erosions are the major natural disaster for the community. Also, it is intense erosive actions of the river, which causes intensive washing of the slopes. It is noteworthy that according to the National Environmental Agency landslide is a major problem for the community (Bakilovani village). However, in the course of field researches neither local population, nor local self-government bodies identify this problem. This fact witnesses that the population is not informed adequately about the natural hazards around them that is a significant challenge.

According to the field researches accomplished in terms of the program the vulnerability of Sakobiano community was assessed as 46.69 points, which exceeds the average municipal index. The deviation from the average is 2.85 (see a diagram). As regards the general level of vulnerability, on the scale of the target scope of the program (target basins), it is assessed as higher than average vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The level of risk for Sakobiano community was assessed as 0.12 that is quite a low index compared to other municipal communities. Deviation from municipal average is -0.03 (see Diagram). As regards the risk level, in relation to the target scope of the program (target basins), it is assessed as very low level of risk (see the map – Assessment of Disaster Risks of Akhmeta Municipality).



If discussed more comprehensively the situation in the villages of the community is as follows:

Kvareltskali Village

Kvareltskali Village is located in the extreme northern part of the Sakobiano community, on the right bank of the Alazani River. The main problem of the community is related to ***floods*** that are mostly characteristic to gorges on the right slopes of the villages. Floods on the Sarue and Kvareltskali Rivers are noteworthy. Usually, in spring when snow melts intensively, or precipitation is increased, these ravines rise from their channels and damage residential houses (20 families), their crofts and agricultural lands. The internal 700 m long roads of the village are harmed either.




Sakobiano Village

The village population gets damages mostly due to ***floods*** and bank washings developed in the Alazani River basin. The Alazani River, when rose from the channel, destroyed a significant part of the protective concrete dam. In consequence, the right bank of the river is washed intensively. Also, sheep transfer routes going through the village, as well as the high-voltage electricity transmission towers from Khadori Hydro-electric Station are under danger. Agricultural lands (total approx. 60 ha) of the population are exposed to swamping as well.


Bakilovani Village

On the extreme South-Western periphery of the village territory, near the upper main irrigation canal of the Alazani River, at the south-eastern slope local landslide body of modern origination is developed. Slope constituting lower Cretaceous age sediments (sandstone gravels, clays, argils and marls) are strongly dislocated, fragmented, depleted and emaciated. These sediments are overlapped by the Quaternary age deluvial yellow-gray clay with 15-20% inclusions of gravel. Their approximate thickness varies from 3-5 meters. The shape of landslide is similar to triangle in the plan. Its length equals to 150 m., the width of the head is 20 m., while the bottom along the channel reaches 50 m. At the source extraction surface height varies from 3 to 5 m and the inclination – up to 45-50^0. ***Landslide*** basis is connected to artificially straightened and cut surface. Landslide body has 10 cm wide and 10-20 meters long activation signs at open extraction cracks, and at its bottom ground water exits. In case of expected landslide shifts the irrigation channel and the populated neighborhood at the lower course area will be exposed to danger.

Landslide process origination and development on the slope were resulted by the following factors - the strong tectonic disorder; high quality of strong fragmentation, cracking and depletion of the slope constituting rock, powerful watering of basic and its overlapping atmospheric precipitation and underground waters. In addition, landslide bottom watering with waters infiltrated from the channels.

Activation of the landslide process on the slope poses a threat to the irrigation channel and the populated neighborhood at the lower course area.

It should be noted that in course of the research the landslide body have not been identified by the local population. They probably did not know about the problem and the potential danger. However, as seen above, landslide body is not in direct contact with the population up to now, which is one of the reasons that people are not informed about the ongoing process. Hence the problem was not considered in course of vulnerability and risk assessments with community participatory methods. The problem was observed on the later stage of the research. Consequently, we believe this problem is due to the additional, expert examination. Informing the population will result in significant changes of risk and vulnerability indicators.

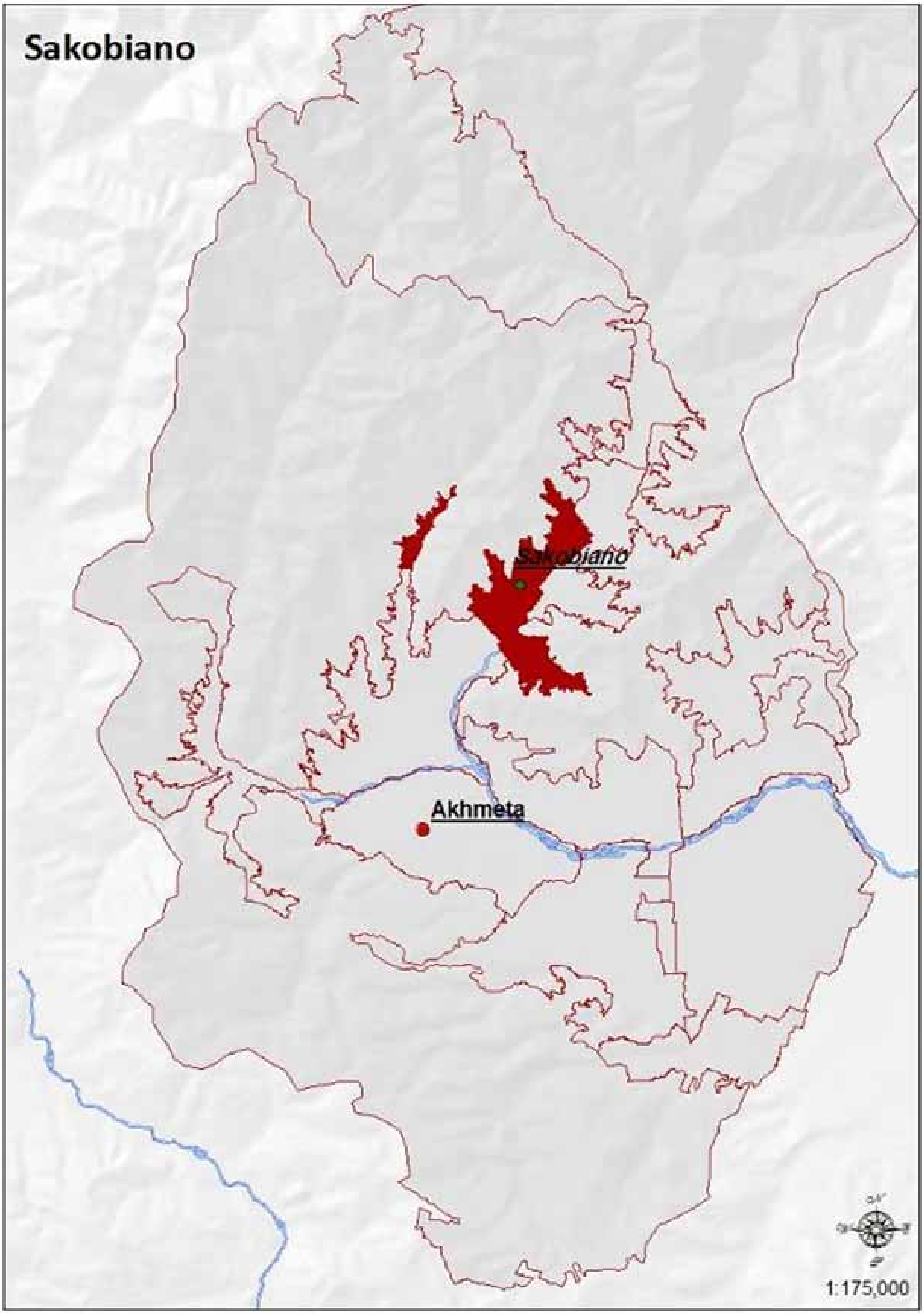
Kutsakhta Village

Near the Kutsakhta village the Alazani River has a shape of a box where the bottom width reaches 1 km. and width of floodplain channel approximates 300 meter. The river creates a delta with islands. The length of one of the islands is around 350-400 m and the width reaches 50-150 m. The river generated an upper floodplain terrace that elevates by 3-4 m from the channel. The surface is straightened and covered with agricultural lands and pastures.

The river washes its bank along 800 meter distance that threatens the agricultural lands and pastures.

Koreti Village

As usual, Qoreti village like other communal villages is damaged by erosive actions of the Alazani River. Within the village boundaries, the Alazani River washes a left bank and threatens the village population, their crofts and agricultural lands.


Sakobiano
Sakobiano
Akhmeta
1:175,000

2.1.3.5. Matani Community

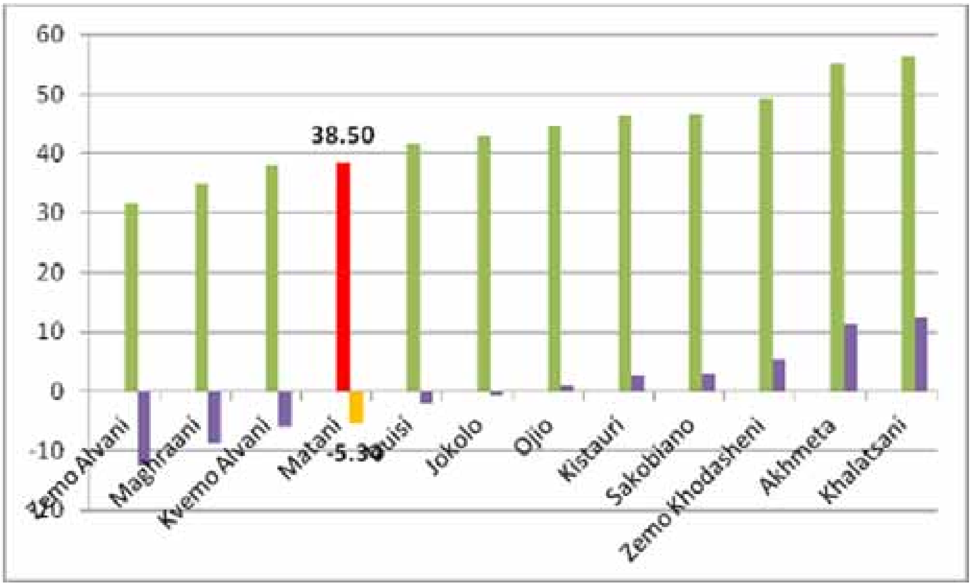
Matani community is located in the western part of Akhmeta municipality, at the confluence of the Alazani and Ilto rivers. The territory of the community comprises the right bank of the Alazani River and the left bank of the Ilto River. In this regard, Matani community is the lowermost course of the Ilto River drainage basin.

Apart from the mentioned rivers, there are other rovers flowing on the territory of the community – relatively small right tributaries of the Alazani River – such as the Kurtanadzeuli River, the MatniskheviRiver, the Kobaantkhevi River, etc.

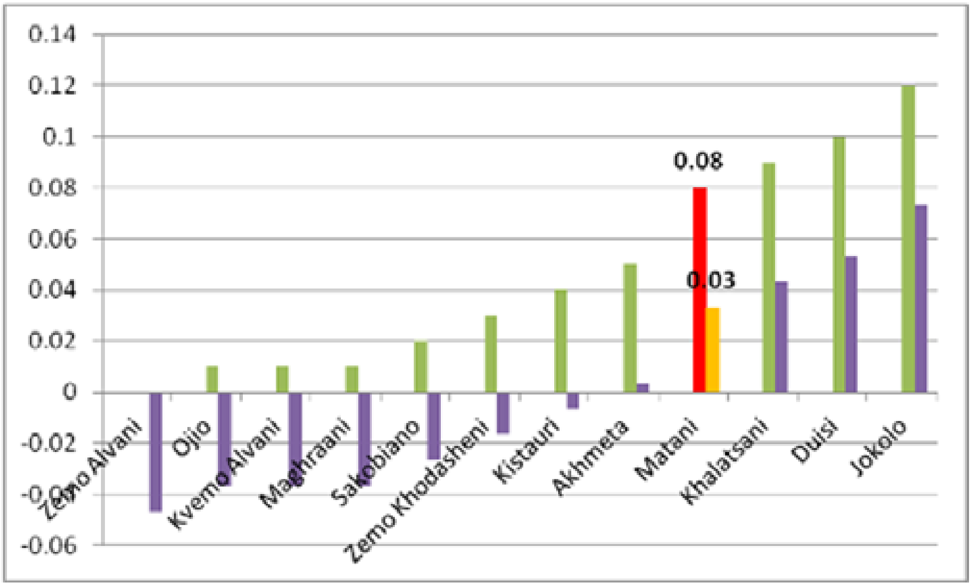
Matani community consists of just one village – the village of Matani. The distance of the village from the municipal center is 4 km.

The field research has revealed that the main problems for Matani community are connected with floods and river erosions, expressed in washing of banks.

In result of the research conducted within the framework of the program, the vulnerability of Matani community was assessed at 38.50 points. This indicator is lower that the average for Akhmeta municipality. That is, the vulnerability of Matani community is lower than the average for the whole of Akhmeta municipality. The difference from the average is -5.34 points. On the scale of the target region of the program the vulnerability of the community was assessed as an average vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Community).



The level of risk for Matani community is 0.08. This indicator of the community exceeds the average for the municipality (the difference from the average is 0.03. Accordingly, the level of risk of Matani community is high, relative to the average indicator for the community (see the graph). On scale of the target scope of the program the risk of Matani community was assessed as an average evel of risk (see the map – Assessment of Disaster Risks of Akhmeta Municipality).

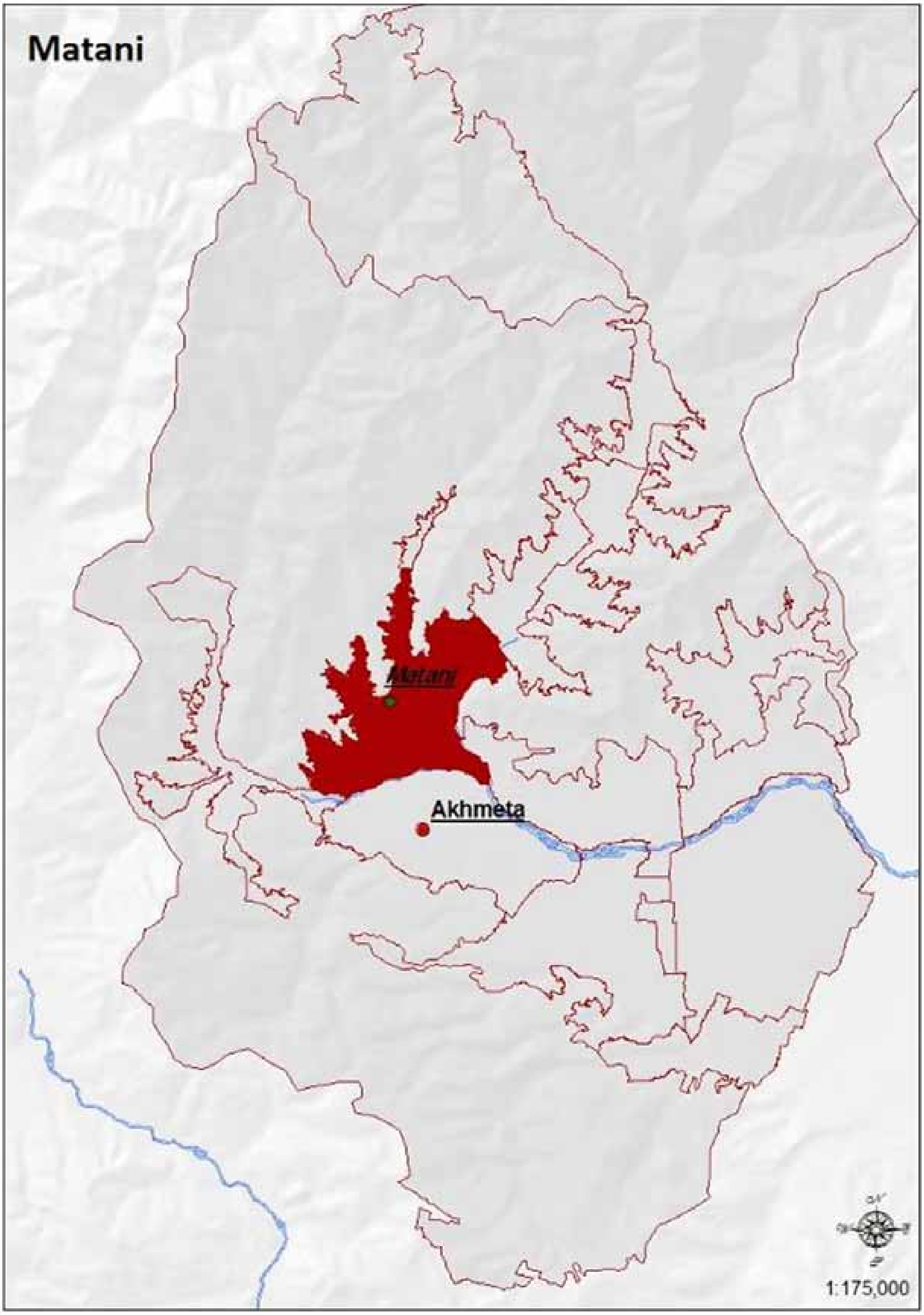


A detailed picture of the situation in Matani community, and in the village of Matani in particular, in respect of natural hazards is presented below.

Floods are characteristic of rivers flowing on the right slope – right tributaries of the Alazani River, among these, the Machitaskhevi River, the Matniskhevi River, the Kurtanadzeuli River. These rivers, in case of flooding (which occurs, as a rule, during springs, in periods of intensive snowmelt and abundant precipitation), damage: houses of the population (40 households), crofts, agricultural lands (up to 50 ha), inner roads, power-transmission masts, the school, the kinder garden, power transformer, cattle farm, bridge (the Matniskhevi River), etc.

The Kurtanadzeuli River is responsible for problems of drinking water supply system for the village of Matani. In particular, the river, that was supplying the head construction of the water supply system, changed its course, because of which the village is no longer supplied with appropriate amount of water.

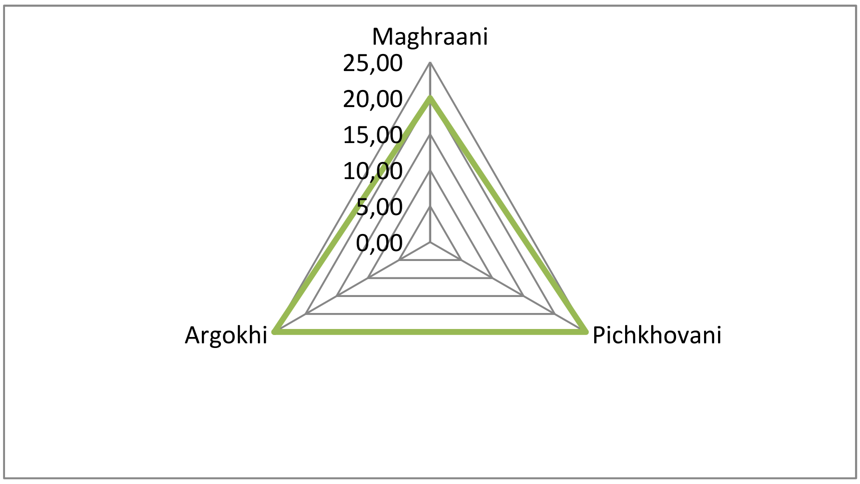
An important problem is created by the erosive action of the Alazani River, in result of which riverbanks are being intensively washed on the territory of the village. In result, agricultural lands located nearby are being damaged. The alternative road leading from Pankisi gorge to the city of Akhmeta is particularly endangered (at the confluence of the Alazani and Ilto rivers), where the river has already damaged existing shore protection tiles and now the road itself is facing the danger of being washed away (approximately a 1 km segment).


Matani
Matani
Akhmeta
1:175,000

2.1.3.6. Maghraani Community

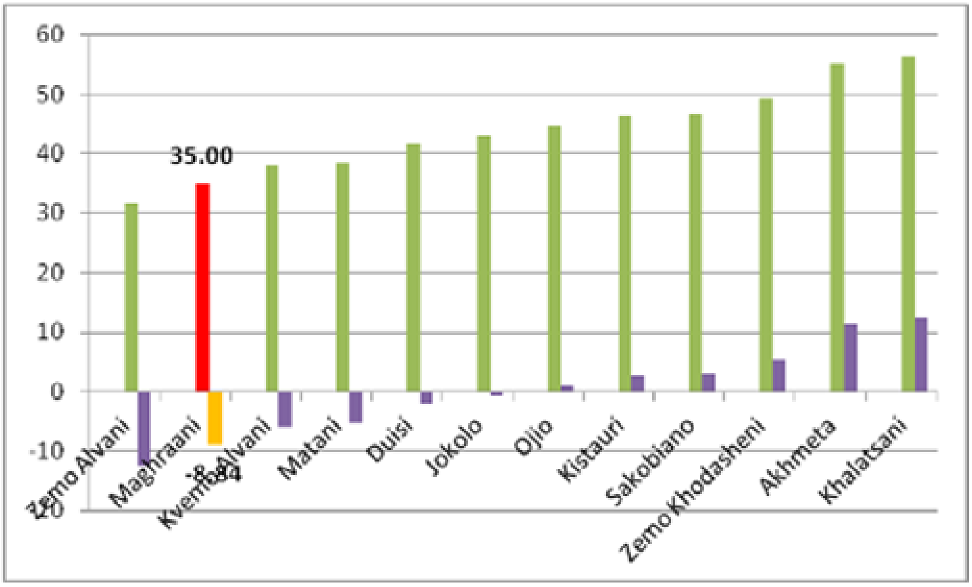
Maghraani Community is located in the northeastern part of Akhmeta municipality. The territory of the community is crisscrossed by the gorges of small rivers. Among these, the Bbabaneuris Psha, Maghraanis Psha and Matchareuli rivers are noteworthy. The biggest of these, the Babaneuris Psha, which gathers its waters on the territory of Maghraani community, merges with gorges of the community, crosses Kvemo Alvani community lattitudinally – from west to east - and then merges into the Alazani River from its left.

Maghraani community comprises three villages: Maghraani, Pichkhivani and Argokhi. The average distance of the villages from the municipal center is 24 km.

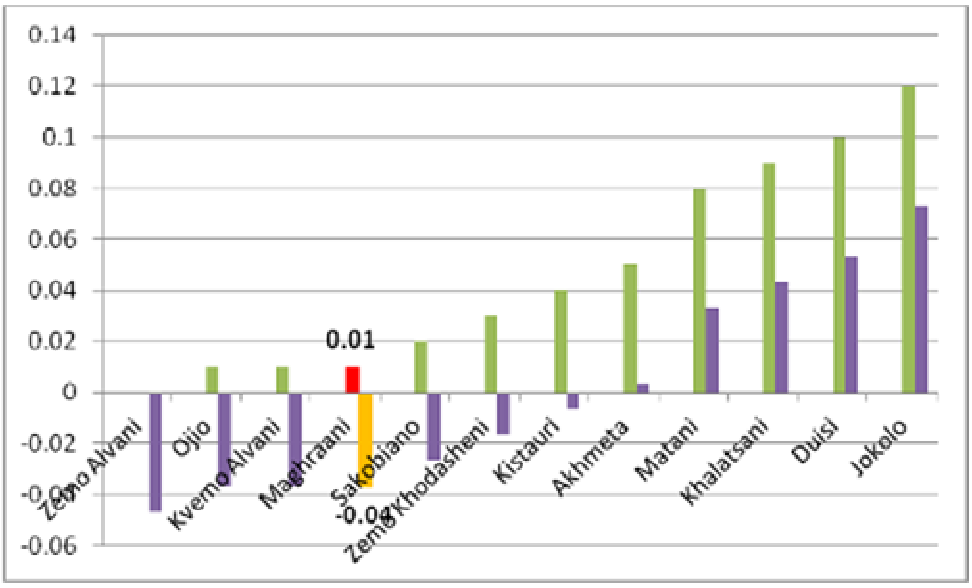


During field research, the local population identified natural hazards in the village of Marghaani only. Furthermore, no natural hazards have been identified on the community's territory in the reports of the National Environmental Agency.

According to the results of the research conducted within the framework of the program, the indicator of vulnerability for Maghraani community is rather low compared to other communities of Akhmeta municipality, it equals 35.00 points (the only community with a better lower is Zemo Alvani). The difference from the average indicator for the municipality is -8.84 points (see the graph). Such a low indicator for the community is due to the low number of hazard zones and the low number of people and agricultural lands in such zones. On the scale of the target scope of the program, the vulnerability of the community was assessed as a lower than the average vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Community).



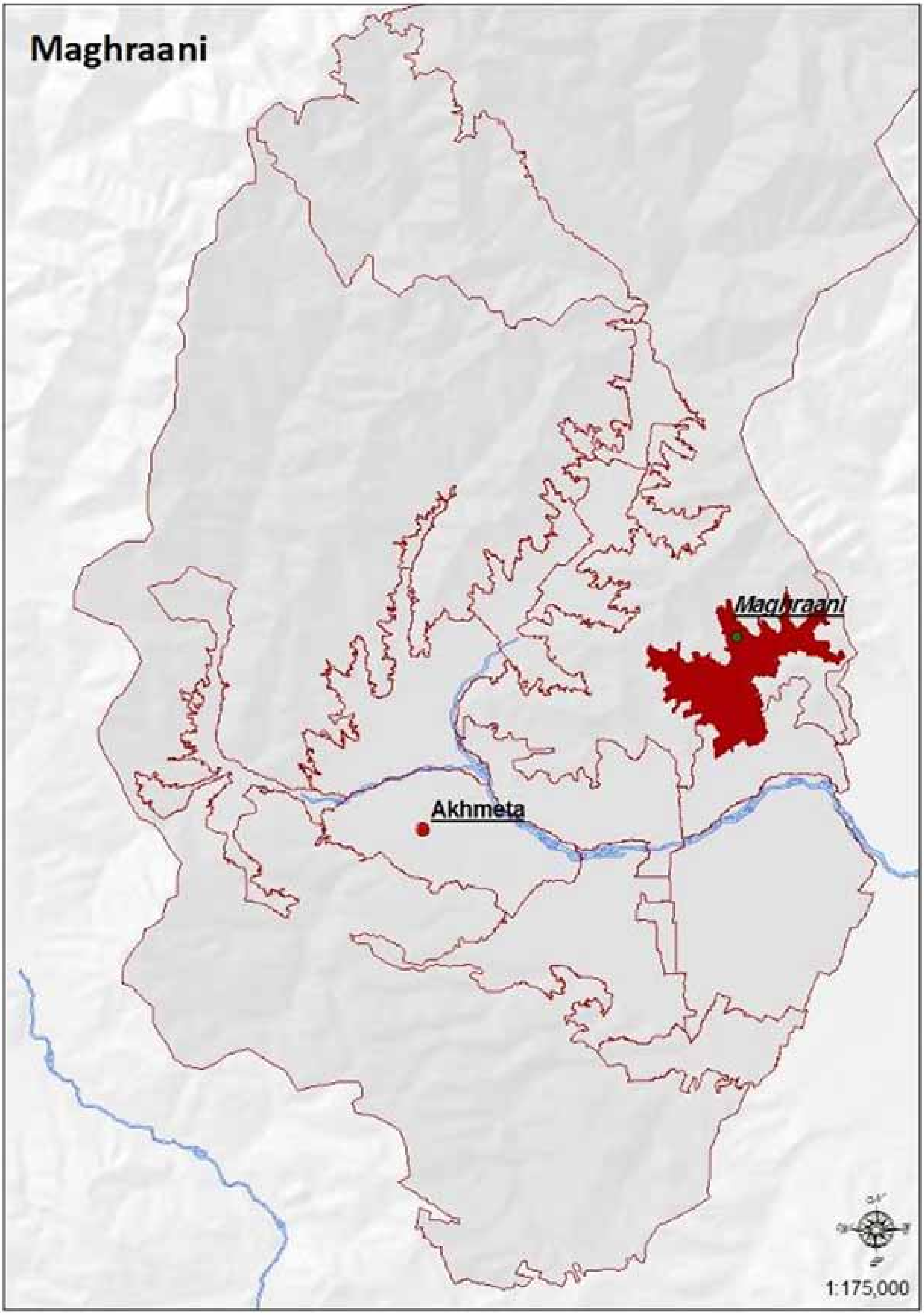
The level of risk for Maghraani community is also rather low and equals 0.01 points. The difference from the municipality's average is -0.04 (see the graph). On the scale of the target scope of the program, the level of risk of Maghraani community was assessed as a very low level of risk (see the map – Assessment of the disaster Risks of Akhmeta Municipality).



A more detailed picture of the natural hazards detected in Maghraani community, in the village of Maghraani in particular, is provided below. As was mentioned above, no natural hazards were identified in the other villages of the community.

The main hazard that affects the population of the village of Maghraani is ***flood***. In springs, during periods of intensive snowmelt or abundant precipitation, the Matcharula River floods and endangers the population. In the upper neighborhood of the village the river has damaged auxiliary constructions and the croft of Tariel Javakhishvili. The house is also endangered. On this segment, the river has changed its course and has endangered a major part of the village – houses, crofts and lands of 27 households (5 to 6 ha) - because of the absence of shore protective constructions.





Maghraani
Maghraani
Akhmeta
1:175,000

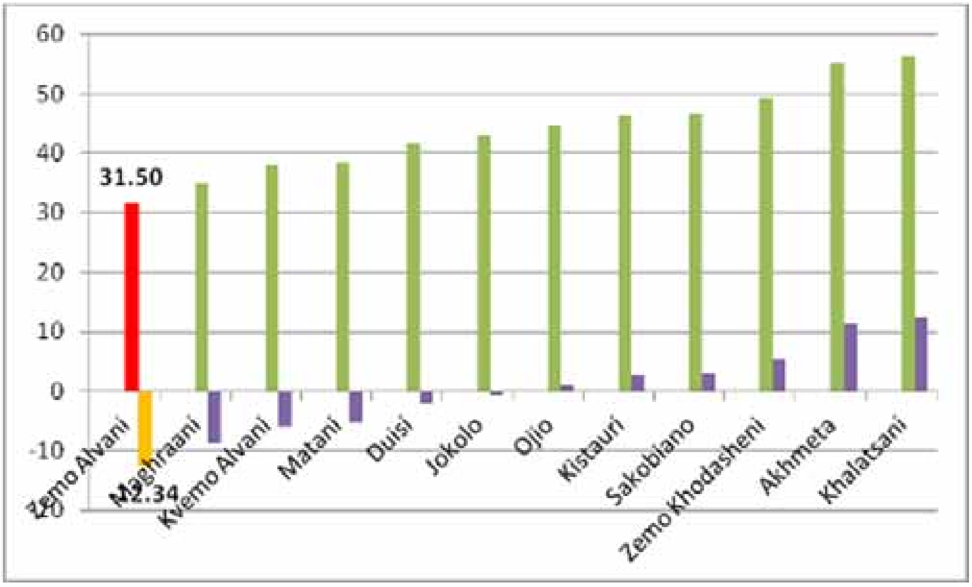
2.1.3.7. Zemo Alvani Community

Zemo Alvani community is located in the central part of the Akhmeta municipality, on the left bank of the Alazani River. The territory of the community is crisscrossed by channels of the irrigation system, which gather their waters on the territory of Zemo Alvani itself.

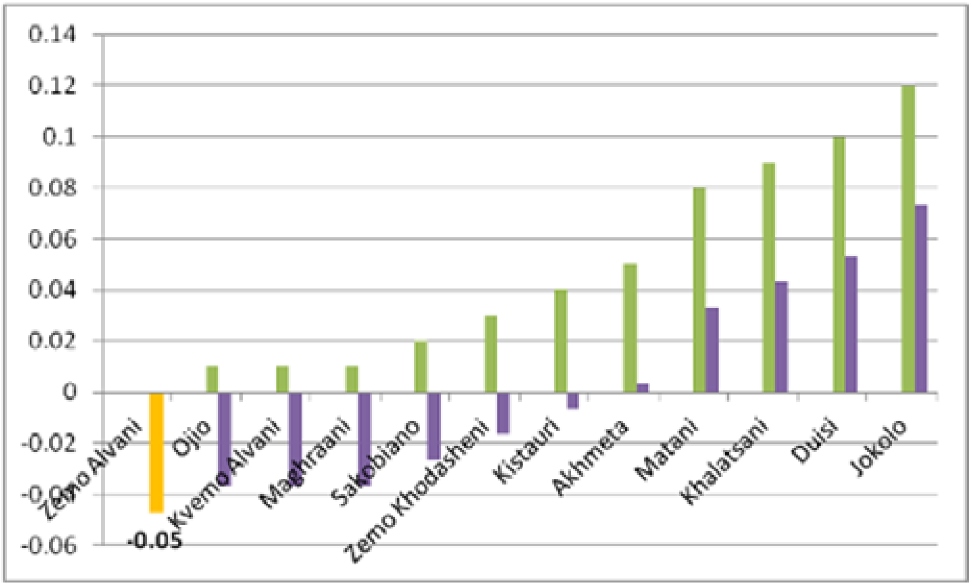
The community comprises of two villages – Zemo Alvani and Khorbalo. The average distance of the villages from the municipal center does not exceed 7 km.

During field research, no natural hazards were identified on the territory of the community neither by the population nor in the reports of the National Environmental Agency.

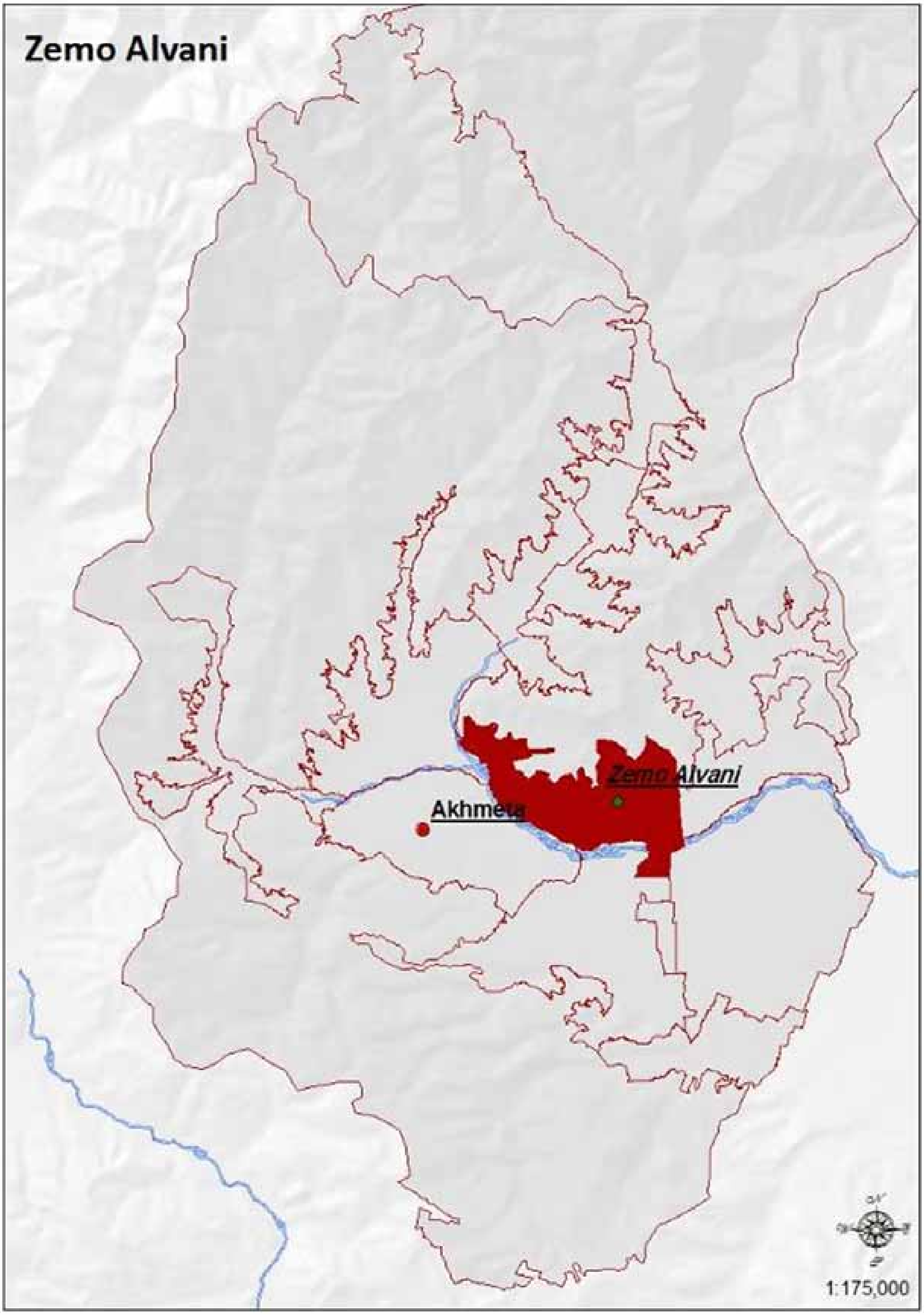
As a result of the research conducted within the framework of the program, the vulnerability of Zemo Alvani community was assessed at 31.50 points, which is the lowest indicator on the scale of Akhmeta municipality. The difference from the average municipal indicator is significant: -12.34 points. Such a low vulnerability indicator was determined by the fact that according to practically all criteria for assessment of vulnerability, indicators of Zemo Alvani community were considerably lower than average indicators for the municipality. Accordingly, Zemo Alvani community can be assessed as the least vulnerable community in Akhmeta municipality. On the scale of the target scope of the program, the vulnerability of the community was assessed as a lower than the average level of vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The risk level for Zemo Alvani community, like the vulnerability level, is the lowest within the municipality and equals 0. This minimal indicator of risk level is determined, on the one hand, by the minimal vulnerability and, on the other hand, by the fact that no natural hazard was identified by any of the sources on the territory of the community. Therefore, on the scale of the target scope of the program the level of risk of Zemo Alvani community was assessed as a very low level of risk (see the map – Assessment of the Disaster Risks of Akhmeta Municipality).



Based on the abovementioned, Zemo Alvani community is assessed as the community facing the lowest level of risk in Akmeta municipality.


Zemo Alvani
Zemo Alvani
Akhmeta
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2.1.3.8. Kveo Alvani Community

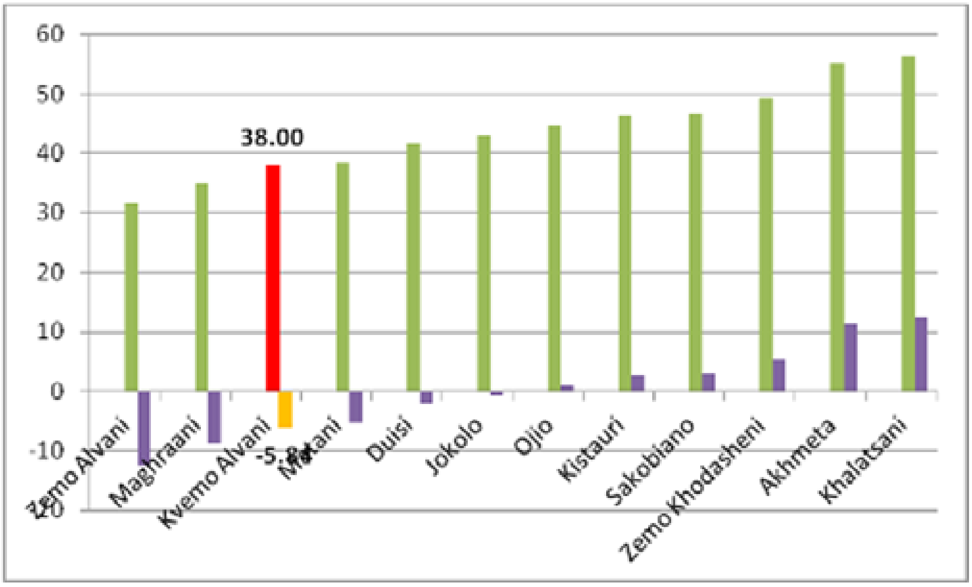
Kvemo Alvani community is located in the eastern part of Akhmeta municipality, bordering Telavi municipality, on the left bank of the Alazani River. The second biggest river is the Babaneuris Psha, which flows in from Maghraani community and merges into the Alazani River near Kvemo Alvani village. The territory of the community is crisscrossed by the channels of the irrigation system, which gather their waters on the territory of the neighboring community of Zemo Alvani.

The community of Kvemo Alvani is comprised of two villages – Kvemo Alvani and Babaneuri. The village of Kvemo Alvani occupies territories next to the Alazani River, while the village of Babaneuri is located relatively further away – in the drainage basin of the Babaneuris Pasha River.

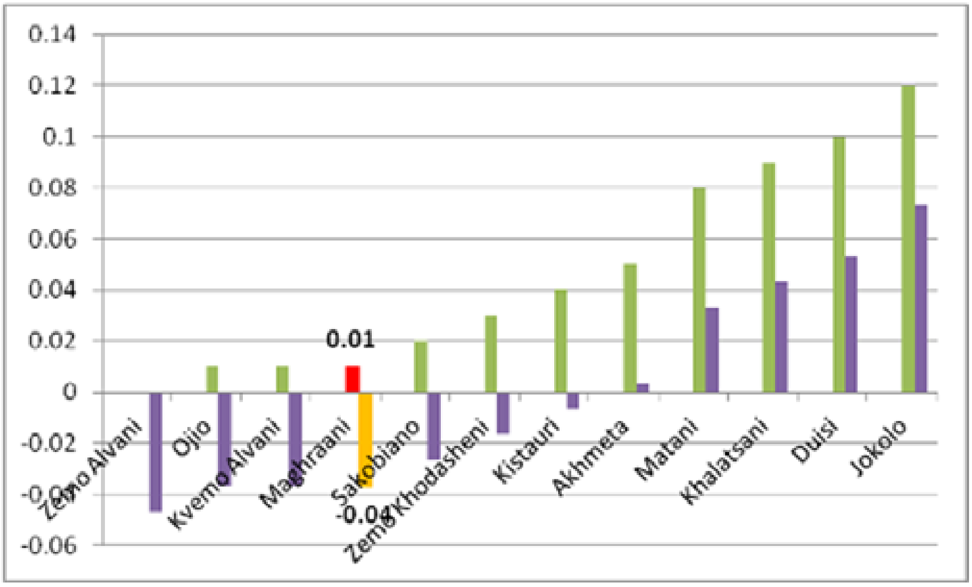
The average distance of these villages from the municipal center is 17 km.

During the field research, mainly floods and river erosion processes were identified as natural hazards.

According to the results of the research conducted within the framework of the program, the vulnerability of Kvemo Alvani community was assessed at 38 points, which is a rather low indicator on the scale of Akhmeta municipality. The difference from the average indicator of the municipality is -5.84 points. Such a low vulnerability is determined, first of all, by a lower scale of hazard zones, as well as by the relatively good economic status of the community. On the scale of the target scope of the program, the vulnerability of the community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The level of risk of Kvemo ALvani community is 0.01 points. With this indicator, the status of the community on the scale of the municipality is identical to its status in respect of vulnerability. That is, the indicator of the community is lower than the average indicator for the municipality (the difference is -0.04 points, see the graph). Accordingly, Kvemo Alvani community, in terms of risks related to climate change and natural disasters, is one of the communities with a lower risk level in Akhmeta municipality. On the scale of the target region of the program, the level of risk of Kvemo Alvani community was assessed as a very low level of risk (see the map – Assessment of Disaster Risks of Akhmeta Municipality).

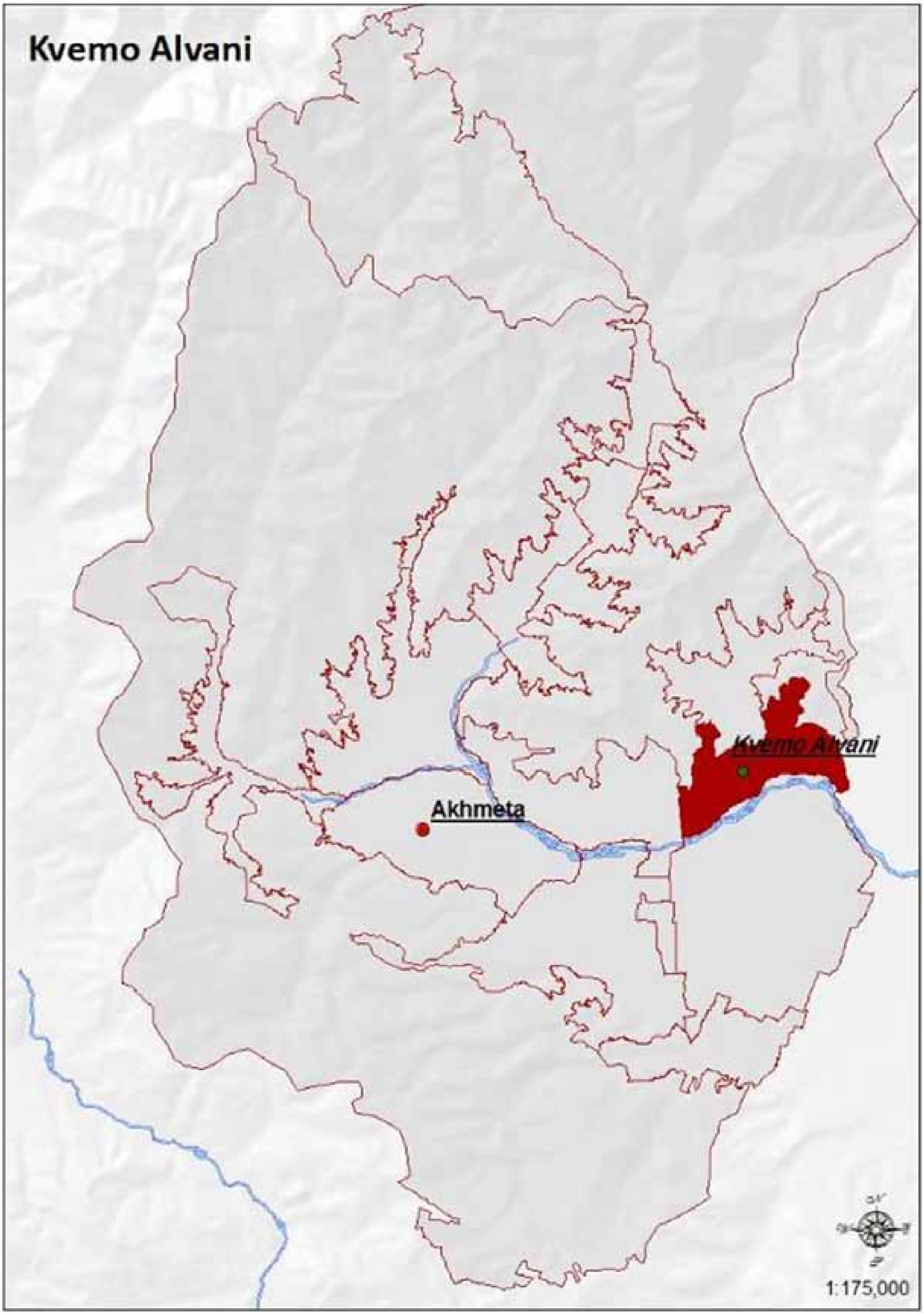


On the community' territory, in terms of natural hazards, ***floods*** and the ***washing of banks*** were identified on the territory of the village of Kvemo Alvani only (both according to the data of the field research conducted within the framework of the program as well as those of the National Environmental Agency). A detailed description of the situation is provided below.

Problems of natural disasters in the village are mainly connected with the action of the Alazani River. The village is entirely located in the lower part of the Alazani River gorge, on the left terrace over the floodplain. The terrace has an even surface and is entirely covered by the population's houses and crofts. The terrace is composed by the pebble mass of alluvial genesis and sandy-clay filling.

On the village's territory, on the left bank of the river, the high terrace of the floodplain and the first terrace above the floodplain are merged and therefore, the boundary between them can be drawn only conventionally. The high floodplain terrace rises at 0.8-1.5 m above the riverbed. The river washes intensively the left bank and carries away a plot of area annually (for example, according to the data of the Agency, a 10 m wide segment was lost to the river in 2010). The river has carried away several big trees from the terrace of the left bank. Furthermore, the population's crofts (15 to 20 households) and pastures (30 ha) are being washed away. A sawing facility, a carpenters' workshops and a fishery are currently endangered. The bank is washed on an area covering 2-3 km from Alaverdi Bridge.





Kvemo Alvani
Kvemo Alvani
Akhmeta
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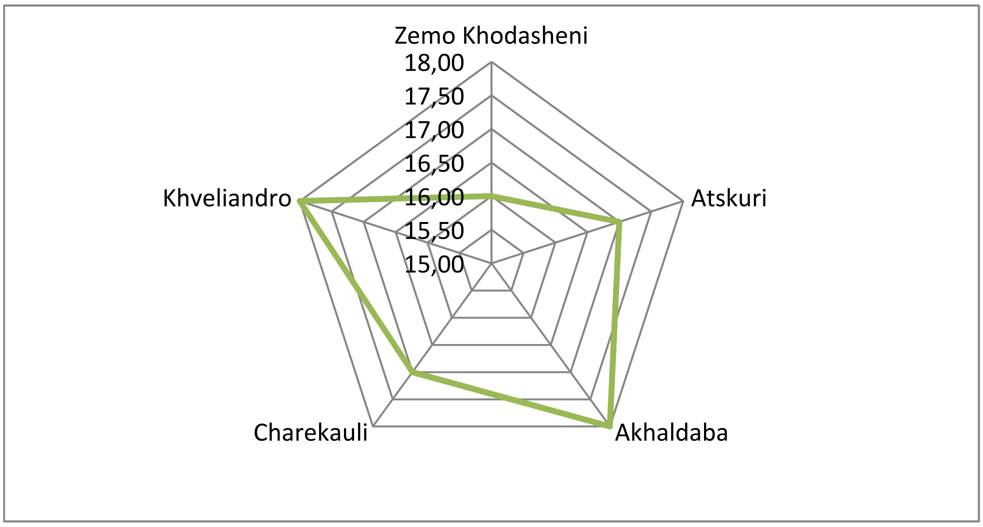
2.1.3.9. Zemo Khodasheni Cmmunity

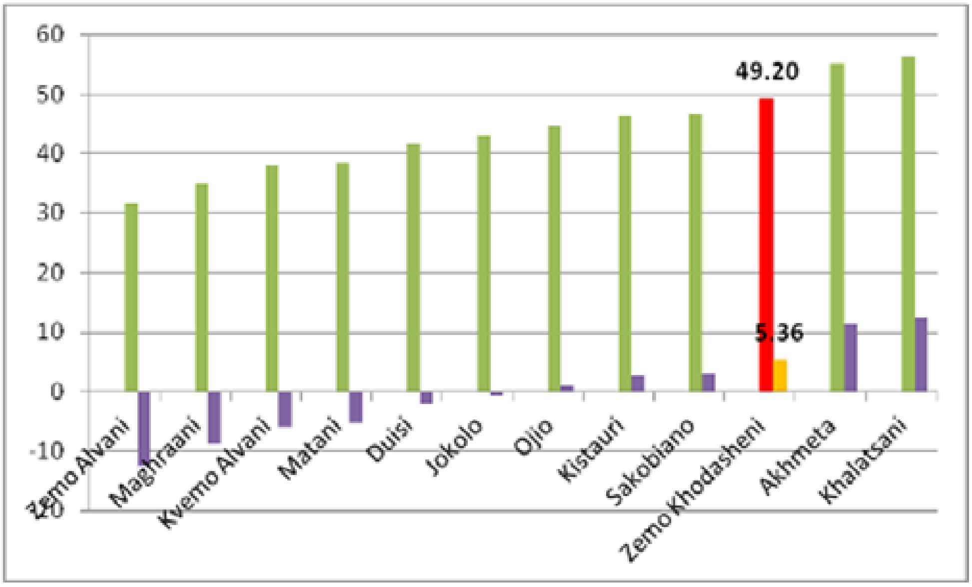
Zemo Khodasheni community is located in the southernmost part of Akhmeta municipality. To the south, the community is bordered by the northern foothills of the Gombori Range. The territory of the community is longitudinally crisscrossed by the gorges of relatively big and small right tributaries of the Alazani River. Among these, the Khodashniskhevi, the Shavkabaskhevi, the Berkhevi rivers are noteworthy. These rivers gather their waters on the territory of Khodasheni community or on the adjacent northern slopes of Gombori Range, cross Zemo Khodasheni community, flow into the territory of Ozhio community where they merge with the Alazani River, from its right side. Apart from these, the community is crossed lattitudinally, along the whole length, by the Zemo Alazani irrigation channel.

Zemo Khodaheni community comprises five villages. These villages are: Zemo Khodasheni, Atskhuri, Akhaldaba Charekauli, and Khveliandro. The average distance between the villages and the municipal center is 17 km.

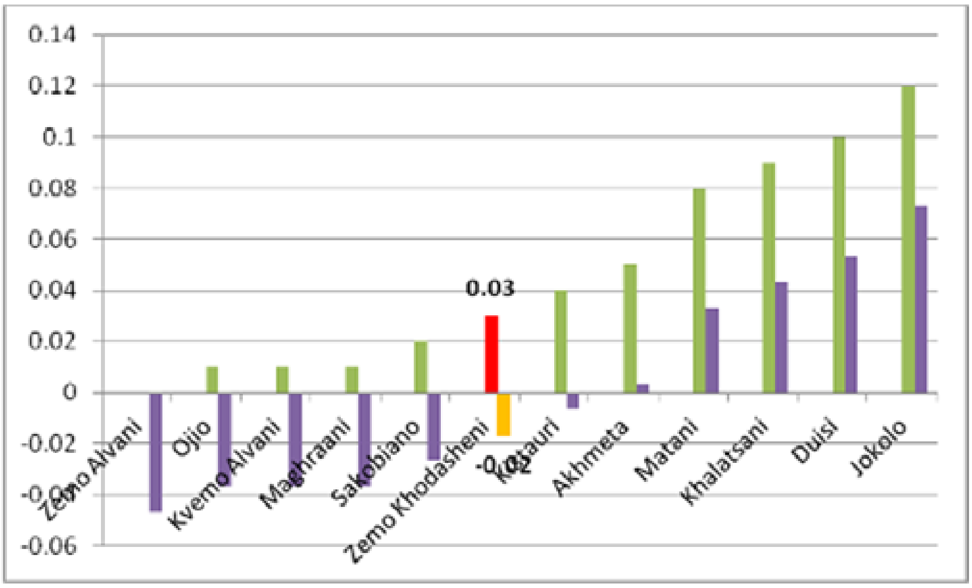


During the field research, mainly river erosion problems were identified on the territory of the villages. These are expressed in widespread mudflow processes and the washing of banks.

According to the data of the research conducted within the framework of the program, the vulnerability of Zemo Khodasheni community was assessed at 49.20 points, which is higher than the average indicator for the municipality. The difference from the average is 5.36 points (see the graph). On the scale of the target area of the program, the vulnerability of the community was assessed as higher than the average level of vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



Zemo Khodasheni community's level of risk was 0.03 points, which is lower that the average indicator for the municipality (the difference is -0.02 points). On the scale of the target area of the program, the level of risk of the community was assessed as a lower than the average level of risk (see the map – Assessment of the Disaster Risks of Akhmeta Municipality).



A detailed picture of the villages' situation in terms of natural hazards follows.

The Village of Charekauli

The so-called Udziro Khevi ('bottomless gorge') flowing through the village of Chareqauli, as a result of lateral erosion, damages the bank and endangers the bridge passing on the gorge. The only road connecting the village to the outer world passes on the bridge.


The Village of Atskhuri

The main problems caused by natural hazards in the village of Atskuri are connected to the Berkheva gorge's passage through the village. In spring, during periods of intensive snowmelt, the gorge floods and inundates the territory of the village in several places. The watercourse of the gorge is filled with carried material, in result of which it cannot conduct surplus water and causes ***floods***. The territory adjacent to the village church should be mentioned, where, in result of such floods, a neighborhood road and crofts and lands of the population get inundated.

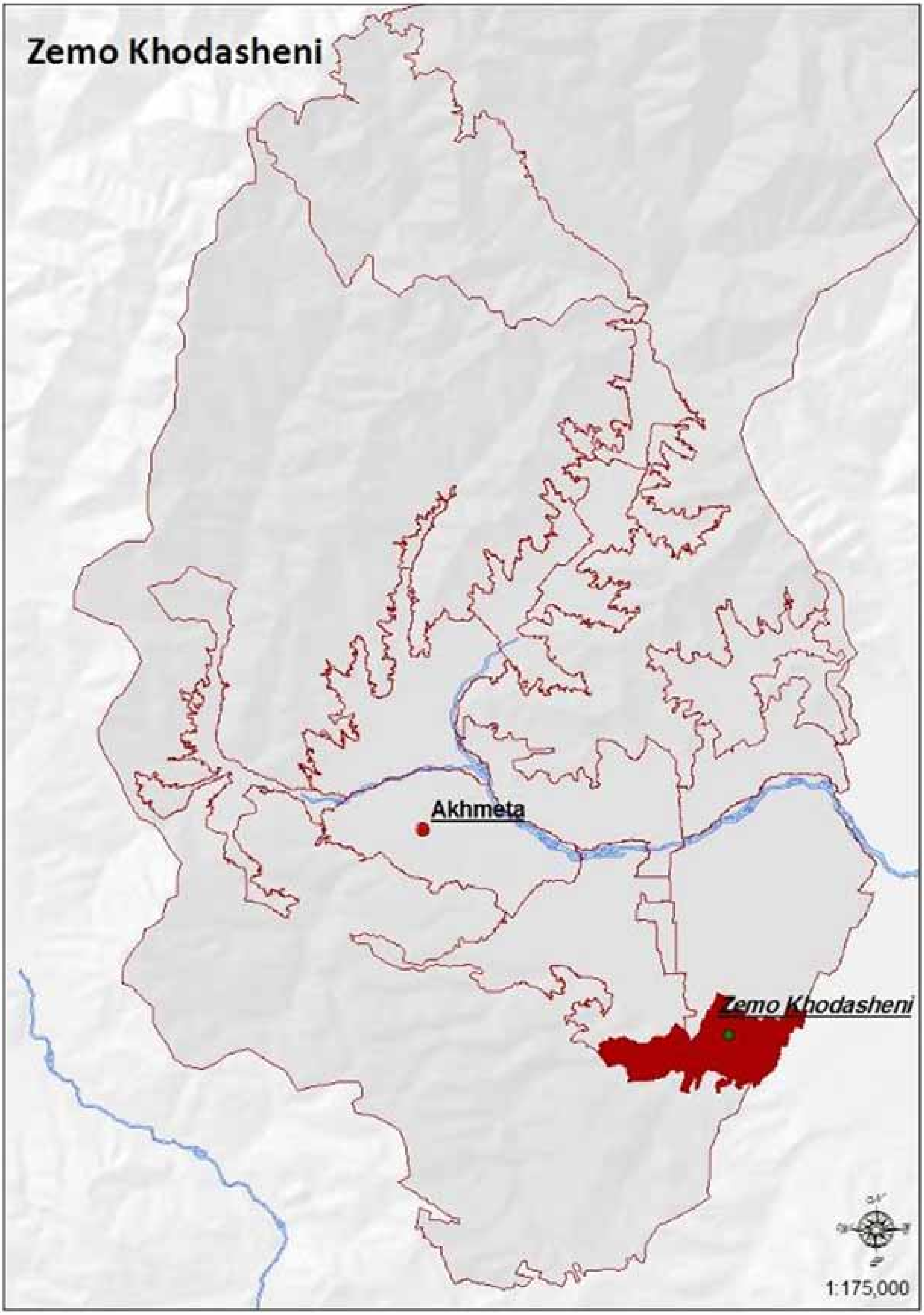
A similar problem is present at the border between the Zemo Khodasheni and Atskuri villages. The same gorge (Berkhevi) floods and inundates the territory of the village school. In the lower course of the gorge, in the village of Khodasheni, the agricultural lands of the population are inundated.


The Village of Zemo Khodasheni

Mudflows and ***bank washing*** developed on the Khodahseniskhevi River represent the main hazards faced by the village of Zemo Khodasheni. The gorge of the Khidashnis Khevi River has an open shape. The floodplain width goes up to 70-80 m within the boundaries of the village and up to 200 m at the central motor road, under the motor bridge. The river branches out, the watercourse is filled to the surface and shore protection constructions are partly damaged. The mudflow streams fill the agricultural lands of the population with sand and silt.

The water washes a 0.2 km segment of the road connecting the village to the villages of Charekauli, Akhaldaba and Khveliandro. Power-transmission masts are endangered.


In the so-called Bachiaurebi, an artificial channel was dug approximately 60 years ago to allow the waters from the Shavkaba River and from the mountains to flow, therefore preventing surface waters from inundating the village. At present, it is largely filled with weathered material. Accordingly, in some places, in times of rainfall, the water overflows and inundates the houses, crofts and agricultural lands of 4-5 households. Furthermore, the central pipe and the head construction of the drinking water supply system are being damaged.



Zemo Khodasheni
Akhmeta
Zemo Khodasheni
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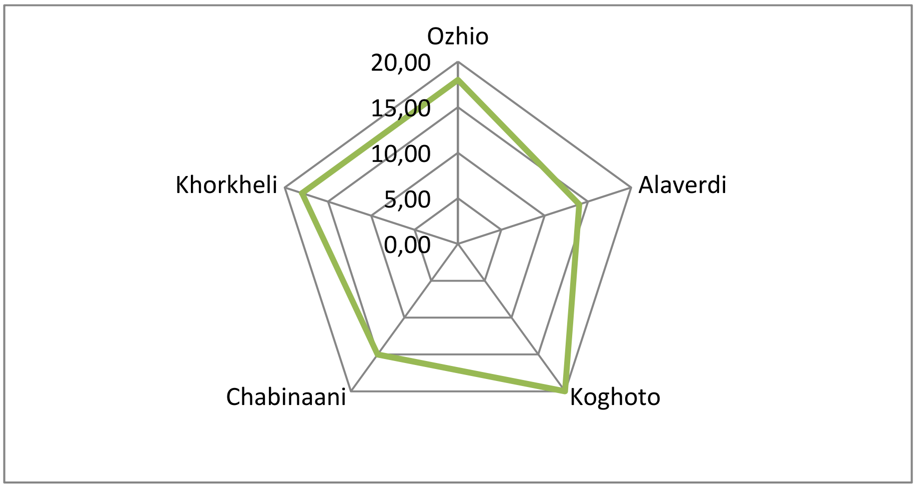
2.1.3.10. Ozhio Community

Ozhio community occupies the eastern part of Akhmeta municipality, and has territories bordering with Telavi municipality. The community is entirely located on the right side of the Alazani River.

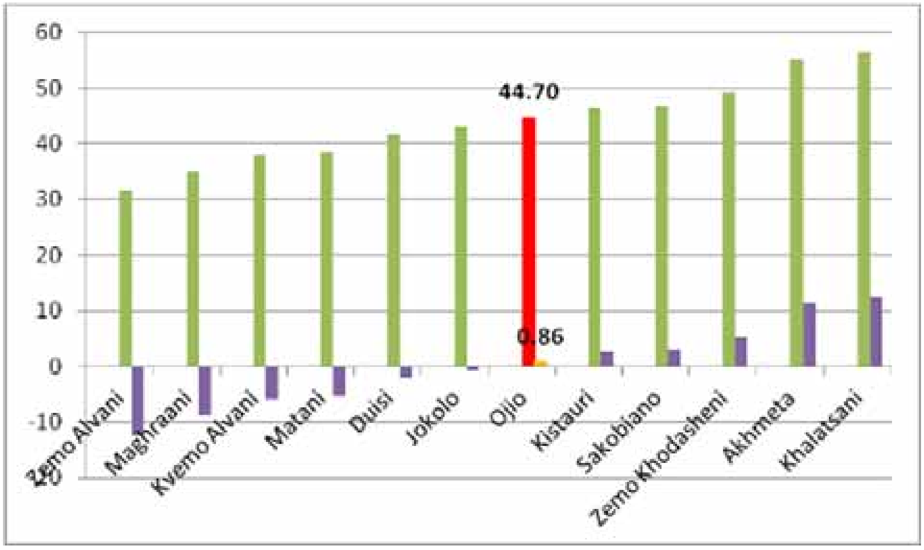
The territory of the community is crisscrossed by the gorges of small and relatively big right tributaries of the Alazani River. Among these, the Khorkheli, Khodashniskhevi, Shavkabaskhevi, and Berkhevi rivers are noteworthy. These rivers flow from Khodasheni community into Ozhio community and merge into the Alazani River there.

Ozhio community is comprised of the villages of Ozhio, Alaverdi, Koghoti, Chabinaani, and Khorkheli. The average distance of the villages from the municipal center is 17 km.

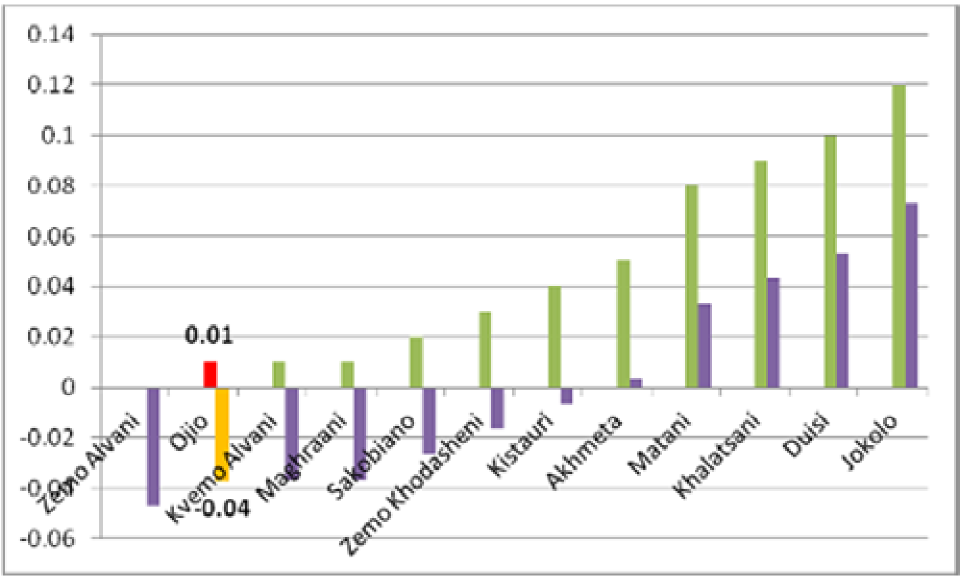


During the field research, mainly problems of river erosion were identified on the territory of the villages, which are expressed by the mudflow processes and washing of banks detected there.

According to the research conducted within the framework of the program, the vulnerability of Ozhio community was assessed at 44.70 points, which is practically equal to the average indicator for the municipality. The difference from the average municipal indicator is just 0.86 points. On the scale of the target area of the program, the vulnerability of the community was assessed as the average vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The level of risk of Ozhio community is 0.01, which is one of lower indicators on the scale of the municipality (the difference is -0.04, see the graph). On the scale of the target area of the program, accordingly, the level of risk of the community was assessed as a very low level of risk (see the map – Assessment of the Disaster Risks of Akhmeta Municipality).



A detailed picture of the situation in the villages in terms of natural hazards is given below.

The Village of Ozhio

In the Village, the Berkhevi gorge (which has its source on the territory of Zemo Khodasheni community), in times of abundant precipitation, overflows its watercourse and inundates the agricultural lands and crofts of the population. The watercourse of the gorge, in general, is filled with abundant sediment material and, accordingly, does not allow the necessary volume of water to flow; this causes ***floods*** on adjacent territories. Approximately 3 ha of arable lands are endangered.


The Village of Alaverdi

The main problem of the village is caused by the erosive action if the Alazani River. The intensive washing of rivers by the Alazani River has been detected in the vicinity of the village of Alaverdi. Here, the gorge of the river has an open form. It has bilateral upper-floodplain terraces, which rise up to 4 meters from the watercourse. The terraces are covered with the houses, crofts and agricultural lands of the village population.

Above the motor road bridge, the left bank of the river is being washed along a 500-600 m segment, and below the bridge, both the right and the left banks are being washed.

At the level of the bridge, on the left bank, a shore protection construction which was installed is partly damaged and has fallen to the water surface. The process further endangers agricultural lands.

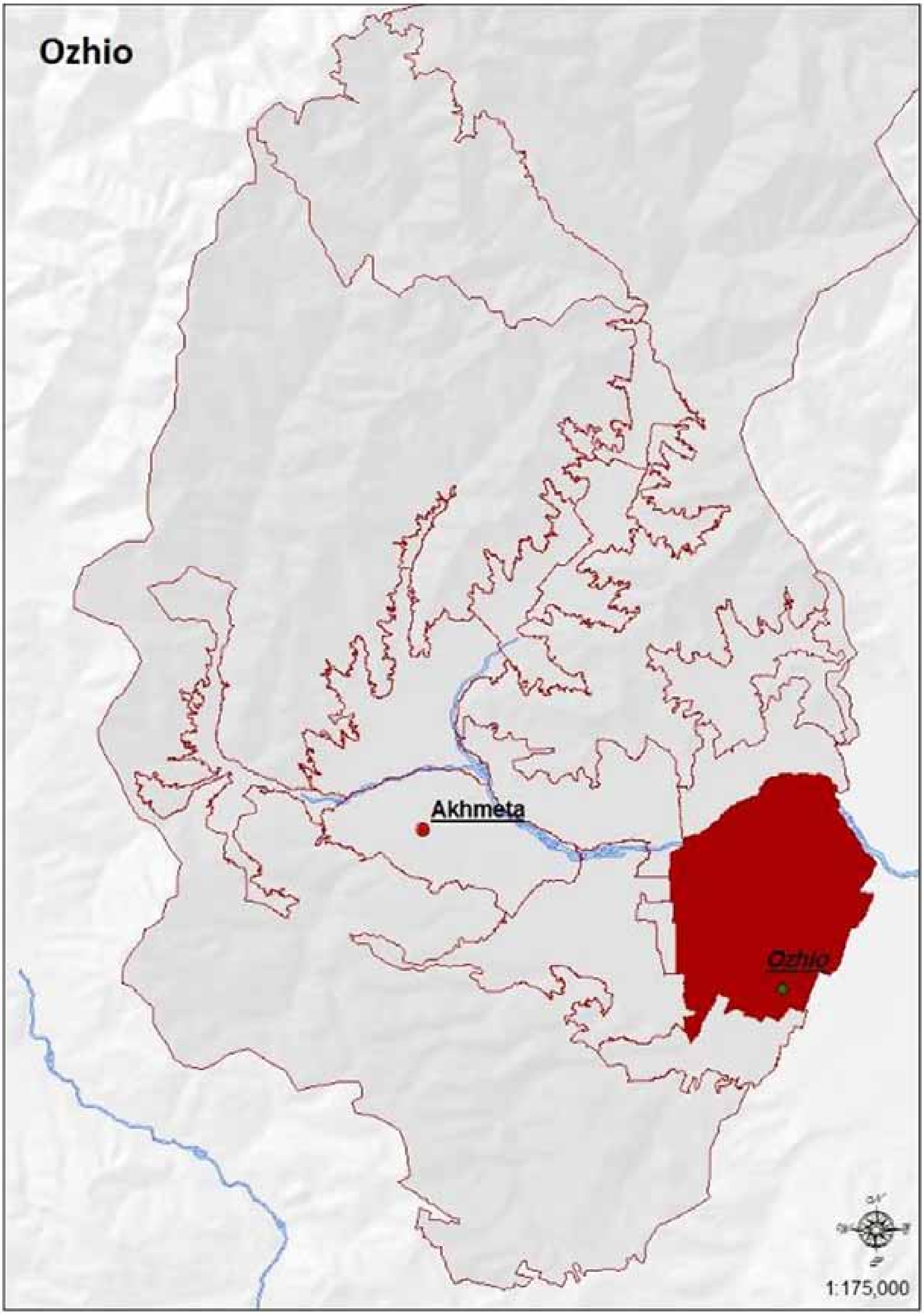
Alaverdi Monastery

Alaveri Monastery is located close to the village of Alaverdi. Because monastry's status as an important cultural heritage site, a seperate assessment of its situation was considered to be important for the report. Furthermore, as the problem existing there is quite complex it is worthy to provide a detailed explanation.

The mentioned problem was not identified during the meetings with the local population, nor is it reflected in the reports of the National Environmental Agency. Accordingly, this component was not considered in the model of the risk assessment. We suppose that considering this issue in the model of risk assessment would change the risk profile of the community essentially.

Approximately 1km to the southwest of Saint George Monastery of Alaverdi, the Zemo Khodashnis Khevi gorge flows. Its basin covers a total area of 90 square meters and a length of more than 30 km, and 112 km if tributaries are also considered.

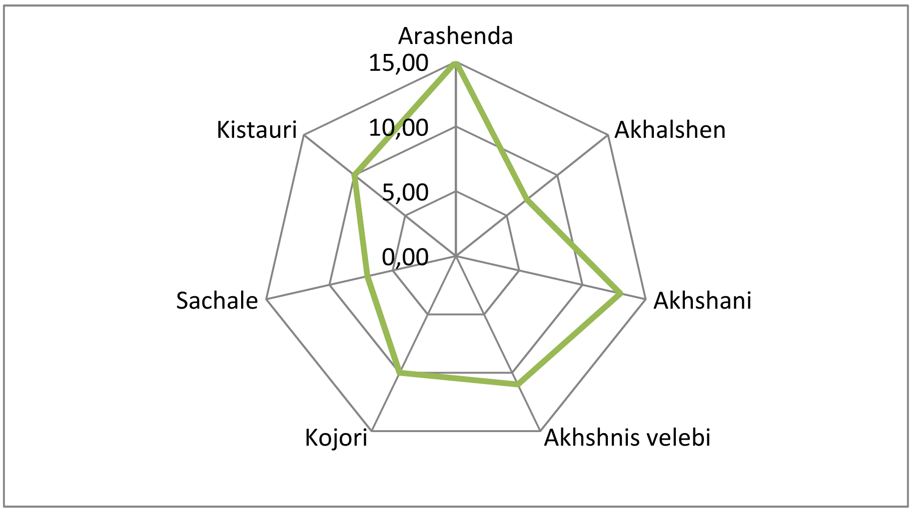
The shore protection constructions which were installed on this gorge several decades ago are now destroyed; the watercourse has been filled with gravel and pebble and in many places its bed is higher than the agricultural lands surrounding it. As a result, in times of early spring and autumn floods, the water changes its direction in some places and a major part of flash flood streams has found its course in the gorge passing next to Alaverdi monastery. The stream (due to its large size) cannot flow through the gorge and this endangers the unique church of Alaverdi constructed almost 1,000 years ago, as well as the entire monastery.


Ozhio
Akhmeta
Ozhio
1:175,000

2.1.3.11. Kistauri Community

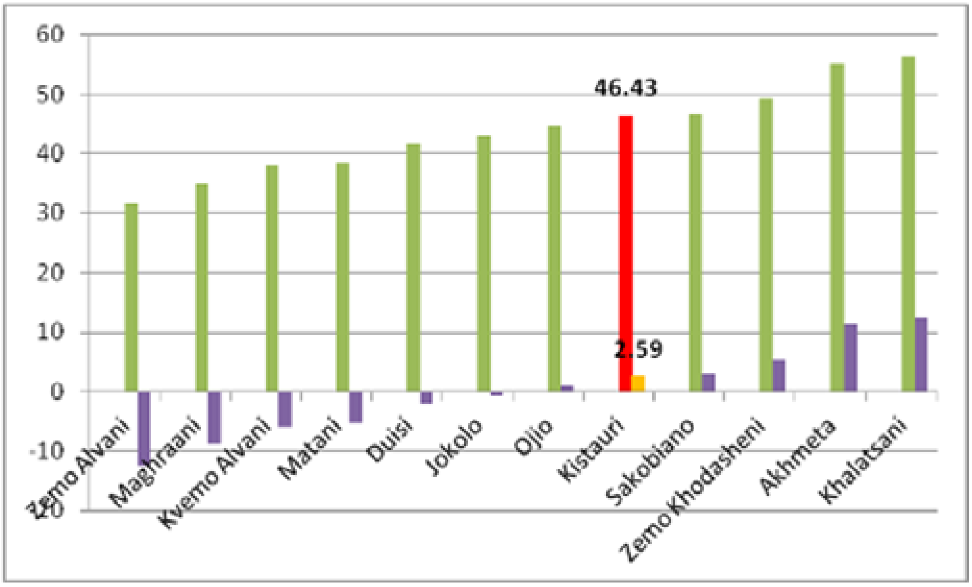
Kistauri community is located in the southwestern part of Akhmeta municipality, on the right bank of the Alazani River. The territory of the community comprises of the northern foothills of the Gombori Range. The territory of the community is crisscrossed by longitudinal watercourses of relatively small right tributaries of the Alazani River, among which the Kistauris Khevi (Khachiris Khevi), Mkhrala, Didtchala, and Gurula rivers are noteworthy. All these rivers gather their waters on the northern slopes of the Gombori Range, cross Kistauri community and merge into the Alazani River on the territory of the community itself. Furthermore, the Kistauri community is crossed lattitudinally, along its entire length, by the Alazani irrigation channel.

Kistauri community is comprised of seven villages. These villages are: Arashenda, Akhalsheni, Akhshani, Akhnis Velebi, Kodjori, Satchale, and Kistauri. The average distance of the villages from the municipal center is approximately 11 km.

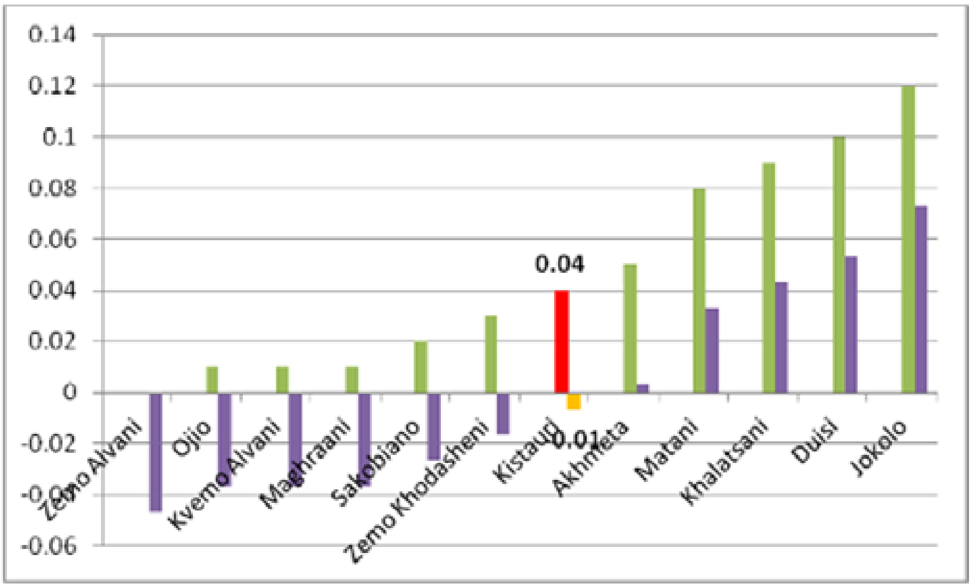


As a result of the field research, mudflows and floods problems were mainly identified on the territory of the community villages.

According to the data of the research conducted within the framework of the program, the vulnerability of Kistauri community was assessed at 46.43 points, which is higher than the average municipal indicator, 43.84. The difference from the average is not big and equals 2.59 pints (see the graph). In general, on the scale of the target region of the program, the vulnerability of this community was assessed as a higher than the average vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The level of risk for Kistauri community was assessed as 0.04 points. This indicator is practically equal to the average indicator for the municipality. The difference is only 0.01 points (see the graph). On the scale of the target region of the program the level of risk of Kistauri community is lower than the average level of risk (see the map – Assessment of Disaster Risks of Akhmeta Municipality).



A detailed picture of the situation in the villages of the community in terms of natural hazards is as follows.

The Village of Kistauri

The main problem for the village is ***mudflow*** streams developed in the gorges passing through the village. Among these, the Kistauris Khevi River is to be mentioned particularly. The Kistauris Khevi River gathers its waters on a northeastern slope of the Gombori Range. In the geological composition of the slope, sediments of the upper Cretaceous period (limestones and marls); while on the territory of the village and lower – alluvial-prolluvial sediments are present. The river is mudflow prone. Above Kistauri village – after the river flows from a slope with a sharp inclination – the gorge has an open shape. The width of the watercourse is up to 20 m.

The watercourse is so filled with sediments that it stands 0.5 m higher than the existing surface. The shore protective concrete tiles are covered. The adjacent territory has a leveled surface, covered with vineyards, arable lands and pastures.

On the territory of the village of Kistauri, a construction which protects the shore of the river is partly damaged, and some of the concrete tiles are displaced. The watercourse is filled with mudflow materials and, where the shore protection is damaged, the water overflows to the left and endangers about 30-35% of the village population with inundations and silt; while below the village, vineyards and arable lands are facing a real danger. Furthermore, the poultry farm of the village, the inner roads, the power infrastructure (transformer, transmission masts), the footbridge, etc. are endangered.

The river Mkhralas Khevi flows through the central part of the village. The gorge's watercourse is practically entirely filled with sediment material. In periods of abundant precipitation, the watercourse cannot conduct surplus water and overflows, therefore damaging the village's arable lands (approximately 70 ha).

Furthermore, the gorge passing on the western side of the village – the Didtchala –, which creates a natural boundary with the village of Akhshani is prone to mudflows. The problem is identical with the one in the previous case – the watercourse is filled with sediment materials brought by the river, in result of which the watercourse does not conduct the surplus water present in Spring and periods of abundant precipitation. Accordingly, water overflows the banks, and damages the adjacent agricultural lands of both villages (approximately 80 ha). Furthermore, the nearby winery is endangered (individual entrepreneur Nodar Manvelashvili).

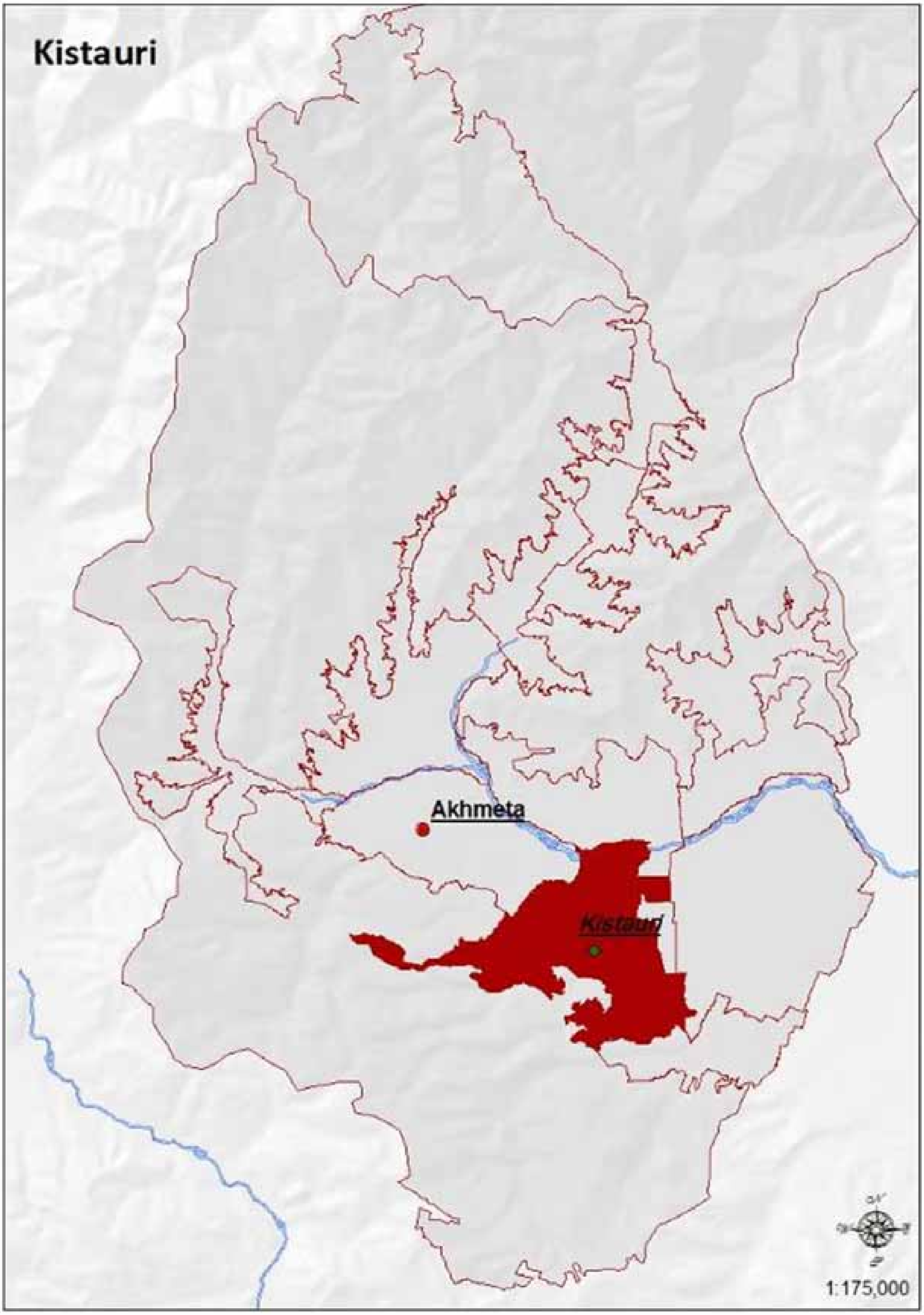
 

The Village of Akhshani

Similarly to the whole of the Kistauri community, the village of Akhshani is mainly damaged by ***mudflow*** stream, for which the cause is identical. The watercourse of the gorge passing in the eastern part of the village (Akhshniskhevi) is filled with sediment material, in result of which the watercourse does not conduct surplus water, which leads to the inundation and damage of the crofts and agricultural lands and roads of the village by mudflow streams.


The Village of Arashenda

The main problem that the population of the village of Arashenda face are ***floods***. In periods of heavy rainfalls, the water from the hills around the village innundates the houses, crofts and agricultural lands (8 ha) of 14 households. The problem is caused by the defunct drainage system of the village, which is filled up and cannot conduct surplus water.



Kistauri
Akhmeta
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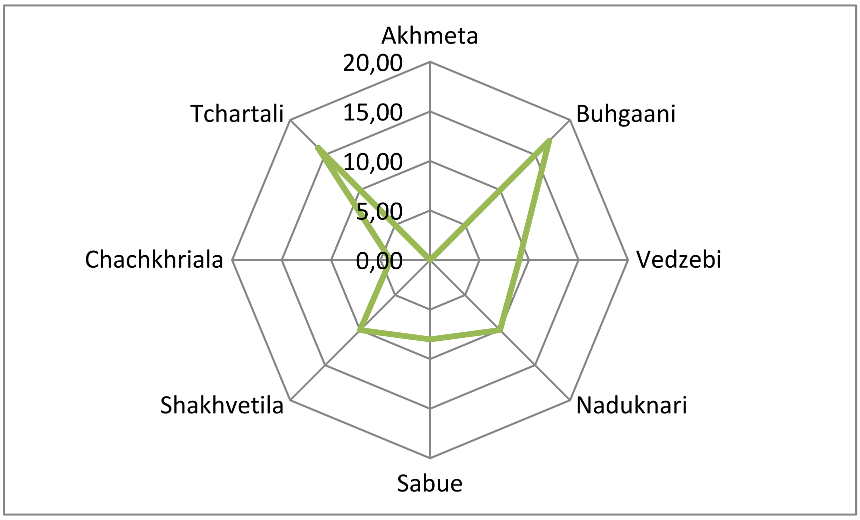
2.1.3.12. The Town of Akhmeta

The territory of the town of Akhmeta occupies the central and western parts of the municipality. In this report, mention of the town of Akhmeta also englobes villages subject to the town's direct administration. Although these villages formed a separate community (Shakhvetila community) in previous years, according to the new administrative division they became part of the Akhmeta town's territorial unit[3]. In this sense, it is reasonable to speak of Akhmeta community not as of the territory of the town only, but as of the unity of the town and the villages subject to it.

The territory of Akhmeta town comprises of the drainage basins of the Alazani and Ilto rivers as well as the confluence of these two rivers. Apart from this, the territory of the community is crisscrossed by the gorges of the tributaries of the Ilto and Alazani rivers, the drainage basins of which fall entirely within the boundaries of the territory of the community. Among these, the Tkhilkhevi, Khevgrdzeli, Badalkhevi, Khintritsa (tributaries of the Ilto River) and Orvili (a right tributary of the Alazani River) are particularly noteworthy.

The Akhmeta community comprises of the following settlements: the town of Akhmeta itself and the villages – Bughaani, Vedzebi, Naduknari, Sabue, Shakhvetila, Chachkhriala, Tchartali. The average distance of the villages from the municipal center is approximately 10 km.



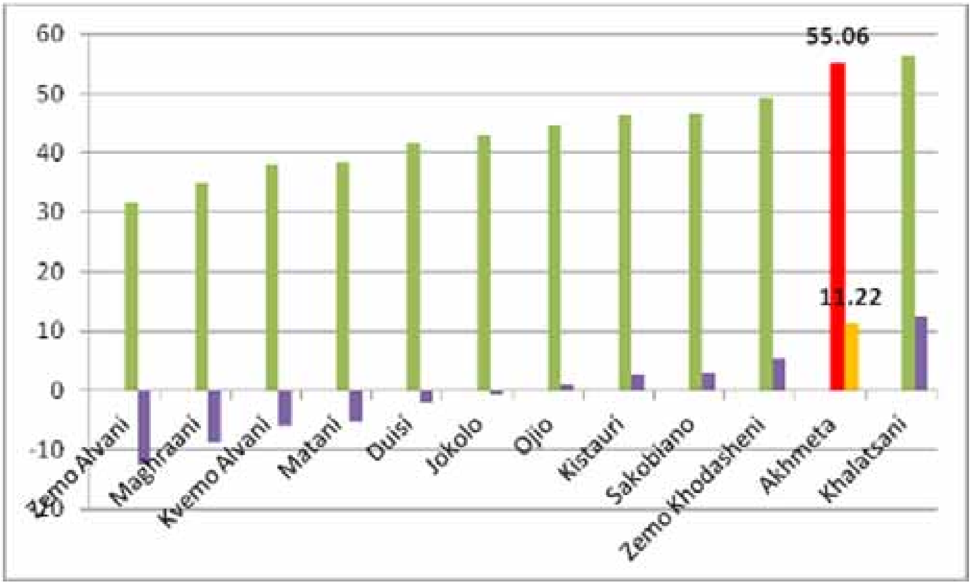
As a result of the field research, on the territory of Akhmeta town, various natural hazards were identified. Among them, the following should be mentioned:

- Floods;
- Mudflows;
- Washing of banks by rivers;
- A landslide process.

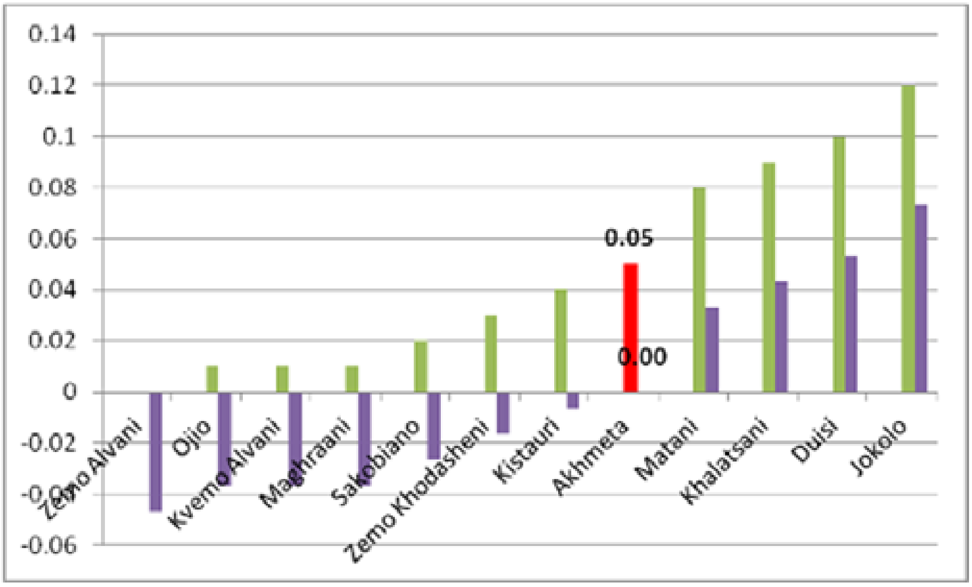
Based on the research conducted within the framework of the program, the vulnerability of Akhmeta town (the town itself as well as villages subordinated to it) was assessed at 55.06 points, which is a rather high indicator on the scale of the municipality (the second highest one after Khalatsani community). The difference form the average municipal indicator is rather big and equals to 11.22 points (see the graph). Such a high

[3] No 36 resolution of the city council of Akhmeta municipality, of March 23, 2012 – "Approval of the statute of the managing board of Akhmeta municipality".

vulnerability is determined, first of all, by the disrupted public infrastructure of the villages of the community (not Akhmeta town itself), and by the lack of measures taken to protect the environment (especially regarding the forests), and a lesser capacity of the villages to respond to the negative consequences of possible natural disasters. In general, on the scale of the target area of the program, the vulnerability of t. Akhmeta community was assessed as a very high vulnerability (see the map – Assessment of the Vulnerability of Akhmeta Municipality).



The level of risk for t. Akhmeta community was assessed as 0.05, which is exactly equal to the average municipal indicator. On the scale of the target area of the program, the level of risk of t. Akhmeta was assessed as an average level of risk (see the map – Assessment of the Disaster Risks of Akhmeta Municipality).



A detailed description of Akhmeta's town situation in terms of natural hazards follows:

The Village of Tchartala

The village of Tchartala occupies the upper part of the Ilto River drainage basin. The main problem for the village are the ***mudflow*** streams that developed on the Ilto River, as well as river erosion processes.

On the territory of the village, in the zone of erosive washing, flood and mudflow hazards, engineering and industrial constructions are located on the right bank. Furthermore, the head construction of the drinking water supply system for Akhmeta town is being damaged.

Furthermore, a principal bridge on the Ilto River at the entrance of the village was destroyed – the Ilto River has taken away its support completely and thereby destroyed it.

It is noteworthy that this bridge still exists on the 2006 satellite image.

The Village of Shakhvetila

The main problem in the village is a ***landslide*** process developed on the western territory of the village, adjacent to the village cemetery. As a result of this process, the houses of the population (almost 15 households) and their crofts (approximately 15 ha) are endangered.

It is noteworthy that there, on a southern slope of the Caucasus, landslides of seismotectonic genesis developed in rocks of flysch and terrigenous-metamorphic formation are among important sources that feed the high density mudflow streams.

Also ***floods*** developed on the Ilto River present a problem for the village. In the center of the village, during floods, the crofts and agricultural lands (approximately 8 ha in total) of 8 households are being damaged. Power transmission masts are endangered too.

The Village of Naduknari

The main problem for the village of Nadukrebi is connected with the Ilto River. During ***floods*** the Ilto River overflows its banks and damages the central pipe of the Akhmeta town water supply system. Also as a result of the floods, the Ilto River damaged (uprooted) the power transmission masts. During the field research, these masts were not yet restored, and therefore, the village of Tchartala was not being supplied with power.

The Village of Vedzebi

In the village of Vedzebi, an important problem is caused by a ***landslide*** process. The village itself is not endangered, but a nearby segment of the 300 mm central pipeline of Tianeti-Akhmeta. There a 1.8 km segment of the pipeline terrace runs on a landslide-affected territory, which englobes entirely the left slope of the Aniskhevi River, from its crown to the riverbed. The surface of the territory is a block-step type, divided into stable and unstable areas by the geodynamics. Practically, the pipeline terrace runs through a landslide area with very difficult engineering-geological conditions. At present, in unstable areas, a secondary generation regression landslide process is underway, in result of which the pipeline is hanging in the air at 4 different locations. The described territory is characterized with extremely complex engineering and geological conditions.

It should be mentioned that, during the field research, the population didn't indicated the mentioned problem. This is easily explained by the fact that the landslide body is not in immediate contact with the population and does not pose any direct hazards to them.

The Village of Chachkhriala

The problems facing this villages are linked to the erosive action of the Ilto River, visible through the intensive washing of banks existing in the village. As a result, the river has taken away approximately 5-6 ha of the village pasture. There is a high risk of process intensification and more areas being damaged.

Town Akhmeta

Within the boundaries of Akhmeta town and lower along the river course, the gorge of the Alazani River has an open shape. The river has developed high bilateral floodplain terraces, which rise above the watercourse at 0.5-0.8 m. The width of the terraces, below the bridge of Akhmeta-Alvani motor road, reaches 200 meters at the left and varies from 30 to 100 meters at the right. The width of the floodplain and the riverbed is 40-150 meters. The river branches out and surrounds islands of 80-150 meters in length and 10-50 meters in width.

The river washes intensively the right bank. The bank is washed along a segment of 500-600 meters and the shore protective gabions are partly damaged. Arable lands and a high voltage mast are endangered.

The Ilto River Gorge. Akhmeta-Sabue-Naduknari-Tchartala Motor Road

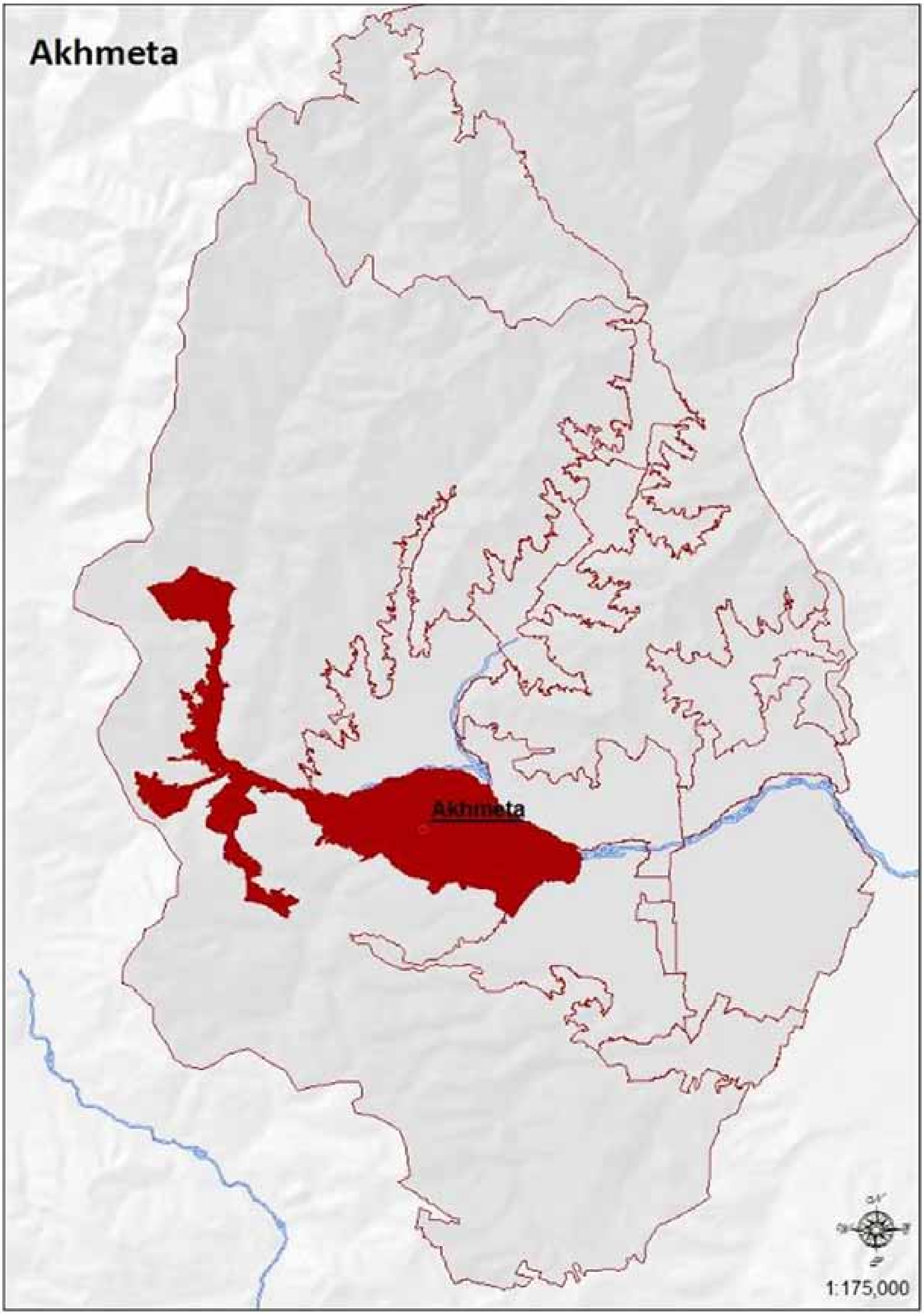
A problem connected with the Ilto Gorge motor road (the only motor road in the gorge) is so important in its scale that we judged it appropriate to discuss the issue in a separate section. At the same time, spacially, events developed there are not connected with any particular village. Their geographic location is rather connected with the aforementioned road.

The Ilto River washes intensively its right bank on the segments near Akhmeta town and near the villages of Sabue, Naduknari, Shakhvetila, and Tchartali. On these segments, the old road connecting the settlements and passing on the first terrace above the floodplain is totally unusable. The head construction of the water supply system of Akhmeta town, the central pipeline of the water supply system passing through the floodplain and the riverbed and the high voltage transmission masts are in a high-risk zone. Specialists of the National Environmental Agency have developed recommendations for protecting the territory. Based on these recommendations, shore protective measures were implemented on the territory nearby the timber factory, in the western part of the village of Chachkhriala. On the territory nearby the village of Naduknari, the stream-directing gabion protecting the head construction of the water supply system of Akhmeta town was restored. A similar gabion is installed on the southern periphery of the village of Tchartali, at 1.2-1.3 km distance from the main settlement. According to the data of the Agency, floods and mudflows occur several times per year on the Ilto River. Its maximum level exceeds the background level by 1.2 m. Under these conditions, the protecting constructions will mitigate bank washing, but will not be sufficient however to entirely stop the process.

An analogous process is underway at the village of Shakhvetila, where a 250 m segment of Sabue-Tchartala motor road is being washed. An even worse situation is created along a segment of the Shakhvetila-Tchartali road, where the road is narrowed, on the one hand, by a groove of a 10 m high terrace above the floodplain and, on the other had, by a gravitational slope reinforced with a protective wall. Because of bank washing, part of the road is washed away. Although it was possible to move the road on the segment of Sabue, Nadiknari and Shakhvetila, this is practically impossible on this segment. In future, motor vehicle communication may be disrupted between the villages.

Close to the village of Naduknari, the motor road runs on a soil dump. On this segment, the Ilto River flows at the extreme right side. The dump is easily washed even when the streams are small. The road is at 3 m above the riverbed. On the washed segment, along 200 meters, asphalt is ruined and the road is narrowed by 2-2.5 meters.

Near the dam on the Ilto River, the construction of a shore protective gabion for the right bank was underway in August of 2010; according to the conclusion of specialists from the National Environmental Agency, however, these measures are not enough to fully resolve the problem on this segment. Shore protective and stream directing gabions should be installed along the whole length of the right bank of the Ilto River up to the settled areas.


Akhmeta
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2.1.3.13. Kasritskhali Community

Akhmeta municipality also includes Kasritskhali community, although it is quite far away from the main part of Akhmeta municipality and is geographically located in the extreme southeastern municipality of Georgia – Dedoplistskaro . However, as was mentioned, administratively it belongs to Akhmeta municipality.

Dedoplistskaro municipality also belongs to the drainage basin of the Alazani River, but occupies its lower course. As a part of the Alazani drainage basin, Dedoplitskharo municipality is also a target municipality for the INRMW program.

In view of the goals of the program, which attribute the principal importance to the distribution of target municipalities in river basisn, we considered it reasonable to discuss Kasristskali community in the report reflecting the situation in the lower course of Riv. Alazani – in Dedoplistskaro municipality in particular. This approach is justified also by the fact that the natural conditions of Kasristskali community (which influence the nature of the hazards), to a certain extent the socio-economic status of the population (which is the decisive factor in vulnerability assessment) are more similar to its bordering territories, than to the territories of Akhmeta municipality, which are located in the upper course of the same river and are rather remote. In accordance with the goals of this research, these factors arem more decisive than the administrative status of a territory. Furthermore, it should also be taken into account that Dedoplistskaro municipality, as a target region of the program, will be assessed independently.

Based on the abovementioned, Kasritskhali community was not studied within the framework of the present report.

2.1.4 Conclusions

A summarized image of the hazardous natural processes observed on Akhmeta Municipality territory can be seen in table 2.1, which gives general information about hazardous natural processes in the communities of the municipality.

Table 2.1.1. A summary of natural hazards detected in the territory of Akhmeta Municipality

Community		Hazardous Natural Processes			
		Floods	Mudflow	Wash of Banks	Landslide
1	Jokolo		+	+	
2	Khalatsani	+		+	+
3	Duisi	+		+	
4	Sakobiano	+		+	+
5	Matani	+		+	
6	Maghraani	+			
7	Zemo Alvani				
8	Kvemo Alvani	+		+	
9	Zemo Khodasheni	+	+	+	
10	Ozhio	+		+	
11	Kistauri	+	+		
12	Akhmeta City	+	+	+	+

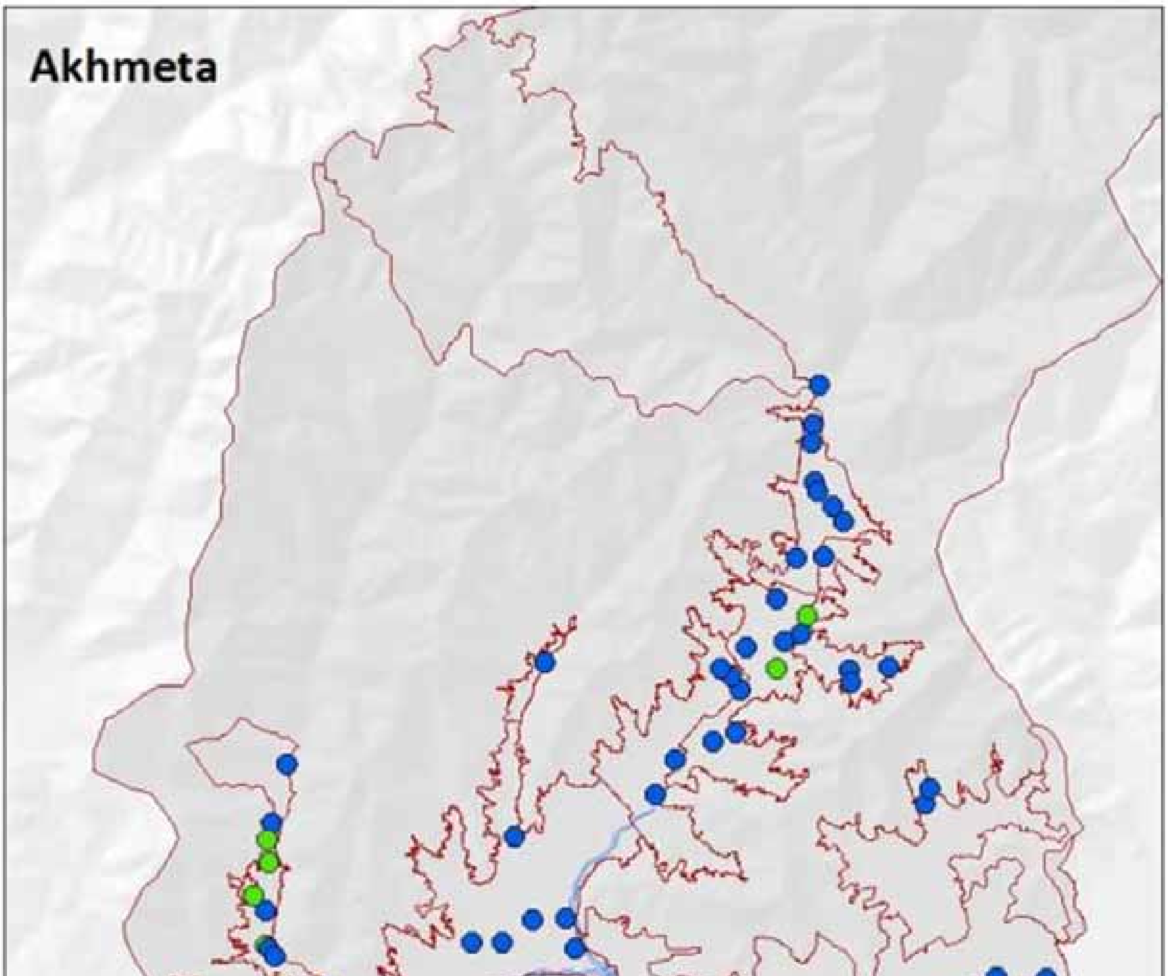
As the table clearly shows the main problems in Akhmeta Municipality are floods and river erosion processes, revealed in an intensive washing of the banks. The mentioned problem is observed in every community of the municipality. Here it should also be mentioned that in the communities where the flood problem is observed, mudflows are also observed (mudflows occur on the majority of the municipality rivers), though in a relatively small scale. In the summarizing table, only the main problems are represented. In the communities where the problem of mudflows is observed, the scale of the process is quite large.

The town of Akhmeta and villages subordinated to it distinguish themsleves by the variety of hazardous natural processes observed. As for Zemo Alvani territory, hazardous natural processes were observed neither during the field research nor through other sources of information. As for other communities of the municipality, 2-3 hazardous natural processes are observed[4].

The data on hazardous natural processes obtained through field research are given in Map 2.1. The green points indicate landslide processes, the blue and brown points indicate floods/washing of banks and mudflows.

[4] In this case the capacity of the hazardous process is not considered. The table gives an image about existence of a certain process only, which was observed during the field research in the program framework, or through other sources.

Map 2.1.1. Natural Hazards Detected on the Territory of Akhmeta Municipality in Result of Field Research



Through the map analysis, one can conclude that the spreading of hazardous processes on the municipality territory is mainly connected to the Alazani river and the Ilto river. Places situated in the river ravines, especially in the upper flow of the basins have the most problematic location. The main problem is the washing of banks and floods.

It should be noted that a landslide process is also present in the upper flow of these rivers. The landslide is one of the causes of the mudflow and is a precondition for catastrophic natural hazards.

Here, it should also be noted that Akhmeta Municipality itself is located on the upper flow of the Alazani river basin. Therefore, the processes observed here appear more frequently in the lower flows of the Alazani river, outside the municipality area, than directly on Akhmeta territory.

The fact that the mudflow processes are characteristic of the riviers of the Gombori range northern slope is also evident.

The data obtained through the field research was synthesised with information from other sources and with the results of the GIS analysis of a map of the possible distribution of the natural hazards in Akhmeta Municipality (see map 2.2 – Possibility of natural hazard distribution in Akhmeta Municipality).

An assessment of the municipality communities' vulnerability was also undertaken, for which different social-economic parameters were taken into account as well as the natural hazards existing in the villages. The results of the assessment can be found in the map 2.3 Vulnerability of Akhmeta Municipality Communities and in the table 2.2 Distribution of Akhmeta Municipality Communities according to the level of vulnerability.

The map and table analysis clearly show that the absolute majority of Akhmeta Municipality Communities belong to a medium or higher than medium vulnerability categories. The analysis of the vulnerability components showed that the main precondition for natural hazards and the main factors influencing the municipality's communities' vulnerability to climate change are a lack of social infrastructure in the communities (such as accessibility to healthcare and education as well as the possibility to purchase primary needs goods and security), complicated communications, and a hard ecomonic situation and low level of readiness for the possible catastrophes and climate change (lack of information and essential skills). The vulnerability index was also significantly affected by the indicator of the communications, economic means (lands) and number of people living in the hazardous zones.

Table 2.1.2. Distribution of the communities of Akhmeta Municipality by the level of vulnerability

Community		Vulnerability Level				
		Low	Lower than Medium	Medium	Higher than Medium	High
1	Jokolo			+		
2	Khalatsani					+
3	Duisi			+		
4	Sakobiano				+	
5	Matani			+		
6	Maghraani		+			

7	Zemo Alvani		+			
8	Kvemo Alvani			+		
9	Zemo Khodasheni				+	
10	Ozhio			+		
11	Kistauri				+	
12	Akhmeta City					+

The vulnerability assessment and the hazard assessment became a basis for the calculation of the municipality communities' risk level (see map 2.4 Risk of Akhmeta Municipality communities towards natural disasters). As we can conclude from the map, in comparison with other communities of the municipality, communities located on the Alazani upstream flow in the Ilto river ravine have a high risk level. Indeed, Jokolo, Khalatsani and Duisi communities have the highest risk level and are geographically located on the uppermost flow of the Alazani river basin. Matani and Akhmeta communities are also characterized by a relatively high index of risk (villages subordinate to Akhmeta city), that geographically comprise the Ilto river ravine – from the source to the confluence. Thus the processes in the river ravines quite strongly affect not only the municipality, but also the Alazani river basin in general. This assumption is a good basis for planning risk reduction activities. It is clear that when planning risk reduction activities, the improvement of the Alazani river and the Ilto river basin upper flow's condition should be taken into consideration (in terms of the sustainable management of resources). Taking into consideration the facts revealed by the research, the abovementioned will be a significant factor for the municipality risk reduction. The assessment of communities in accordance to the risks is given in table 2.3.

Table 2.1.3. Distribution of the communities of Akhmeta Municipality according to the level of risk

Community		Vulnerability Level				
		Low	Lower than Medium	Medium	Higher than Medium	High
1	Jokolo				+	
2	Khalatsani				+	
3	Duisi				+	
4	Sakobiano	+				
5	Matani			+		
6	Maghraani	+				
7	Zemo Alvani	+				
8	Kvemo Alvani	+				
9	Zemo Khodasheni		+			
10	Ozhio	+				

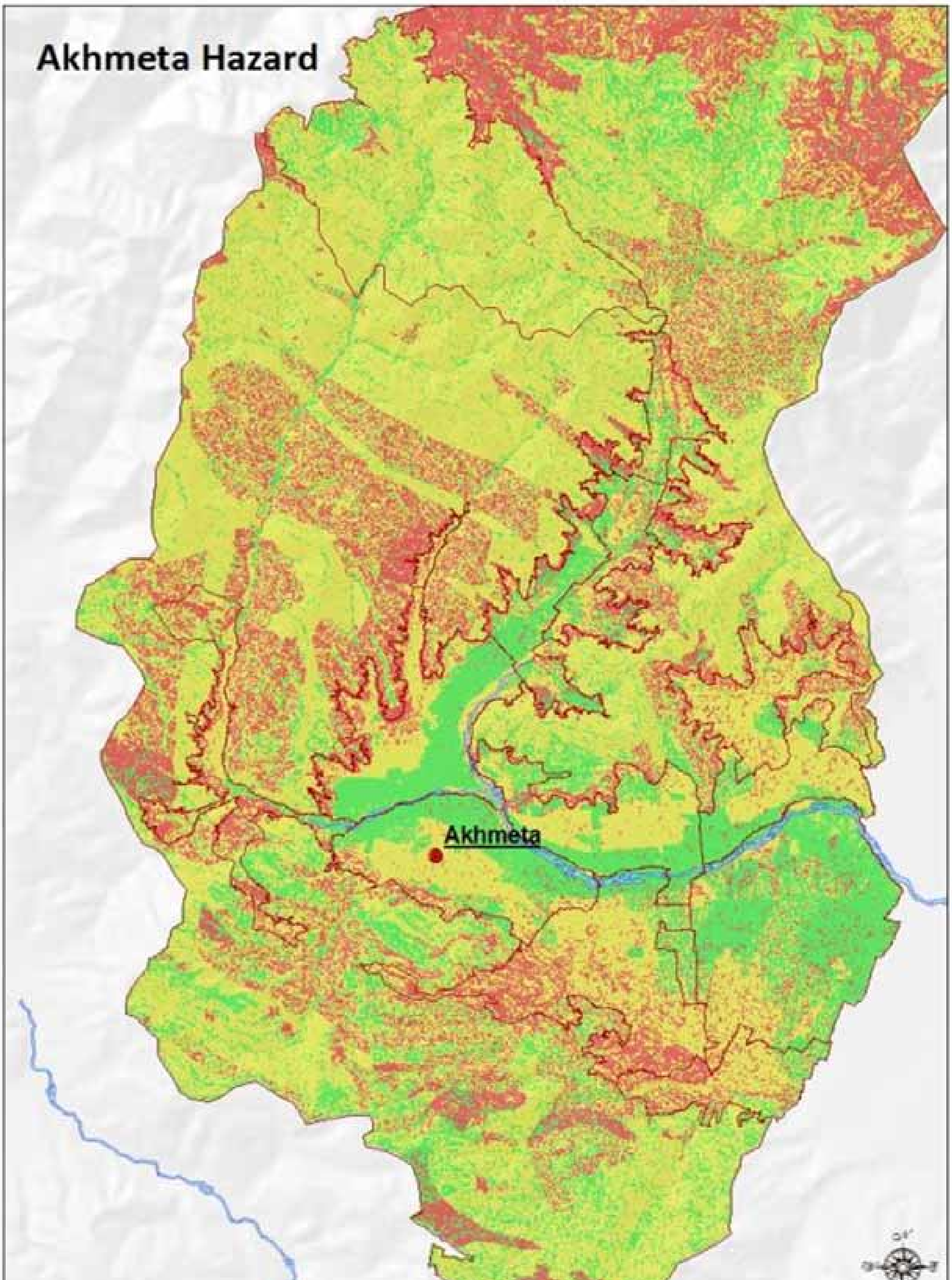
11	Kistauri		+			
12	Akhmeta City			+		

Based on the table we can note that the risk level for the majority of Akhmeta communities is close to the average. Thus the risk level for the whole municipality can be assessed as medium level risk towards regarding natural disasters and climate change.

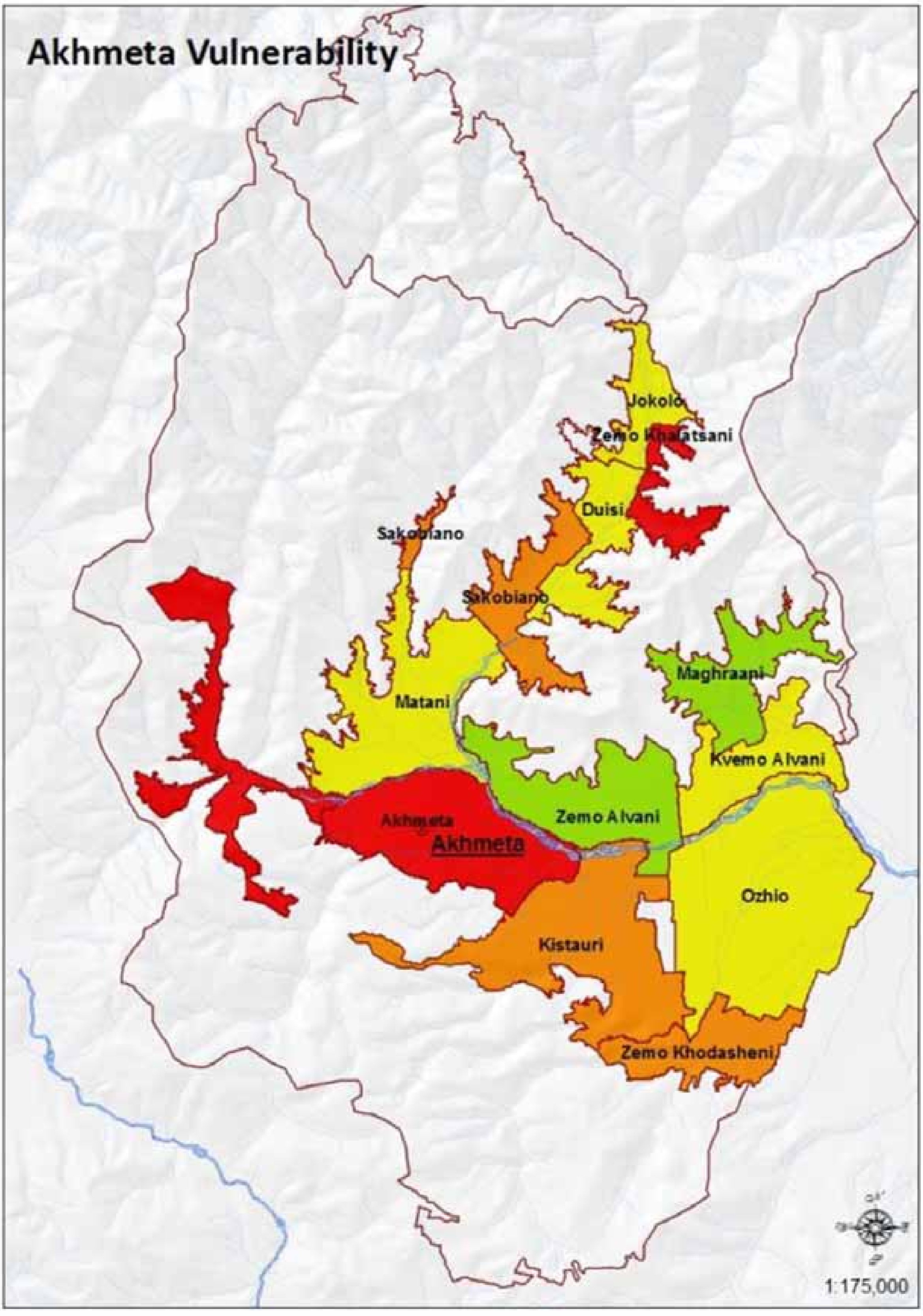
Here it should also be noted that when analyzing the hazard profile of the municipality, as we have seen above, the main hazard the municipality population faces is connected to the floods and mudflow processes in the river ravines. According to the analysis of the climate change scenarios developed for Akhmeta Municipality (Cahpter – 1.2 Climate) we find that the activation of mudflow processes and floods is expected in the municipality. It is also important to note cases of annual precipitation exceeding the annual average by 200 mm or more.This is a criterium for landslide processes and according to the scenario there ,two more cases of landslide activation processes can be assumed and will be reflected in the activation of mudflow processes too.

Based on the abovemetioned we can conclude that, in the light of the communities' high vulnerability, the natural catastroph risk level of the municipality communities will increase in parallel to the increase of the scale of the hazards caused by the possible climate change. This will eventually be reflected in an amplification of the damages caused by the catastrophes.

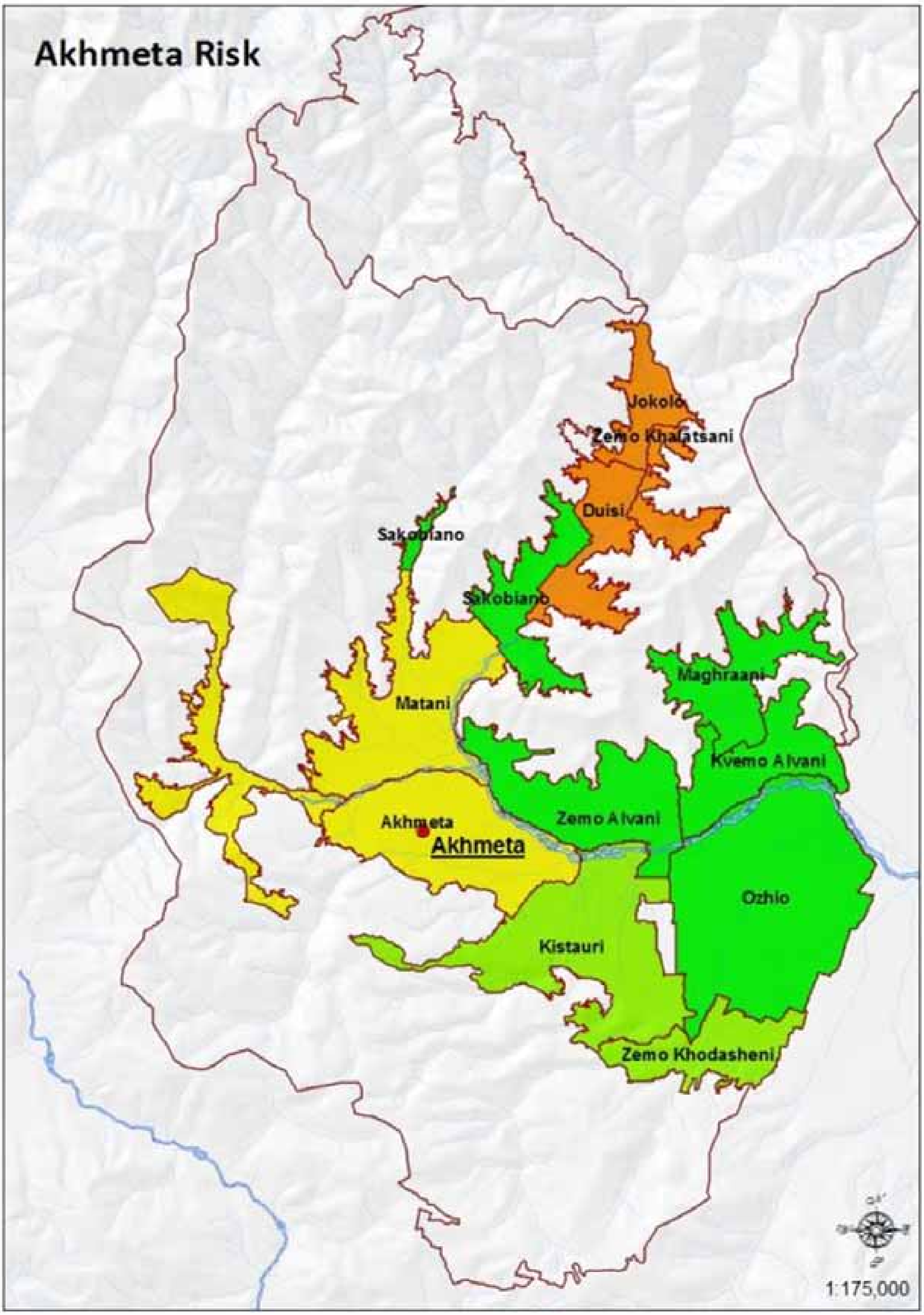
Map 2.1.2. Probability of Distribution of Natural Hazards in Akhmeta Municipality



Map 2.1.3. Vulnerability of the Communities of Akhmeta Municipality to Natural Disasters



Map 2.1.4. The Level of Risk of the Communities of Akhmeta Municipality to Natural Disasters



2.2 Telavi municipality

2.2.1 Expected re-activation of natural hazards

According to the meteorological changes detected through materials of 1956-2005, to the regional PRECIS and ECHAM4 models, and to the comparative data analysis of Scenarios A2 and B2 on world socio-economic developments, average annual terrestrial air temperature will increase by 2.5^{0}C in the territories of Telavi Municipality in the years 2020-2050. This parameter rises by 3.6^{0}C in winter. The average maximum will increase by +3-4^{0}C (in autumn and winter) as well. Likewise, the tendency is in agreement with temperature rise reported for all seasons during last 25 years. Both seasonal and annual average maximums increase. Average maximum rises especially in winter (4^{0}C), though in other seasons, as well as annually, this parameter increases by 1.6-2^{0}C. Both seasonal and annual average minimal temperatures increase by 1.5-2.5^{0}C. Therefore, compared to the observation period (1956-2005), all parameters of air temperature will significantly rise in Telavi Municipality. Consequently, drought risks of various intensity and duration will increase as well.

According to both scenarios, total annual precipitation increases by 8%, 9%. A rise of total summer precipitation by 22% and 15% is the most considerable (B2 and A2 Scenareios). Maximal value of daily precipitation increases in spring by only 11%. The most significant decrease of this parameter is anticipated in summer (approximately 50%). Annual precipitation maximum continues to change as well. Daily precipitation maximum lowers too. Daily precipitation maximum, compared to the observed perios, decreases in all seasons except spring. Average values of daily precipitation maximum will be subject to decrease in the period 2020-2050. This parameter minimizes in the summer most acutely (40%). Annually, a decrease in this parameter will reach 30%. Together with the abovementioned anticipations, the number of days with 10mm daily precipitation will increase, while daily precipitation maximum and a number of days with 20 mm daily precipitation will decrease. Occurrence of daily precipitation reaching 50 mm and 90 mm is not expected. If total annual precipitation exceeds 200 mm or more (a criterion of landslide hazards) the number of landslides will increase by two cases.

The consequence of the aforementioned informationfor the years 2020-2050, following the current climate changes (1956-2005 occurrences), are that the risk of mudflow hazards will be steady, though the risk of landslides will increase.

Regarding the current climate changes, intensive development of mudflow processes is observed on the south-west slopes of the Great Caucasus Dividing Range, on the slopes of Nakerala, Sajikhve-Gorgial, Andarazani and Kakheti sub-ranges and Gombori range, as well as in the erosive-accumulative gorges of the rivers - Stori, Didkhevi, Lopota and their tributaries. The result of strong anthropological degradation of forests (started and continued since the mid 19th century), these gorges and mountain slopes became powerful debris sources. During showers, mudflows bring a considerable volume of sandstone and stonemud flows to the slightly inclined and plain of Stori, Lopota, Turdo, Kisiskhevi, Vantkhvei River gorges and damage populated areas and agricultural lands. Demonstrative examples for the abovementioned processes are Turdo and Lopota River gorges, whose channels, immediately after leaving the main watershed area, are filled with alluvian-prolluvian materials. The gorges are elevated from their adjacent territories by 0.5 m in similar morphodynamic conditions and during intense showers, mudflow streams flow out of the river channels, flood the adjacent territories and threaten the neighboring villages, private crofts and agricultural lands.

During the observation period a number of rivers adjacent areas across the municipality, after having been flooded and fleshed, developed intensive erosions and inundations (that were hazardous for inhabited villages and agricultural lands). Namely, significant impacts of mudflow processes and heavy floods were observed in:

the Stori River gorge – near Laliskhuri village, where the Stori River from the left bank gets tributary from a nameless ravine. During heavy showers this gorge gets a stony debris flow that damages agricultural lands and a 1 km section of a local road. Also, the washing of a 500-meter section of a road on the bank of Didkhevi River should be noted. As a result of the abovementioned washing, the surrounding vineyards, as well as some crofts, were damaged. Because of the intense erosive effects of the Lopota River, its right bank and the adjacent territories of Saniore village are washed, which appears to be a high risk hazard zone for population's households and residences. Agricultural Lands, crofts and residential buildings of the population of Lapankhura Village are subject to the intense erosive effects of the Lopota River.

The Namaskhrala River ravine also features debris flows. A canal of the mentioned ravine is filled and blocked with debris materials, this causes the river to overflow and menaces the agricultural lands, threatening flooding.

Debris flows of Telavi Ravine crossing the city of Telavi are worth of special attention as its occasional passage often damages the city.

While observing the municipality territory, in terms of landslide processes revealed, the Vantkhevis river slope on the left upper side of the basin must be discussed. In this part of the basin a 1 km long and 300-400 m wide landslide zone is in active development and when intensified blocks the river channel. As usual, it results in a temporary reservoir formation. Intensive development of landslide processes is also characteristic on the right slope of the Turdo River gorge, near the Tetrtsqlebi village areas (56 km of the Gombori-Telavi road), that block the river channel and threaten the main water pipe and separate road districts of Telavi.

Anthropogenic pressure on municipality ecosystems, especially in forest cover is expected to increase in the future. As it is known, forest cover is very important for the regulation of surface water drainage. Deforestation, in terms of significant an increase in atmospheric precipitation will further enhance the intensity of these natural processes and compound the risks and hazards. Most of all, mudflows, floods and landslide hazards and risks appear to be enhanced in these areas, which during the observation period (1956-2006) and earlier were subjected to the destructive impacts of these natural processes.

Within Telavi Municipality boundaries an upward trend of above listed natural processes and an increase in the anthropogenic pressure factor will definitely contribute to an increase in degradation and the erosion of adjacent areas of the river channel. It will also harm the neighbouring forests and the soil developed under them; to the detriment of various agricultural lands, and in some cases, to their total destruction. The breakdown and failure of engineering and public utility buildings, roads and other communications will be another consequence. All of this will damage the economy and agriculture in Telavi municipality.

2.2.1 Problems Related to Expected Climate Changes in 2020-2050

According to the projected climate scenarios within the Telavi district boundaries, in the 2020-2050 years of the observation period, a high risk of mudflows, flood and freshet hazards will be maintained, though landslide processes will become more active. It is noteworthy that the spontaneous activation of natural processes (along with climate changes, mainly an increase in the total atmospheric precipitations) will be triggered by the relief having a high energy potential (deeply and intensely fragmented, and inclined slopes are steep, terrain surface consisting of rocks - mostly variously depleted, slightly concreted slope sediments) and damage to economic activities.

Generally, in the Municipality of Telavi vulnerability of the infrastructural facilities and of ecosystems to future climate changes in will depend on changes to the mean values of meteorological elements, as well as on the strength of extreme events and their repetition frequency. Furthermore, it should be noted that the identification of the dynamics of extreme meteorological elements is hardly predictable. However, the development of natural hazardous processes depends on the occurrence of extreme natural events.

According to the projected climate scenarios, below are discussed major problems generated by the anticipated changes of meteorological elements across Telavi Municipality.

2.2.1.1 Floods and Washing of Banks

In 2020-2050 in the basins of the Alazani river and its tributaries (Stori, Lopota and Turdo) if having into account the minor changes in total annual and summer atmospheric precipitation and in the result of massive flood and freshet discharges passing from Akhmeta Municipality (as forecasted, in its jurisdictional boundaries in 2020-2050 the total annual and seasonal atmospheric precipitation will increase nearly by 50%) through Telavi Municipality – probable flood intensification and enhancement and subsequent increase of risks of the river area flooding and erosion are anticipated.

2.2.1.2 Mudflows

In 2020-2050 (compared to the baseline period) an increase in total annual atmospheric precipitation, a maximum spring precipitation increase of 11%, multiplication of rainy days with more than 10 mm (even if a number of days with more than 20 mm and 50 mm will modestly decrease), the high risk of mudflow processes characteristic of the 1956-2005 period will be sustained; or popssibly enhanced depending on the possible increase of pressuring anthropogenic factors. In debris filled ravines, the accumulation of alluvial-prolluvial sediments, and sharp decline in their capacity to pass mudflows, indicate that debris will overflow to surrounding areas. Intensive surface erosion of ravines and their cover by debris is also expected.

2.2.1.3 Landslide Processes

Compared to the baseline period, 2020-2050 is expected to see total annual atmospheric precipitations increase by 8-9% and total annual rainfall exceed 200 mm. Because of sedimentary distribution areas being less resistant to erosion and denudation processes on the slopes of the Alazani Valley and its tributaries (Turdo, Vantkhevi and otehrs), and in the context of intense deforestation, frequent and extensive rains, and periodically exposed earthquakes, the activation of creeping or block landslides with a range of depths, as well as new landslide formations are projected.

2.2.1.4 Droughts

According to the projected climate scenarios, the period 2020-2050, in terms of the partial Increase of atmospheric precipitations (compared to the baseline period), is expected to see a slight decline in drought occurrence with a changes to their duration and intensity. However, under the conditions of a relatively dry climate in the past, agricultural lands, gardens and vineyards on the plains and their surrounding undulating areas, located within the boundaries of Telavi municipality, always required irrigation. As already mentioned, according to the climate scenarios the municipality territories are projected to get a partially increased volume of atmospheric precipitation. Nevertheless, a significant increase in annual and seasonal values of air temperature is rather noteworthy. Therefore, irrigation of agricultural lands will still be of crucial importance.

2.2.1.5 Forests

According to the climate scenarios, an increase in average annual air temperature by 2.5^{0}C, and a 8-9% increase in annual total precipitation and under the conditions of slight decline in drought occurrences, the thermal and Mesophilic forests within the boundaries of Telavi municipality may become subject to partial xerophilization. This may lead to a reduction of Mesophilic forests distribution in the area. However, according to the same climate scenarios along with the projected rise of air temperature, the coming decades will feature an anticipated increase in total annual atmospheric precipitation. Therefore, it is expected that the municipality will maintain a favorable climate for the development of mountain forests.

2.2.1.6 Sub-alpine and Alpine Meadows

Within the boundaries of Telavi Municipality the sub-alpine and alpine meadows are widespread over 1900-2000 m above sea level (at the ridgeline of the Great Caucasus Dividing Range and Nakerala, Sajikhve-Girgala, Andarazani and Gombori Range slopes). First of all, it should be noted that the vast majority of the abovementioned areas are occupied by summer pastures. Generally, within the boundaries of Telavi Municipality, there have been no management plans for the summer and winter pastures implemented over the last three decades. Based on the survey findings, the municipality winter pastures are overused, with bovine animals in summer and with sheep flocks in winter. Part of this problem is related to the municipality's summer pastures, which are located on Kakheti, Sajikhve - Girgala, Sajikhvistavi, Andarazani, Nakerala and Gombori slopes of the ranges. Overgrazing of Pastures contributes to the enhancement of grass depletion, turf destruction, denudation of the soil surface, and consequently, the soil is easily subject to harmful effects of water and wind erosion. Furthermore, It should be noted that in recent years pasture weeds, non-edible for animals are multiplying, resulting in a decline of pasture productivity. A traditional system of usage and maintenance of the damaged pastures is observed. Pasture users demonstrate less responsibility for the negative consequences of unsystematic, unmethodical and uncontrolled use. Pasture and hayfield maintenance practices, due to negligence or lack of money, are almost completely forgotten by their owners.

2.2.1.7 Impact of Future Climate Conditions on the Health of the Population

It has been proved that global climate changes have significant impacts on human health.

During recent decades numerous studies have been conducted by various countries, authoritative international organizations and regional programs dedicated to the human body's sensitivity to climate changes and its impact on health.

Climate change does not cause any kind of direct impact on human health, but it can significantly aggravate the diseases sensitive to climate changes; for this reason it is important to ensure timely and effective interventions on global as well as regional and country levels.

In order to realistically assess the consequences of climate change and variability, we should understand what kind of sensitivity local residents have to new conditions and how adequately they can react. Connection among sensitivity, adaptation capability and potential consequences are defined by standardized schemes. Humans' health sensitivity to climate changes is determined by:

- Perception, which includes the degree of sensitivity of health, natural and social systems (which is important in terms of influence on the results of the human population health) to weather climate change, and moreover, the characteristics of the population, such as the level of development and demographic structure.
- Impacts of hazardous weather and climatic factors (climate-related variations, including their level and frequency).
- Measures and activities taken for adaptation, which aim to reduce the burden of having unreasonable and undesirable impacts on human health (initial level of adaptation) and the efficiency of which determines the attitude of "exposure - response".

The groups and subgroups of the population and systems that are not capable of adaptation are particularly susceptible. Those characterized by high perceptibility to weather and climate changes are also at risk. Overall, the population sensitivity to any kind of threats depends on local environment, the level of material resources and effective management (at both local and municipal levels), on quality of public health infrastructure and access to information.

For the purposes of this report rates of population morbidity (incidence) and prevalence, for both contagious and non-contagious diseases and the applicability to medical institutions were researched across Telavi municipality.

The health status of the population has been studied according to the various disease groups in the Municipality.

In order to study the structure of population morbidity and the trends of disease prevalence in Telavi Municipality, official statistical information on the spread of disease through the municipality, Kakheti region and all over Georgia in years 2000-2010 was examined. Rates of morbidity (incidence) and disease prevalence were analyzed to support the abovementioned study.

The total increase in morbidity and prevalence of diseases. The 2000-2010 trends in general morbidity and disease prevalence indices show that the growth trend in these indicators reached its peak in 2009. This was the case in Telavi Municipality, as well as in general indices of the country and the region. However, in all cases, the morbidity and prevalence indices reported in the municipality were significantly higher than the overall rates on the regional and country levels. This was mainly due to the high capacity of medical facilities in the municipality, and therefore due to their higher workload (at the expense of a neighboring municipality) and the municipality's performance as a regional health center.

Consequently, general increase in morbidity rates, caused by projected climate changes, may be reported in Telavi Municipality. This will become another pressure for big hospitals and require additional interventions.

Analysis of 10-year dynamics of **transmitted disease** data showed that the trend of growth in the incidence of this group of pathologies is significant in the municipality. In addition, the indices reported here are higher than the overall regional index; it exceeded the overall country index in 2009. In the same year, the prevalence of transmitted diseases in the region reached the peak levels of contrast. This process will be further strengthened as a result of climate change. Significant increases in the incidences will be mainly caused by acute respiratory infections and intestinal infections and will be mainly related to the deterioration of sanitary conditions.

It is noteworthy that the Telavi medical facilities (stationary treatment of infectious diseases for Kakheti region is processed only in Telavi) would bear a greater burden as prevalence of infectious diseases in the Kakheti region grows in the population of neighbouring areas.

The analysis of incidences in 2000-2010 caused by **Endocrine system diseases** indicates that the rate of the endocrine system diseases was significantly lower in the municipality compared to the regional and country rates. In addition, growth in trends indicating the prevalence of the disease is not observed. Diabetes prevalence levels are low; indicating that in terms of expected climate changes the growth of endocrine disease incidence will not be significantly different compared to the country indices and will not necessitate additional interventions in the region or planning of mitigation measures.

The analysis of incidences in 2000-2010 caused by **cardiovascular diseases** indicates that in Kakheti Region, as well as in Georgia the rate of the cardiovascular diseases has significantly grown. This particular growth is observed in the ischemic diseases of this group. Analysis of the 2000-2010 data allows us to consider that the incidence rate of this pathology was high in the municipality, but 2009 featured a decline in the prevalence of the disease. The decrease in prevalence should be related to the increase of capacity of the health services in neighboring municipalities, where opposing trends were observed. However, the increasing prevalence of pathology in Telavi municipality’s population prevail the respective indices of the total region. In addition, a significant growth trend is expressed in the incidence of arterial hypertension. This indicates that the local population is at risk of an increase in cardiovascular diseases, including ischemic heart disease and arterial hypertension. This is because global warming and related climate changes contribute to the exacerbation and complications of chronic diseases. Therefore, together with the growth of incidences of cardiovascular pathologies in the population the morbidity and mortality rates caused by the diseases related to cardiovascular complications (myocardial infarction, stroke) will increase as well.

The analysis of ten-year (2000-2010) dynamics of the **Respiratory disease** indicates that in the Telavi Municipality and Kakheti Region, as well as in Georgia overall, the rate of incidence is rising. The prevalence of this group of pathologies is significantly higher in the municipality. The same cannot be mentioned of asthma prevalence, because the indicators of incidences of this pathology, in most cases, are lower than the Kakheti regional indicators. Nevertheless, the influence of factors related to expected climate change will cause a growth in population morbidity inasmuch as the weather significantly impacts its the occurrence, distribution and seasonality of allergens. In addition, the concentration of pollutants (nitrogen oxides, ozone, CO gases, solid admixtures, etc.) continue to increase in the atmosphere. Greenhouse gas emissions have different scales of impacts on human health. Locally, those are solid admixtures emitted by transportation vehicles in the atmosphere which have adverse impacts on human health. On a regional scale – transmission of nitrogen and sulfur oxides causes acid rain. Globally a wide specter of factors harmful to human health related to the interaction between climate changes and environmental factors is generated. These factors have an immediate impact on and irritate the human respiratory system, cause allergic reactions (e.g. rhinitis) and acute bronchial asthma and in general aggravate the prevalence of respiratory diseases.

Analysis of ten-year trend data on ***Diseases of the digestive system*** showed an increasing trend in morbidity is caused by this group of pathologies in the municipality, and generally, in the region. This will become even more noticeable because of the expected effects of climate change, since the decrease of food supplies (for instance, lessening of harvest and livestock productivity) and reduced accessibility to food products results in malnutrition. This deficiency is directly related to the development of Diseases of the digestive system.

Analysis of ten-year trend data on ***injuries, poisoning, and accidents*** shows that in all cases the recorded indices in the municipality are higher than regional and national ones. This is mainly due to the urgent and serious nature of these pathologies and which are mostly covered by the regional medical facilities in the Telavi district, since the neighboring districts lack the capacity of the existing health services. In terms of the flooding caused by climate change, a significant increase in injuries is expected, which will be another pressure on Telavi municipality hospitals, and require the implementation of additional interventions to increase access to health services.

2.2.2 Assessment of Vulnerability and Disaster Risks by Communities

The present subchapter analyzes the results of field research conducted within the framework of the program ("Integrated Natural Resources Management in Watersheds (INRMW) of Georgia"), based on which, the vulnerability of municipal communities to climate change and natural disasters was determined. Communities risk to natural disasters was assessed in terms of size. On the basis of information presented in this section vulnerability, hazard and risk maps has been prepared.

Below we present a detailed description of the communities within the municipality, which is primarily based on analysis of field research data carried out by CENN in the framework of the program. In addition, data from the annual bulletin prepared by the National Environment Agency is used (materials of 2006, 2007, 2008, 2009, 2010 are used[5]).

2.2.2.1 Laliskuri Community

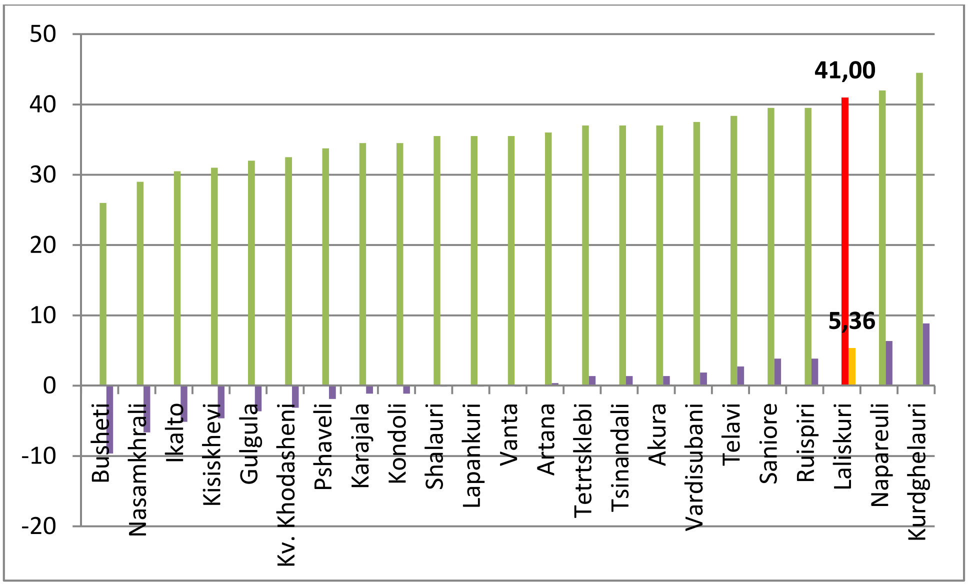
The Laliskuri community is located in the western part of Telavi Municipality, in the Stori River gorge. The community territory comprises the right bank of the Stori River and the left bank of the Alazani River. This territory also comprises the confluence of Stori and Alazani rivers. Therefore, Laliskuri community is the lower course of Stori River basin.

The Laliskuri community consists of only one village - the village of Laliskuri. The distance of the village from the municipal center is 32 km.

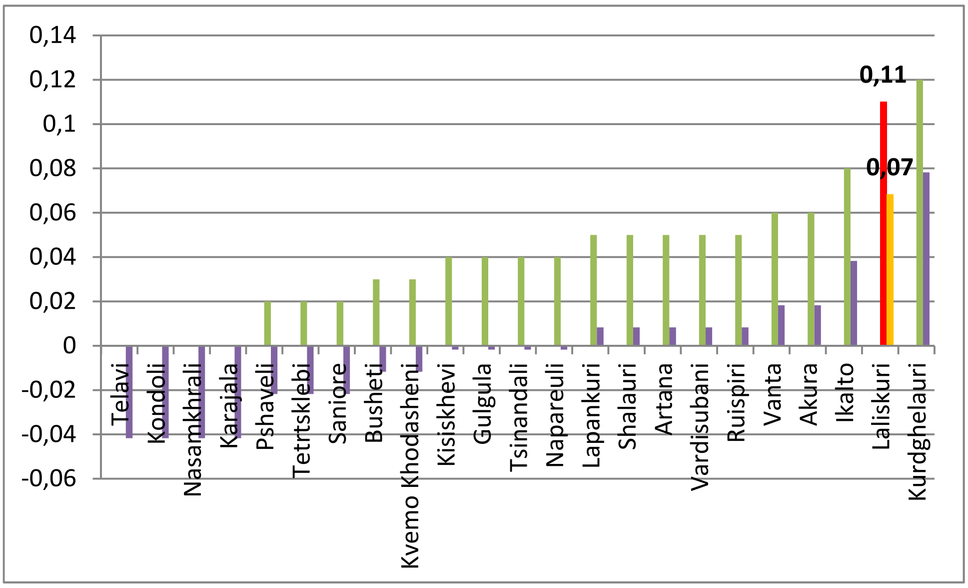
The field research has revealed that, from the perspective of hazardous natural events, the main problems for the community are connected with floods and debris effects occurring in Stori River basin. Landslide processes have also been observed in the community.

According to the research conducted within the framework of the program, the vulnerability of Laliskuri community was assessed at 41.00 points. This indicator significantly exceeds the average index of the municipality, which is 35.64 points for Telavi Municipality. The difference from the average is 5.36 points (see the diagram). On the scale of the target area of the program (target river basins) the vulnerability of the community was assessed as an average vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).

[5] Ministry of Environment Protection of Georgia. The National Environmental Agency. Department of Geological Hazards and Geological Environment Management. Division of engineer-geology and eco geology of hazardous processes. Information Bulletin – Results and forecasts of development of geological hazardous processes in Georgia.



The level of risk for the community is 0.08 points. This is one of the highest indicators within Telavi Municipality (the second after Kurdgelauri community). The difference from the average (0.04 points) is 0.07 (see the diagram). On the scale of the target scope of the program (target River basins) the risk level of the community was assessed as higher than the average (see the map – Assessment of Disaster Risks of Telavi Municipality).



Therefore, within the scope of Telavi municipality, the Laliskuri community can be assessed as one of the so-called “hot spot” with regards to the risk of disasters and climate changes.

A detailed picture of the situation in the village with respect to natural hazards is presented below:

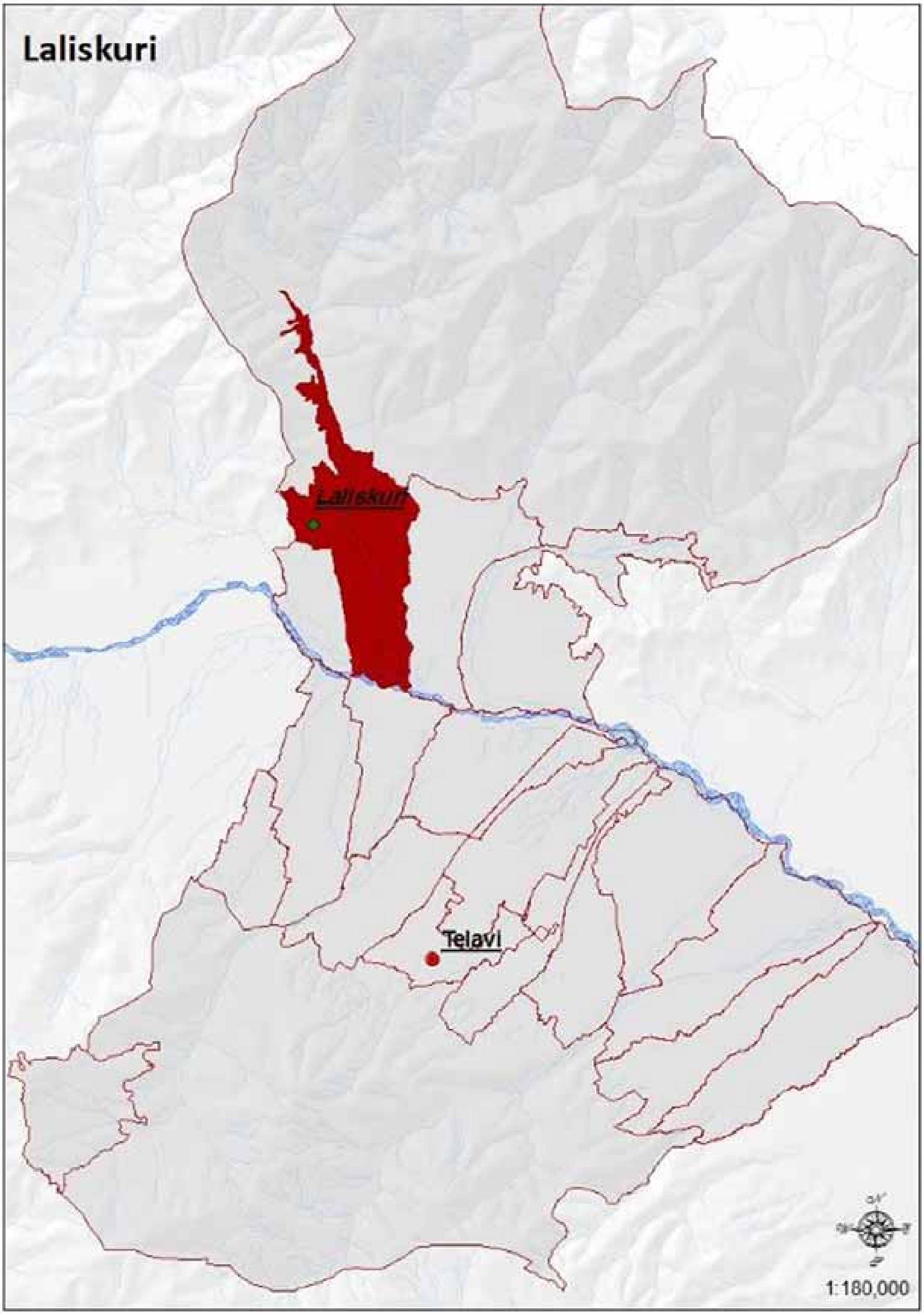
As was mentioned, the village is located in the lower course of Stori River gorge. The gorge is a “V” shape, the slope inclination is 20-35^0, covered by forests, and the surface is fractioned by numerous dry and slightly streamed ravines. The geological structure of the slope consists, in places, of the sediments of the middle Jurassic period, represented by the sandstones and clay-slates.

Near the village, on the left side, the Stori River is joined by the slightly streamed ravine; from time to time ***debris flows*** of stone mud form in the bed of the river. These mudflows damage a section of the road. As a result of mudflows a 1km section of road was covered in 2010 that stalled traffic. The nearby territory was completely flooded.

In the mentioned section the agricultural lands (about 50-80 ha), owned by the rural population, are also damaged, as well as the road to these lands, a nearby swine farm and high-voltage electrical transmission towers (some of them fell down).

In the northern part of the village ***floods,*** occurring in the Stori River, endanger the main body of drinkable water (watershed basin), as well as the water system pipes, which supply the village with drinking water. In the case of massive flooding, the vast majority of the rural population, as well as cultural objects located in the village, the church and Cholokashvili fortress fence will be endangered.

Landslide process is also a problem for the community. In the northern part of the village, the Stori village washes the right board and contributes to the development of coastal landslide. The process negatively affects about 400 meters of drinking water pipes.


Laliskuri
Laliskuri
Telavi
1:180,000

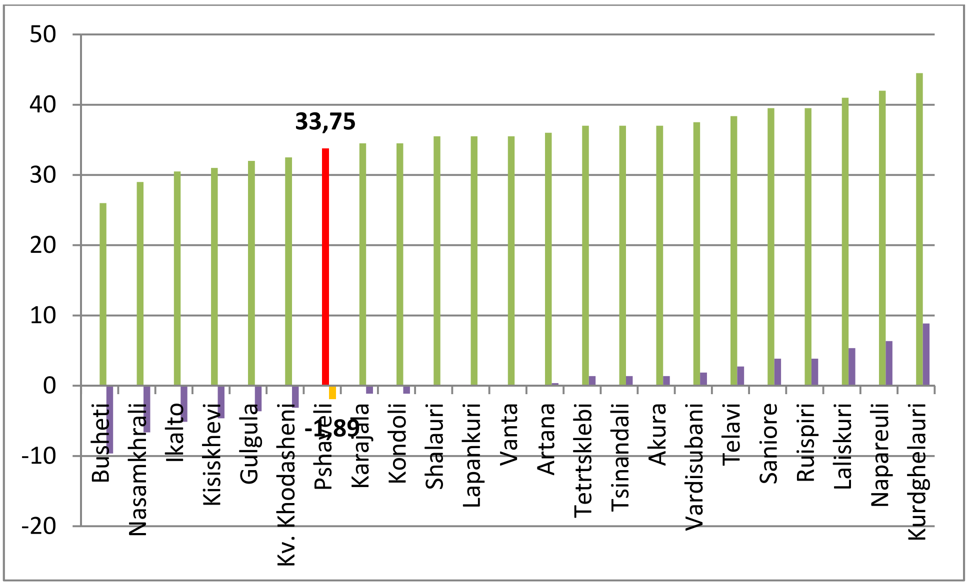
2.2.2.2 Pshaveli community

Pshaveli community is located in the western part of Telavi municipality in the ravine of the Stori River. This area covers almost the entire basin of the Stori River, except for its confluence with the Alazani River, where Laliskuri and Saniore communities are present.

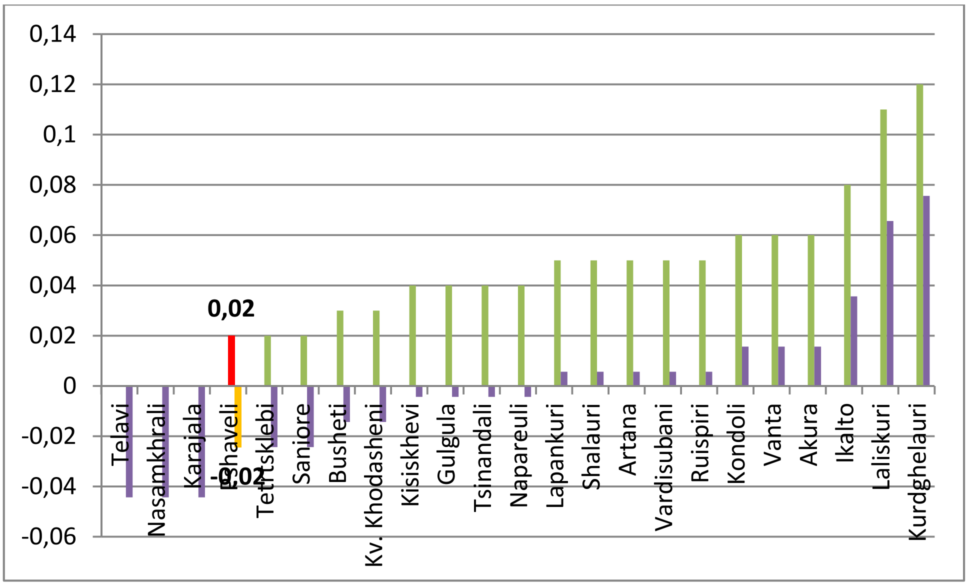
Pshaveli community combines two villages - Pshavela and Lechuri. The village Lechuri is located in the upper flow of the Stori River, while the village Pshaveli is located in the lower flow. The average distance between villages and the municipal center is 34 km.

The field research has revealed that a flooding problem is occurring only in the territory of the Pshaveli village. Moreover, it should be mentioned that according to the data of National Environmental Agency, no hazardous natural processes has been observed on the territory of Pshaveli community.

Within the research conducted within the framework of the program, the vulnerability of Pshaveli community was assessed at 33.74 points. This indicator is slightly lower that the average for Telavi Municipality which was assessed at 35.64 points. The difference from the average is -1.89 points (see the diagram). On the scale of the target region of the program the vulnerability of the community was assessed as lower than the average vulnerability (see the map – Assessment of the Vulnerability of Telavi Community).



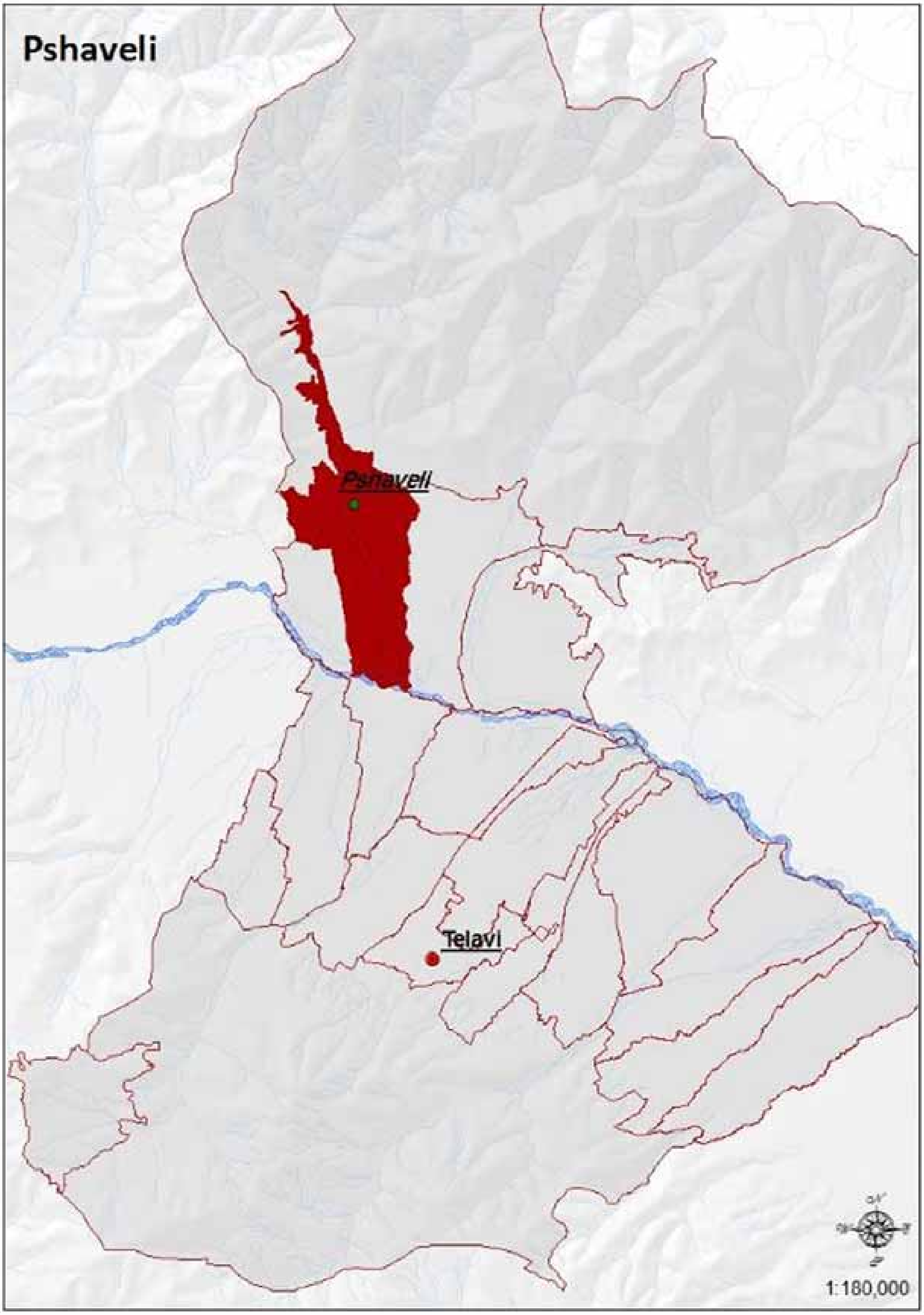
The level of risk for Pshaveli community is also one of the lowest within the municipality and comprises 0.02 points. The difference from the average is -0.02 (see the diagram). The reason for such a low index is the low level of vulnerability of the community on the one hand, and on the other hand, the lack of hazardous natural events on the territory of the community. On the scale of the target scope of the program (target river basins) the risk of Pshaveli community was assessed as lower than the average risk level (see the map – Assessment of Disaster Risks of Telavi Municipality).



A detailed picture of the situation in Pshaveli village, in respect to natural hazards, is presented below. (As mentioned above, the problem is observed only in the village of Pshaveli).

The main source of hazards in the village is the ravine of the Chichakvi River, located in the north-eastern part of the village. In spring, when intensive snowmelt and/or abundant sedimentation occur the river is ***floods***, and thus endangers the agricultural lands of the population and rural communications. 2 years ago the River damaged protective constructions and flooded the crofts and agricultural lands of the population. In total, about 100 households were endangered, crops were lost and there were cases of poultry death.

In spring, in the case of heavy rainfall a large-scale resurgence of the flood is expected.


Pshaveli
Pshaveli
Telavi
1:180,000

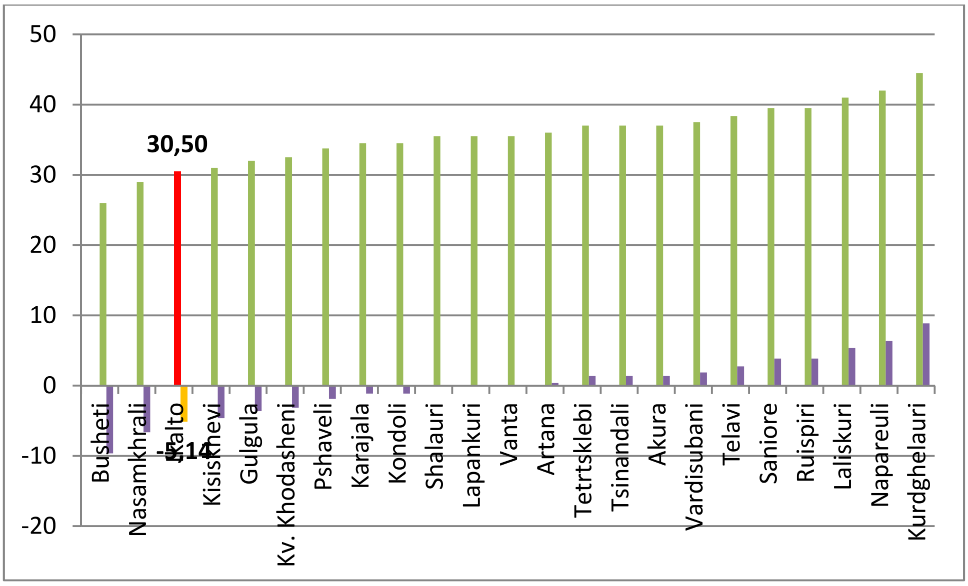
2.2.2.3 Ikalto Community

The Ikalto community is located in the western part of Telavi Municipality, bordering Akhmeta municipality. The main river of the community is Chumatkhevi River, on the right tributary of the Alazani River. The Ikalto community comprises the sources of the mentioned river and the upper part of its basin. The lower part of the basin and the nearby territory of Alazani River tributary is located within the borders of Ruispiri community.

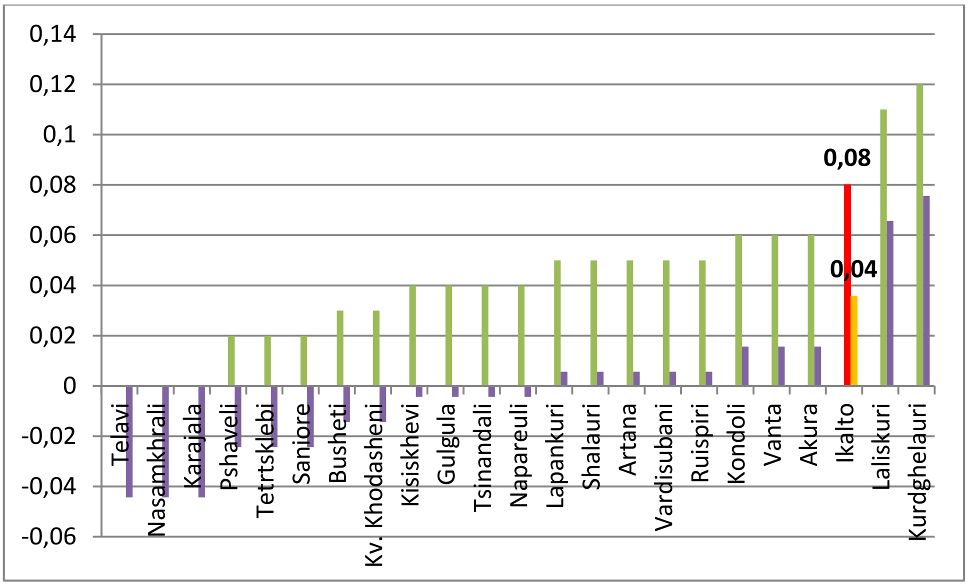
The community consists of only one village - the village of Ikalto. The distance of the village from the municipal center is 7 km.

The field research has revealed that, regarding hazardous natural events, the risk of floods and landslides have been observed.

In result of the research conducted within the framework of the program, the vulnerability of Ikalto community was assessed at 30.50 points, which is a low indicator within the Telavi Municipality borders. The difference from the average is -5.14 points. The low indicator is caused by the relatively good economic conditions of the community in comparison to the average in the municipality (mainly this is caused by tourisim potential in the community), the possibility to react to disasters and comperatively well regulated infrastructure. On the scale of the target area of the program (target river basins) the vulnerability of Ikalto community was assessed as below average (see the map – Assessment of the Vulnerability of Telavi Municipality).



According to the research, the level of risk for the Ikalto community is 0.08 points. This is one of the highest indicators within the Telavi Municipality. The difference from the average is 0.04 points. Such high level of risk, despite having a low level of vulnarability, was caused by relatively large scales of hazardous natural processes identified by the population in the territory of the community. In general, on the scale of the target program, the risk level of the community was assessed as average (see the map – Assessment of Disaster Risks of Telavi Municipality).



A detailed picture of the situation in the Ikalto community in respect of natural hazards is presented below:

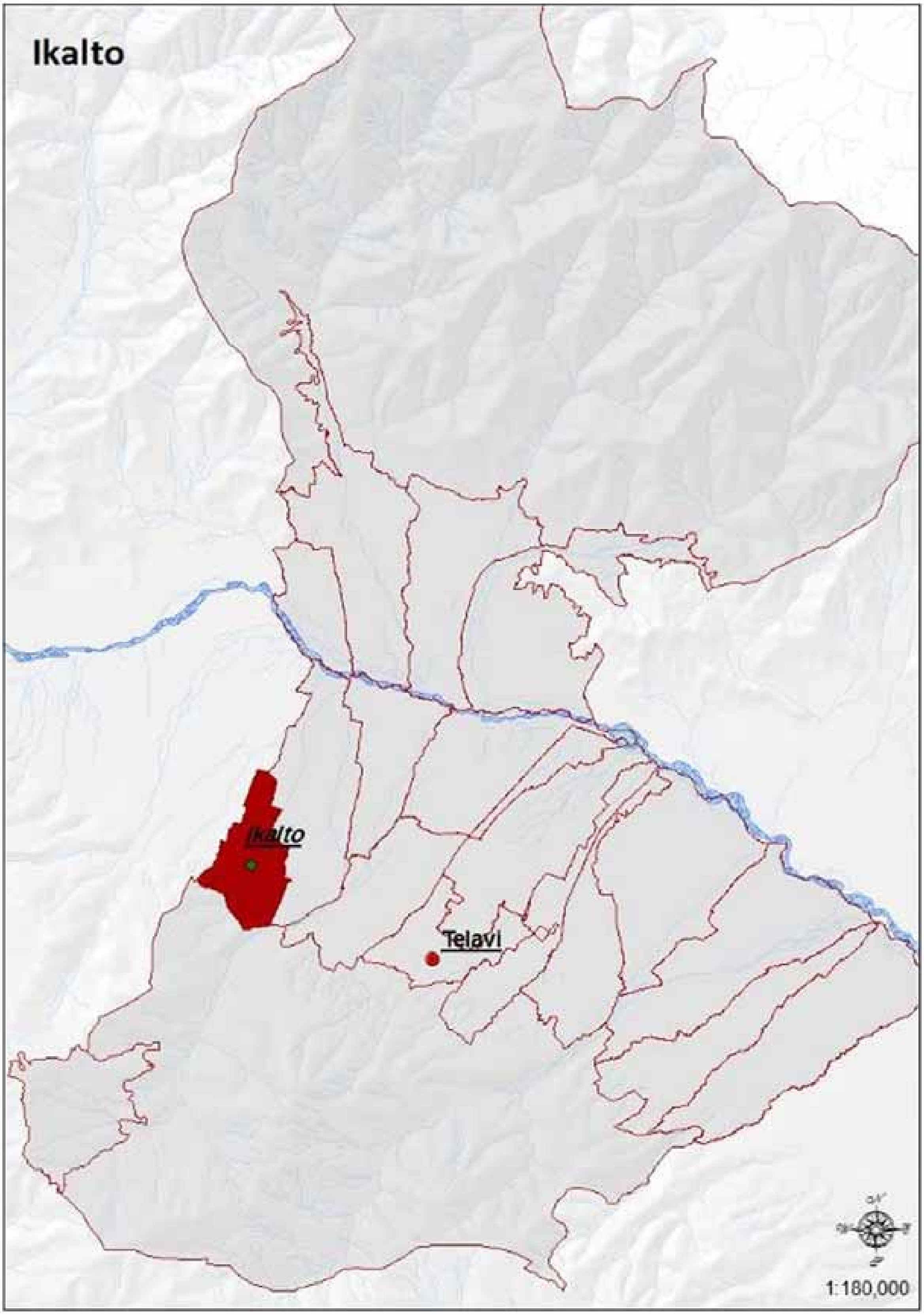
The main problem, with respect to hazardous natural processes, that Ikalto community faces is ***debris*** processes. The Chumatkhevi River (Ikalto ravine) that goes through the community is predisposed to mudflows. In spring, in case of extensive rainfall, the formation of mudflows is frequent in the ravine. Mudflows endanger the main building of drinkable water, electronic transformer, and electricity transmission towers. The bridge connecting the school with the village is damaged. In the lower part of the village mudflow coming from this ravine damages the inner communications of the village and the road to the agricultural lands. Agricultural lands of the rural population have been significantly damaged. The crofts and lands of 7 inhabitants have also been damaged (about 3 ha).

The boards of the mentioned ravine are unstable in the face of erosive-gravitational and erosive washing processes. Accordingly, the river washes the banks, damages the buildings located near the banks and threatens part of the village with floods. For example, in 2010 the lands of 25-30 households were flooded; the total volume of the agricultual lands that were damaged by the flood comprised more than 10 ha. Also, the local kindergarten also faces the possibility of flooding.

The so-called Taglauri ravine is also disposed to mudflows. The debris flows formed in the gorge damage the 300 meter section of the road connecting the village to the rural pastures and the cemetery. In addition, the main building of drinkable water and other lands located near the ravine (about 1.5 ha) are also endangered.

In addition to the natural conditions that facilitate the mudflow processes in case of Ikalto community, according to the population, the activiation of mudflow processes were enhanced by the recent intensive exploitation of forests in the territories surrounding the villages.

During the field research the ***landslide*** area was also observed in the Ikalto community. Landslides exist in the southern part of the village, on the road to Ikalto monastery. The process threatens the road (section of 100 m) and the croft land of an inhabitant living nearby. In case the proccess activates, the house of the inhabitant will be endangered as well.


Ikalto
Ikalto
Telavi
1:180,000

2.2.2.4 Tetri Tsklebi Community

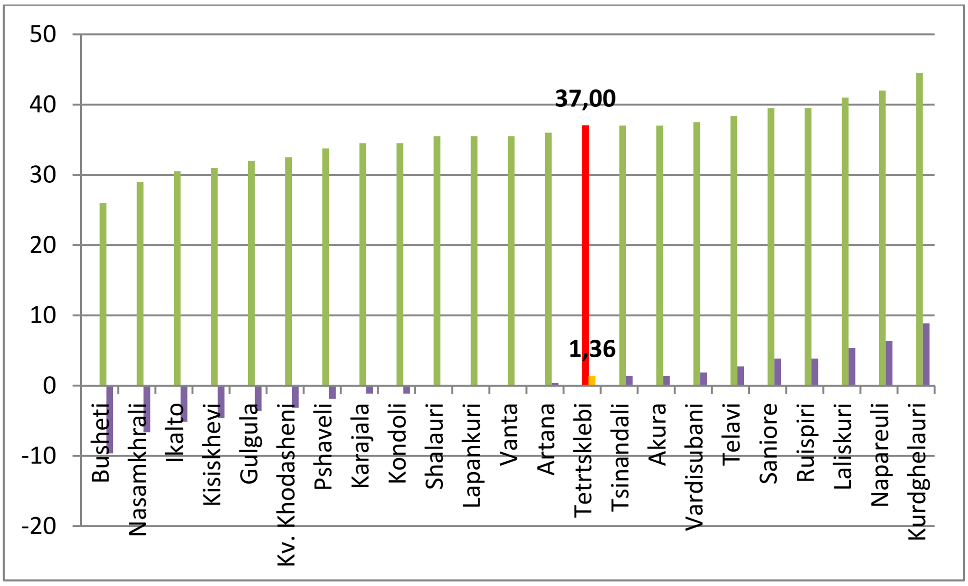
Tetri Tsklebi community is located in the southern part of Telavi municipality. The community territory comprises the northern slopes of Gombori mountain range. The community is crossed by the Tbilisi-Vazniani-Gombori-Telavi state road. Its territory also comprises the highest point of this road – Gombori pass (at an altitude of 1,620 m). It should be mentioned that the Tetri Tsklebi community is located quite far from the other communities of the municipality.

One of the main rivers of the municipality, the Turdo River, has its source in the territory of the community. Therefore, the community comprises the extreme upper stream of Turdo River basin. In addititon, the community territory is crossed by watercourses of small tributaries of the Turdo River.

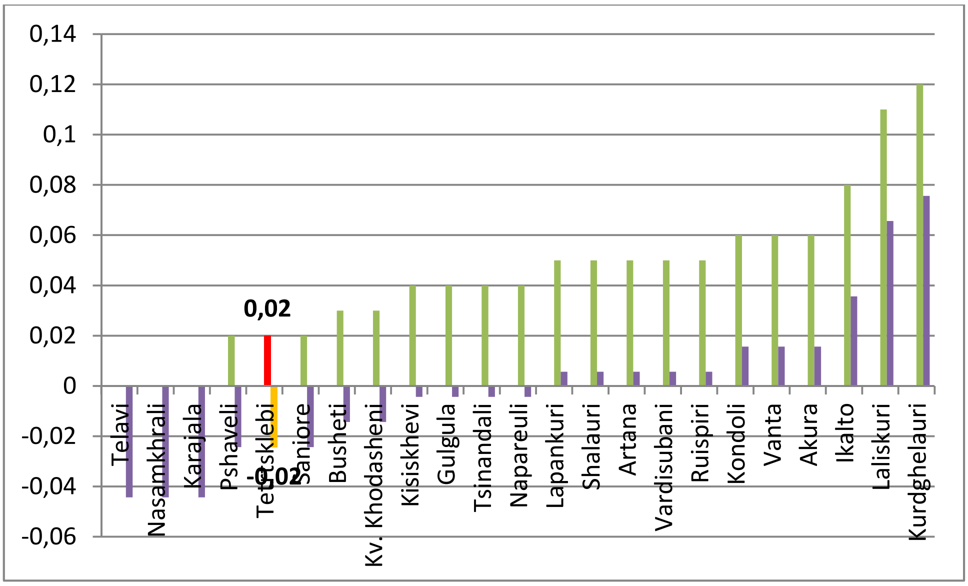
Tetri Tsklebi community consists of only one village - the village of Tetri Tsklebi. The distance of the village from the municipal center is approximately 18 km.

The field research has revealed that the main problem from the perspective of hazardous natural events is landslide processes.

In the results of the research conducted within the framework of the program, the vulnerability of Tetritsklebi community was assessed at 37 points. This indicator exceeds the average index of the municipality. The difference from the average is slight and comprises 1.36 points (see the diagram). In general, on the scale of the target area of the program the vulnerability of the community was assessed as average (see the map – Assessment of the Vulnerability of Telavi Municipality).



According to the research conducted, the level of risk for the Tetritsklebi community comprised 0.02 points. This is one of the lowest indicators within Telavi Municipality. The difference from the average of the municipality is 0.02 points (see the diagram). Such a low indicator was caused by the relatively small scale of natural hazards represented in the community. Another reason is the fact that these processes are not in direct contact with the population. On the scale of the target scope of the program (target River basins) the risk level of the community was assessed as lower than the average (see the map – Assessment of Disaster Risks of Telavi Municipality).



A detailed picture of the situation in the Tetritsklebi community in respect to natural hazards is presented below:

As already mentioned above, the main problem for the village is the ***landslide*** processes developinf in this territory. From this perspective, the so-called Kobakhidzes district that is represented by numerous landslide areas should be underlined. Within this district, the landslide located in the so-called Serodni ravine should be highlighted. This landslide was caused by the erosive activities of the ravine, as a result of which the slope located nearby loses its foundation and causes the development of landslide processes. The process damages about 1 km of the section of the road that connects different districts of the village with each other.

The possibility of activation of landslide processes in other areas of the district is also high; this risk is derived from the unity of geomorphological characteristics in the territory. For example, this kind of activation has occurred in 2006 when, because of the landslide processes, the traffic was actually stopped on the Vaziani-Gombori-Telavi road. The landslide took away almost 1/3 of the road. The landslide, of a north-easterly exposition, was developed in the middle and lower part of the slope. The width of the landslide was 60 m, the length was 120 m, and the approximate capacity was 6-8 m. The unnamed left tributary of the Turdo River served as its basis. The washing of the right bank of the tributary caused the activation of the landslide. The landslide developed in the clays of eluvial-deluvial genesis; the type of its relocation was block-sliding in the upper part of the landslide and plastic in the lower part. The width of the blocky steps was 6-10 m characterized by sloping surfaces. The picture below shows the situation in 2006. The mentioned section was rehabilitated within the rehabilitation process of Vaziani-Gombori-Telavi road.

Taking into consideration the geological construction and geomorphological parameters of the district, the possibility of a similar processes recurring is high.

Besides this, in the territory of the Tetri tsklebi community a landslide prone district exists that directly threatens the Tbilisi-Vaziani-Gombori-Telavi road. This district is widely described in the reports of the National Environmental Agency; however, this district has not been identified by the population during field research. We believe that the reason for this is the fact that the landslide does not directly affect the community population.

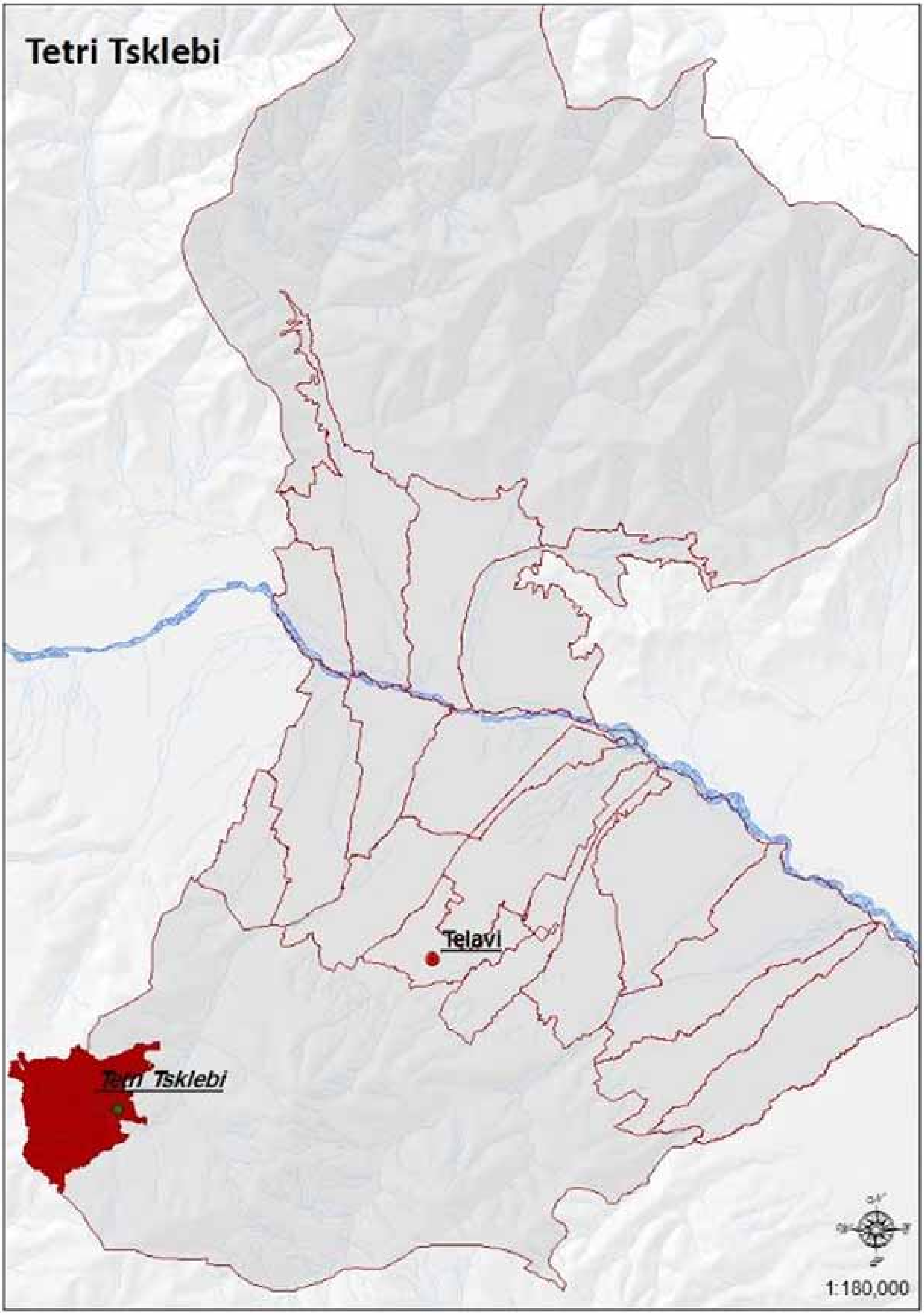
The process developed in the lower part of the right slope of the Turdo River gorge, at the 56^{th} km of Tblisi-Vaziani-Gombori-Telavi road. The slope inclination is within $25\text{-}40^0$, with uneven, distinguished steps.

Within the geological composition of the territory are contributing sediments of paleocene period presented by shaled clays, argillites and lamellar sandstones. The main rocks are covered by deluvial layers of strong capacity. Both old and modern tectonic disorders have an improtant role in the formation of the terrain.

The landslide process was developed on the slope, the formation of which is connected with tectonic disorder, as well as over-humidity of soil and a sharp decline in their phisical-mechanical characteristics. The length of the landslide body is 400-450 m, the width in upper part is 100-120 m and in lower part it is 180-200 m. The landslide processes deform not only the ravine boards, but the ravine channel as well, indicating that the depth of the body deformation is no less than 20-25 m.

In the landlside zone the plain part of the main road is deformed and is torn apart at depths of up to 1.5 m. The pressure of the landslide mass has caused the deformation of a water pipe, and torn apart the water supply pipelines of Telavi.

In this section of the road, traffic and Telavi water supply are restored, although it should be noted that there still is the danger of activation of landslide processes.


Tetri Tsklebi
Telavi
Tetri Tsklebi
1:180,000

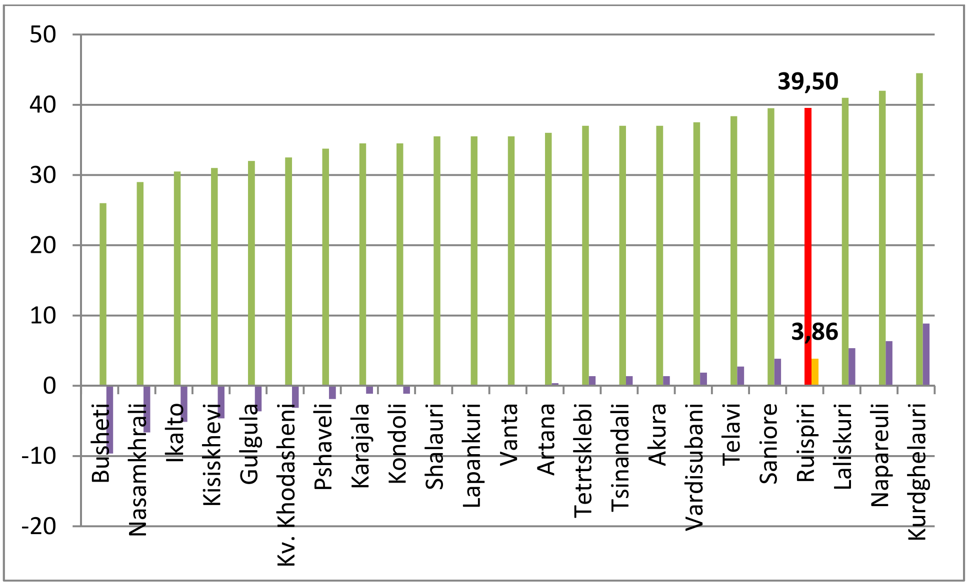
2.2.2.5 Ruispiri Community

The Ruispiri community is located in the westernmost part of Telavi Municipality, on the border of Akhema Municipality. The community occupies the west bank of the Alazani River. The Ruispiri community is at the uppermost flow of the Alazani River within the Telavi Municipality borders. In addition to the Alazani River, the tributaries of Alazani are also represented in the community – Chumatiskhevi (taking its source within Chumati community) and Turdostskali (taking its source in Tetri tsklebi community). It is noteworthy that at the confluence the Turdo River is divided in three parts that independently join the Alazani River. They are Turdostskali, Tatrebis Turdo and Turdo. Out of these three rivers, only Turdostskali River goes through the Ruispiri community.

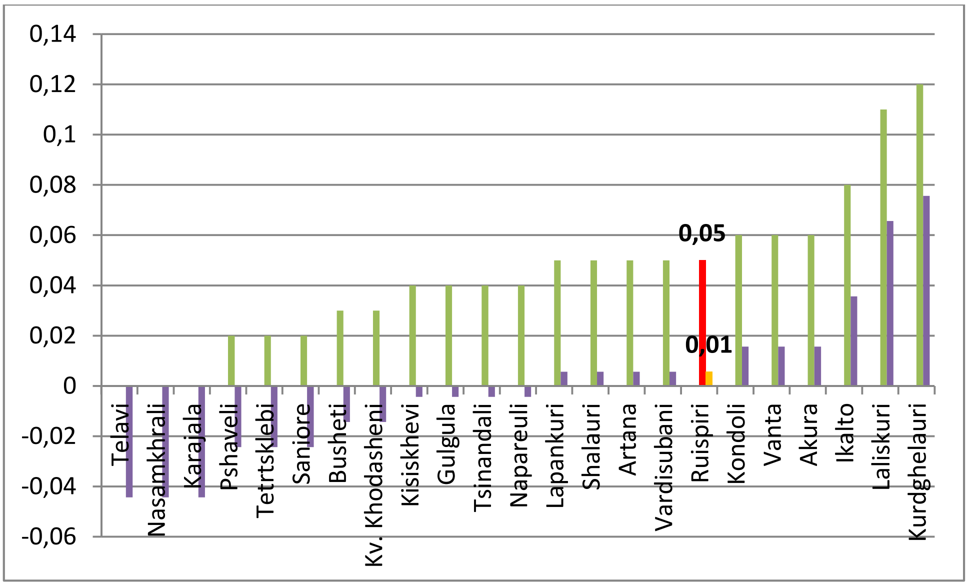
Ruispiri community consists of only one village - the village of Ruispiri. The distance of the village from the municipal center is 7 km.

During the field research it was revealed that, of hazardous natural events, the main problems are connected with debris flows.

In the results of the research conducted within the framework of the program, the vulnerability of the community was assessed at 39.50 points. This indicator exceeds the average index of the municipality (difference from the average indicator of the municipality is 3.86 points). Such a high index of vulnerability was caused by the disarrangement of drinking water infrastructure, as well as a low economic index and the poor capability to respond to disasters. On the scale of the the whole program the vulnerability of the Ruispiri community was assessed as an average vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



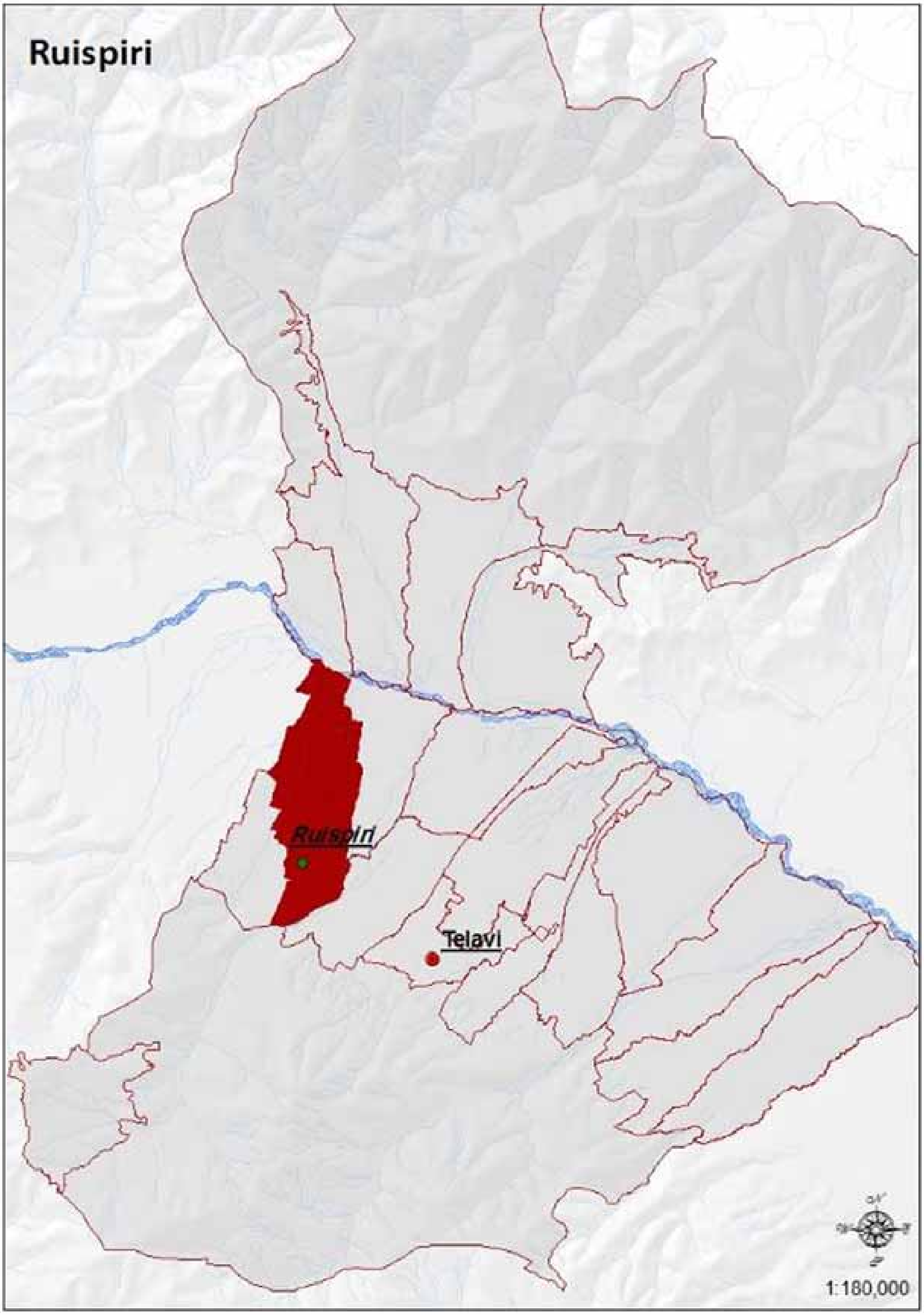
The level of risk for the Ruispiri community is 0.05 unit. Similar to the vulnarability index, this indicator also slightly exceeds the average indicator of the municipality (difference is 0.01 points). On the one hand, this is caused by the relatively high vulnarability of the community and on the other hand, the character of the hazardous natural events observed in the territory during the field research. As for the general scale of the target scope of the program, the risk level of the Ruispiri community was assessed as an average risk level (see the map – Assessment of Disaster Risks of Telavi Municipality).



A detailed picture of the situation in the community with respect to natural hazards is presented below:

As was already mentioned, the major problem for the community is ***debris processes.*** The debris flows occurring in Chumatkhevi (the same as at Ikalto gorge) channel destroy the majority of agricultural lands of the village (more than 30 ha). The road to the agricultural lands is also damaged. The cause of the problem is not directly in the territory of the Ruispiri community, but the situation in the upper stream of the river basin (Ikalto community). In recent years, according to the population, the northern slopes of the Gombori gorge were cut down intensively, which caused the increase in the rate and strength of debris flows. In this case, Ruispiri as the lower stream of Ikalto ravine is damaged because of the processes being undertaken in the upper stream of the river.

Debris flows are also occurring in the so-called Chichkana ravine, located in the village, in Sarajishvili and Tandilashvili districts. In case of extensive sediments, the debris flows formed in the ravine channel flood the houses of the population (20 households), crofts and agricultural lands (approximately 10 ha).


Ruispiri
Ruispiri
Telavi
1:180,000

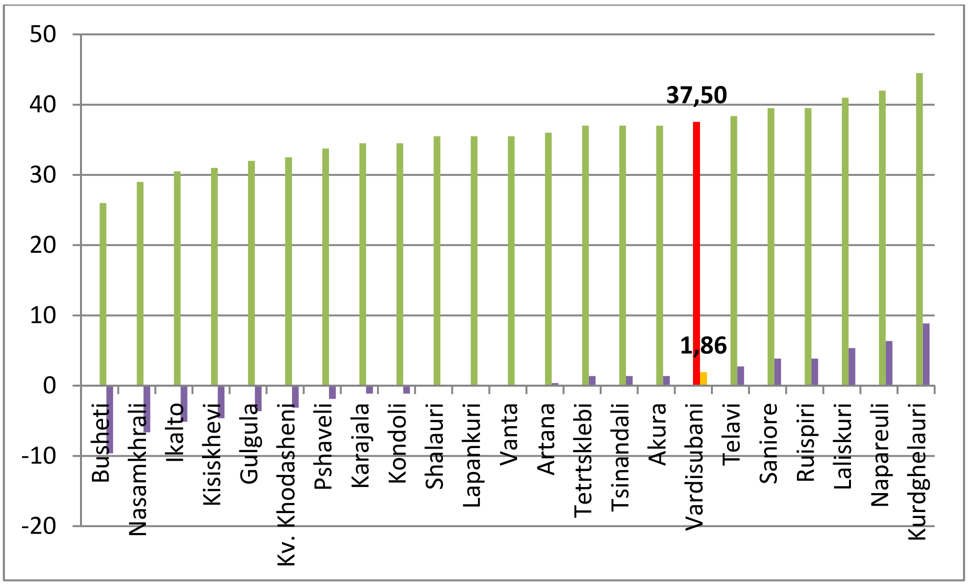
2.2.2.6 Vardisubani Community

Vardisubani community is located in the western part of Telavi municipality, on the northern slopes of the Gombori Range. The community immediately borders Telavi town. The territory of the community comprises the middle course of the Turdo River (the Turdo River – the upper course is in Tetri Tskhlebi community, the lower course is in Gulgula and Kharajala communities). It should be also noted here that Vardisubani community also comprises the territory adjacent to the right bank of the Alazani River, where the agricultural lands of the community are mainly located.

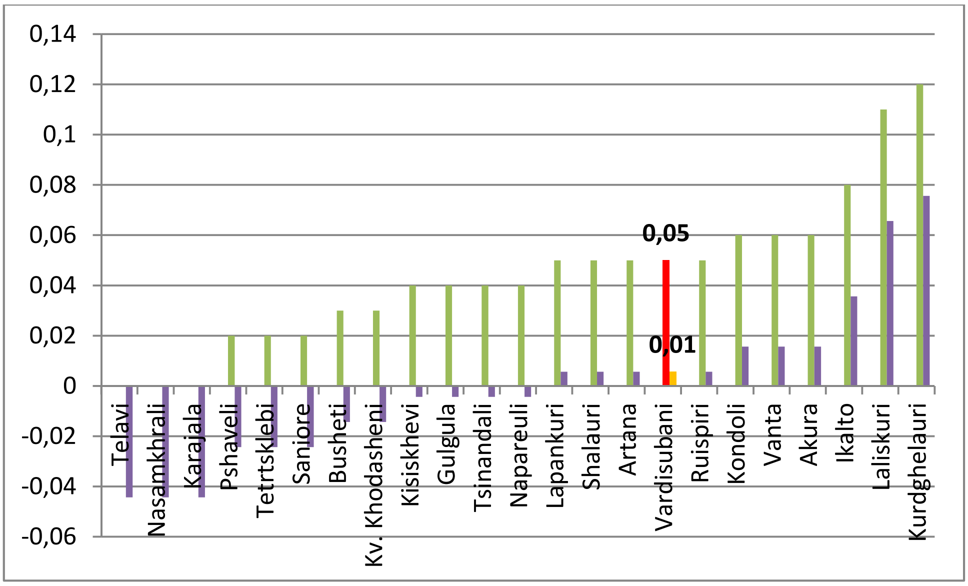
Vardisubani community comprises one village – the village of Vardisubani. The distance from the village to the town Telavi (the municipal center) is 2 km.

During the course of the field research maily mudflows and floods were detected in the territory of the municipality.

Based on the results of the research conducted within the framework of the program, the vulnerability of Vardisubani community was assessed at 37.50 points. This indicator is somewhat higher than the average for the municipality (35.64 points). The difference from the average is 1.86 points (see the graph). In general, on the scale of the program, the vulnerability of Vardisubani community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



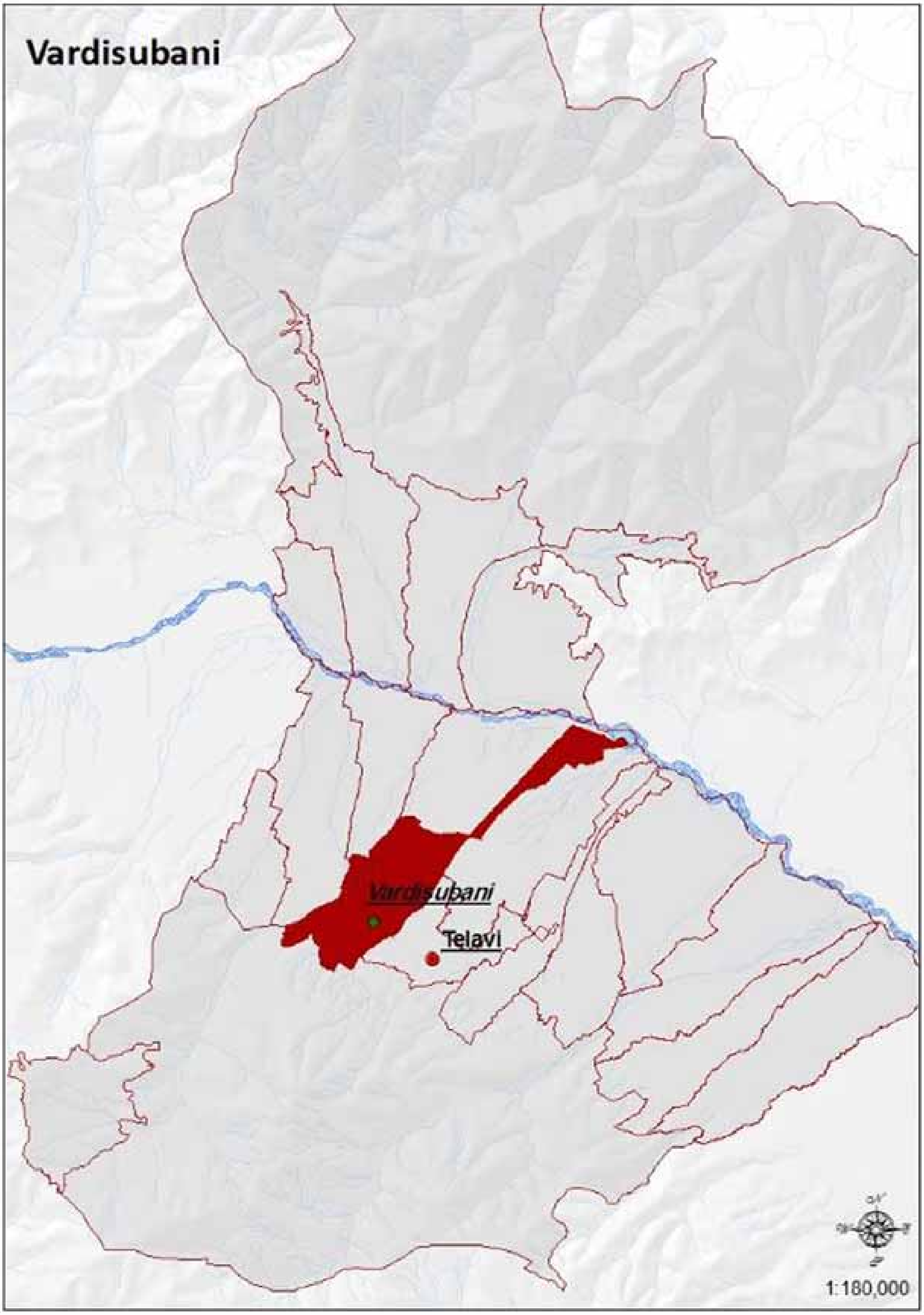
According to the same research, the level of risk in the community was assessed at 0.05 point. Like the vulnerability, this indicator is somewhat higher than the average for the municipality (the difference being 0.01 point). Such a low difference enables us to conclude that Vardisubani community is not distinguished by the indicators of risks existing in the municipality. Within the scale of the target scope of the program, the level of risk of the community was assessed as the average level of risk (see the map – Assessment of the Natural Disaster Risks of Telavi Municipality).



A detailed picture of the situation of the community in regard of natural hazards is as follows:

Vardisubani community is mainly affected by problems resulting from ***floods*** and ***mudflow*** streams. The Telaviskhevi gorge passing through the village is mudflow-prone. The course of the gorge is filled with debris material, the result of which is water overflows beyond the banks during spring in times of frequent rainfalls and damages agricultural lands of the village (in total, about 100 ha lands are flooded and damaged). Also, the village church is endangered. The gorge passing through the so-called Kharaulashvili neighborhood is also mudflow-prone. In periods of abundant precipitation a mudflow stream forms there and endangers crofts and houses of the population (approximately 20 households).

An important problem is posed by the situation at the head of the village, in the territory adjacent to the cemetery and the water storage tank. In periods of abundant precipitation, water accumulates there and floods the upper neighborhood of the village. The result of which is that the village cemetery, a 2 km segment of the inter-neighborhood roads of the village, and crofts of 8 households (approximately 1 ha) are being damaged.


Vardisubani
Vardisubani
Telavi
1:180,000

2.2.2.7 Kharajala Community

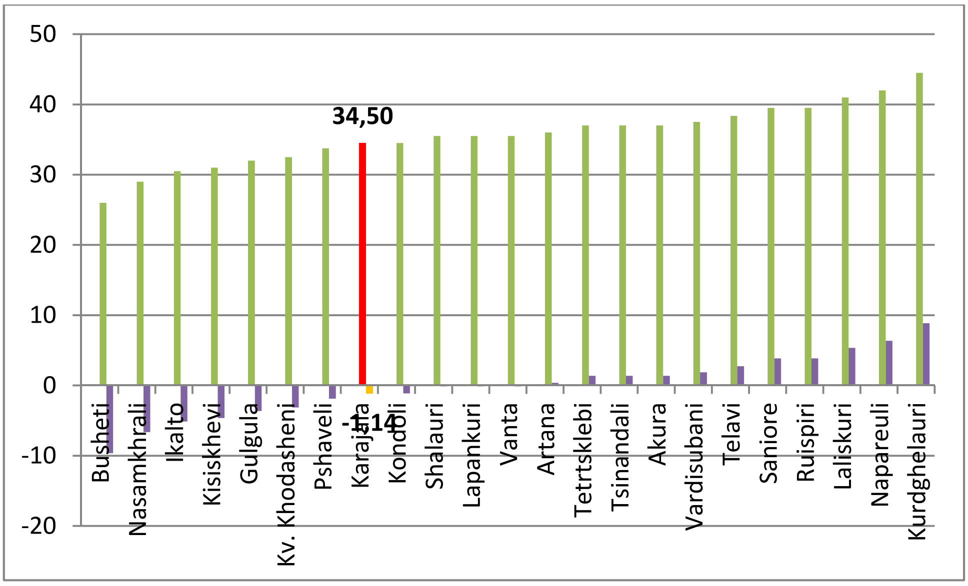
Kharajala community is located in the western part of Telavi Municipality, on both banks of the Alazani River. The only village of the community – Kharajala – is located on the right bank of the Alazani River, while its agricultural lands are mainly located on the left bank of the river.

Apart from the Alazani River, the territory of the community is crossed by the gorge of the Turdo River, which merges into the Alazani River from the right, within the boundaries of the community. It is noteworthy that the Turdo River branches out into three streams near the confluence, which merge into the Alazani River independently. These streams are the Turdostskhali, the Tatrebis Turdo, and the Turdo. Among these, only the Tatrebis Turdo flows within the boundaries of Kharajala community.

As was mentioned earlier, the community only comprises of the village of Kharajala, the distance of which from the municipal center is 7 km.

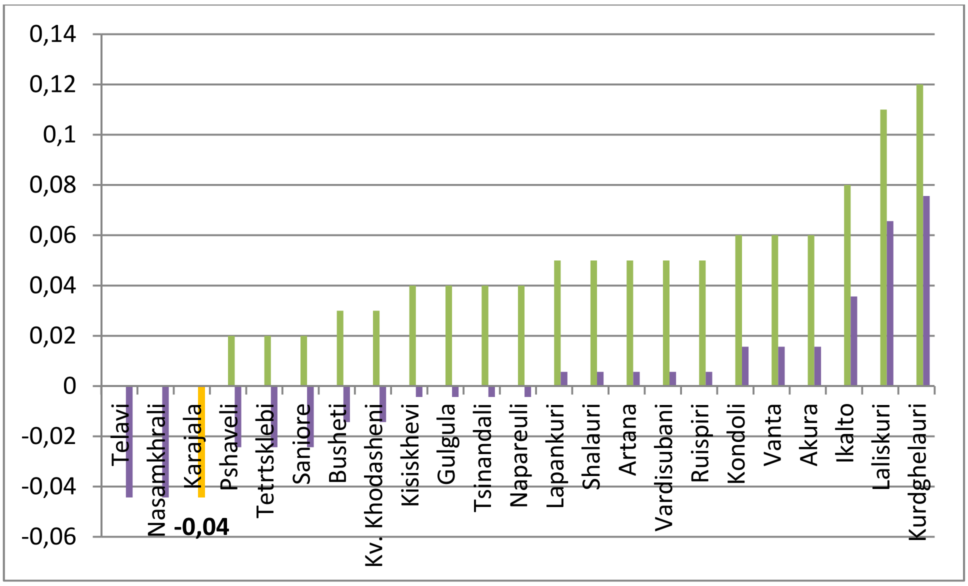
As a result of the field research, the only kind of hazardous natural processes indicated by the population was flooding. It should also be mentioned that the data of the National Environmental Agency contain no indication of hazardous natural processes in the territory of Kharajala community.

In the results of the research conducted within the framework of the program, the vulnerability of Kharajala community was assessed at 34.50 points. This indicator is slightly lower than the average from the municipality (the difference being -1.14 point, see the graph). Practically, the vulnerability of the community coincides with the average vulnerability of Telavi municipality and in this regard it is not distinguished from other communities. On the scale of the target scope of the program (target rivers' drainage basins), the vulnerability of the municipality was assessed as lower than the average vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



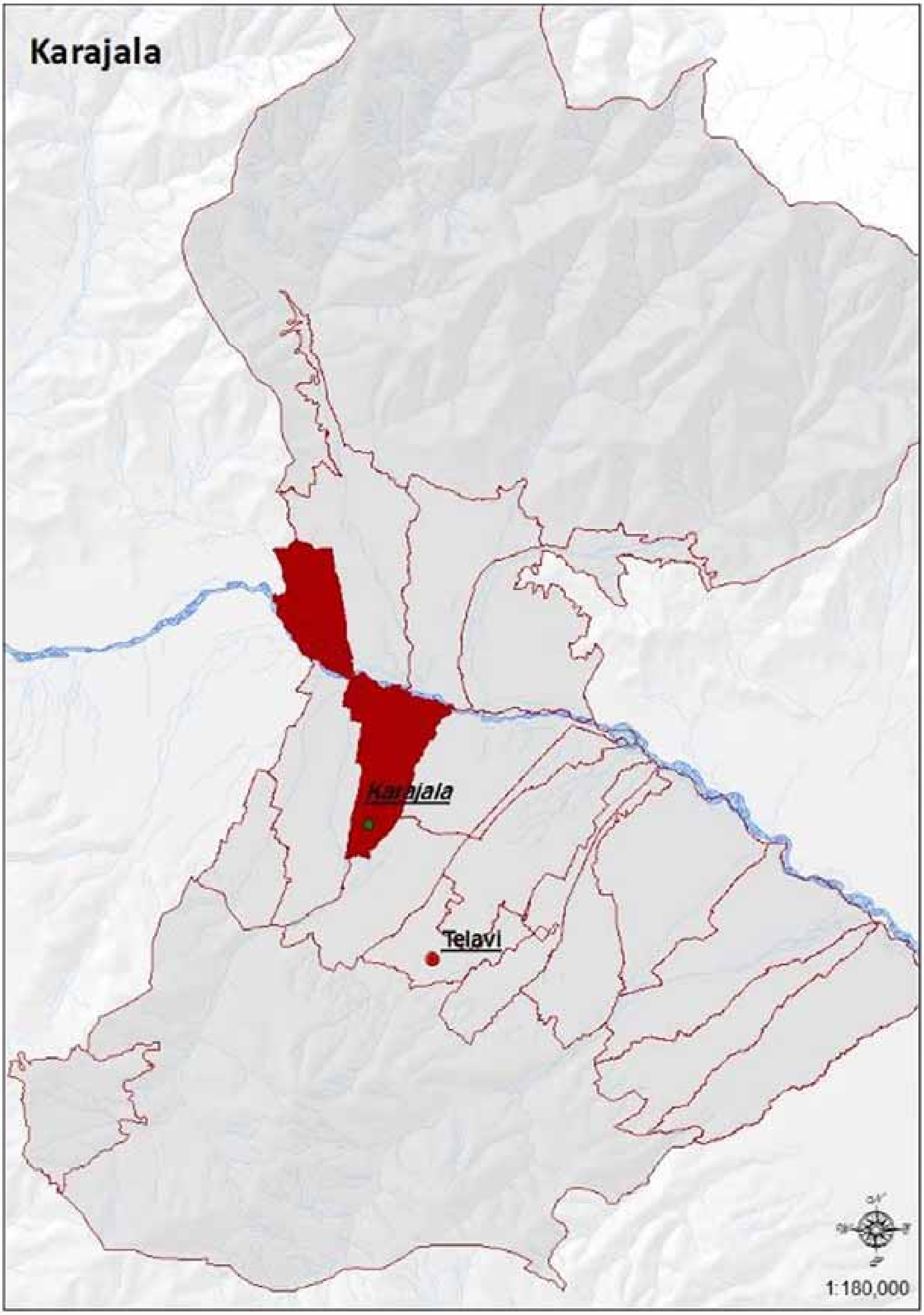
The level of risk for the Kharajala community, based on the data obtained from the research conducted within the framework of the program, is assessed at 0. This indicator is accounted for by a very small scale of hazardous natural processes detected in the territory of the community. At the same time, a relatively low level of vulnerability of the community should be taken into account. Such a minimal indicator was established for only four communities in Telavi Municipality, one of which is Kharajala community (see the graph). With regards to the general assessment, on the scale of the target scope of the program, the level of risk of

Kharajala community was assessed as a very low level of risk (see the map – Assessment of Natural Disaster Risks of Telavi Municipality).



As mentioned earlier, the only kind of hazardous natural phenomena indicated by the population was ***flooding***. Floods occur on the Turdo River, which rises in springs during intensive snowmelt or abundant precipitation, and endangers the lands of 2 or 3 households. According to the population reports, there were cases of flooding crofts of these households. In case of floods, crofts and lands of the population (approximately 1 ha of 2 households) and the village cemetery can be endangered.

A good understanding of the situation is afforded by the satellite image of the territory, in which the territory subject to flood risk is marked red.


Karajala
Karajala
Telavi
1:180,000

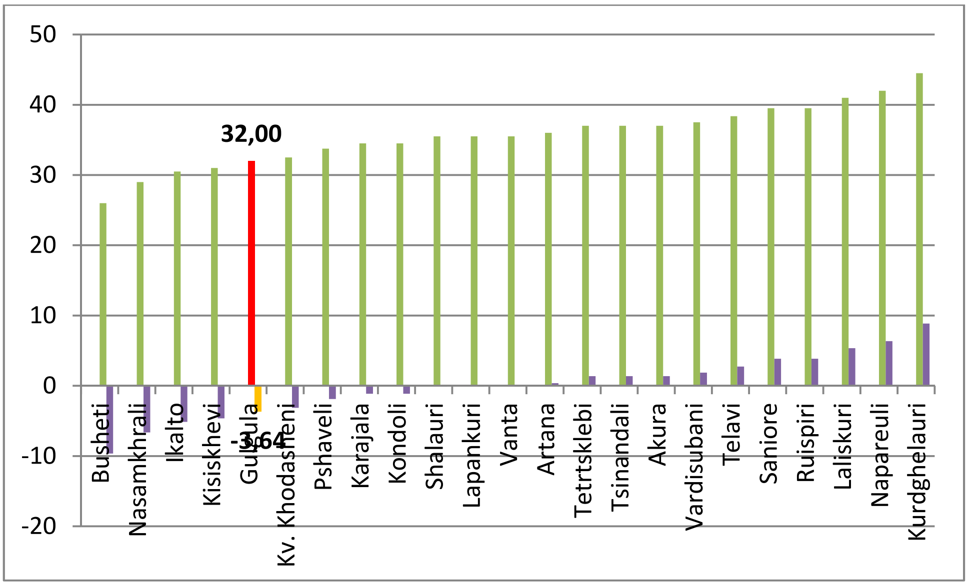
2.2.2.8 Gulgula Community

The Gulgula community occupies the central part of Telavi Municipality, on the right bank of the Alazani River. The territory of the community contains the lower course of the Turdo River. The village of Gulgula itself is located along the Turdo River (on its right bank). And the agricultural lands of the community are located mainly on the right bank of the Alazani River.

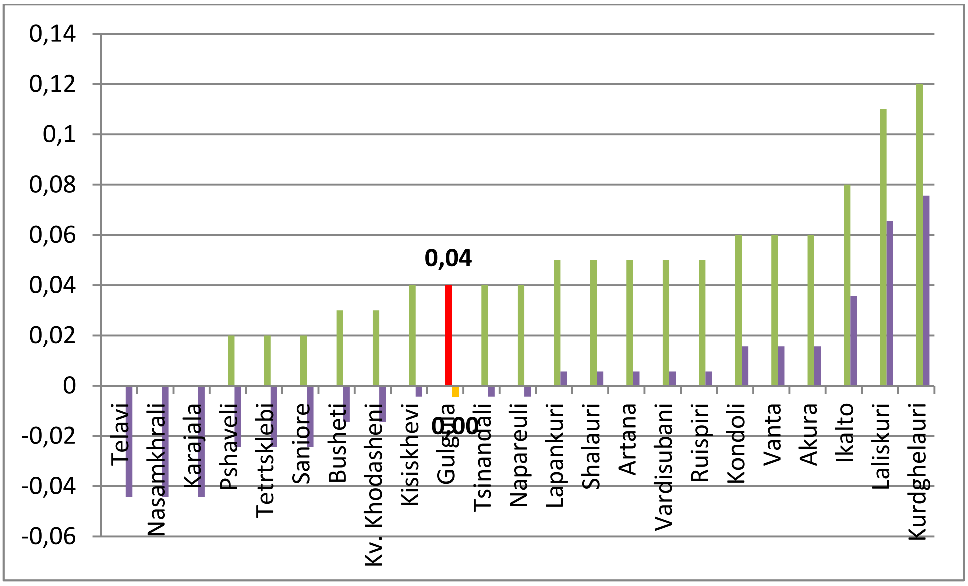
Gulgula community comprises one village only – the village of Gulgula. The village is located 7 km from the municipal center.

Among natural hazards, floods were detected in the community as a result of the field research.

Based on the data obtained from the research conducted within the framework of the program, the vulnerability of Gulgula community was assessed at 32.00 points, which is lower than the average indicator for the municipality by 3.64 points (see the graph). Accordingly, Gulgula community has a low vulnerability compared to other communities of the municipality. In general, on the scale of the target scope (target drainage basins) of the program, the vulnerability of the community was assessed as a lower than the average vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



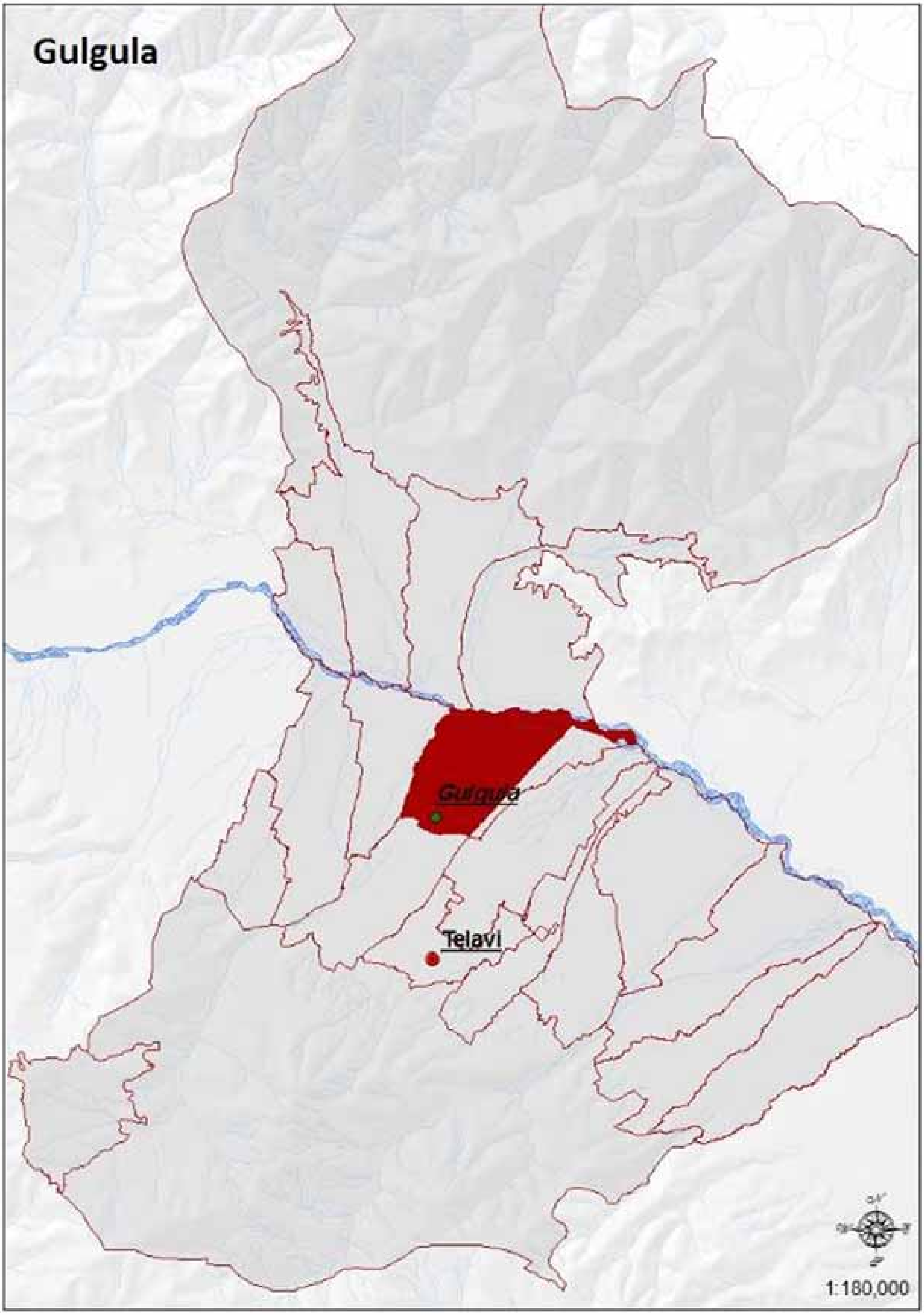
The level of risk for Gulgula community was assessed at 0.04, which is exactly the same as the average municipal indicator (see the graph). On the scale of the target scope of the program, the level of risk of the community was assessed as a lower than the average level of risk (see the map – Assessment of the natural Disaster Risks of Telavi Municipality).



The detailed picture of the situation in respect of natural hazards in the community is as follows:

As mentioned earlier, the main problem of the community is ***floods***, which are characteristic both to the Turdo River as well as the Telaviskhevi gorge, which flows through the territory of the community. The population recalled the devastating flood from the Turdo River in the spring of 2011. The river burst its banks and flooded houses and crofts of the population. Loss of poultry as a result of the flood was also registered. Water ruined crops, agricultural lands and walnut seedlings (about 10 ha in total). High voltage transmission masts, the village supermarket and inter-neighborhood roads of the village were also damaged. According to the population reports, after this event shore reinforcing works were undertaken.

Floods are characteristic also for the Telaviskhevi gorge passing through the community. The cannel of the gorge is filled with debris, the result of which, in periods of intensive rainfalls in spring, is that the water flows over the banks and damages the agricultural lands of the village. Approximately 80 ha lands can be flooded.


Gulgula
Gulgula
Telavi
1:180,000

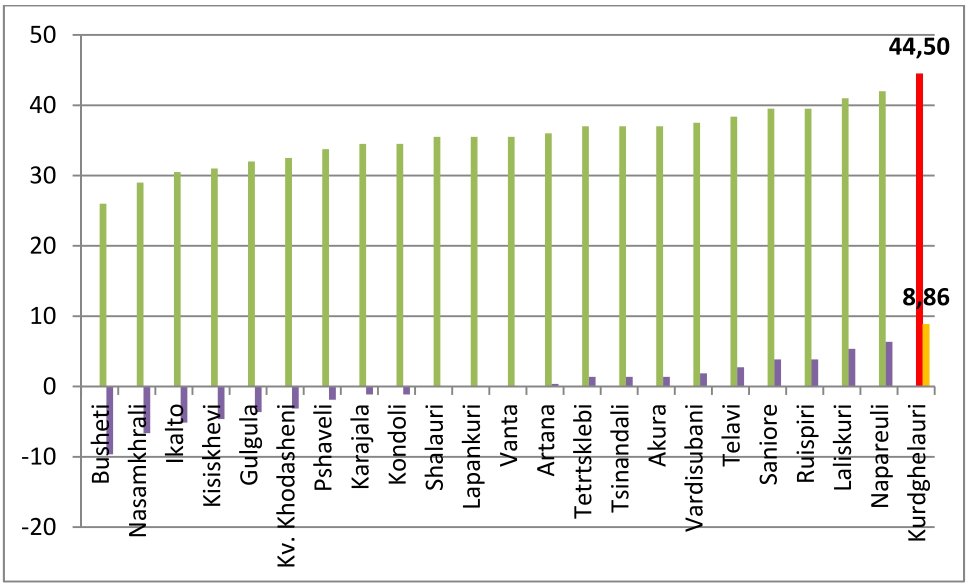
2.2.2.9 Kurdghelauri Community

Kurdghelauri community is located in the central part of Telavi Municipality, on the right bank of the Alazani River. The territory of the community immediately borders Telavi town to the north. The major rivers of the community are the Telaviskhevi and the Matsantsara, which gather their waters near Telavi. They come together in the northern part of Kurdghelauri community territory and merge into the Alazani River as the Begona Psha from the right.

Kurdghelauri community is comprised of only one village– the village of Kurdghelauri, which is practically continuous with the town Telavi and is considered as its suburb. There are no sharp geographic boundaries between these two settlements. The distance of the village from Telavi town is 2 km.

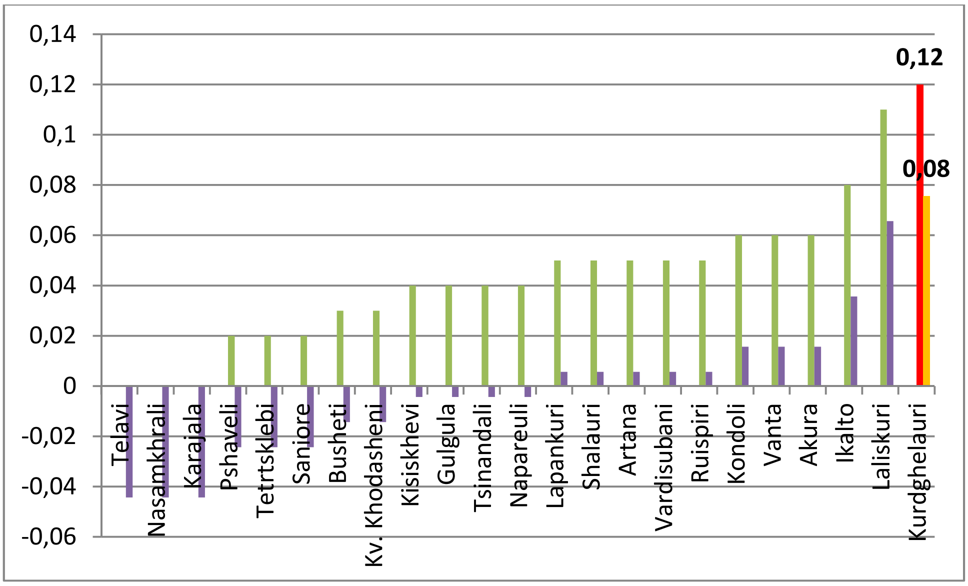
In course of the field research, the population mainly indicated mudflow hazards as the major natural hazard.

According to the results of the research conducted within the program, the vulnerability of Kurdghelauri community was assessed as 44.50 points, which is the highest indicator within the whole of the Telavi municipality (see the graph). This indicator is interesting considering the fact that the community is immediately connected with the town Telavi, which ensures accessibility of social infrastructure for the population of the community; and this fact ensures that they are privileged compared with other communities of the municipality. However, notwithstanding the fact that the situation is better in this respect other indictors determining the vulnerability of a community are considerably higher than averages for the municipality. In this respect, the demographic situation of the community is particularly remarkable (the percentage of vulnerable groups is high in the community), as well as the percentage of the population inhabiting hazard zones and the existence of agricultural lands located in such zones. On the scale of the target scope of the program (target watersheds), the vulnerability of Kurdghelauri community was assessed as an average kevel of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



Based on the data obtained from the conducted research, the level of risk of Kurdghelauri community was assessed at 0.12 points, which, like the vulnerability indicator, is the highest throughout Telavi Municipality (the difference from the average for the municipality is 0.08, see the graph). Such a high level of risk is determined by the scale of natural hazards detected in the community, accompanied by the high indicator of vulnerability for the community. On the scale of the target scope of the program the level of risk of

Kurdghelauri community was assessed as a higher than the average level of risk (see the map – Assessment of Natural Disaster Risks of Telavi Municipality).

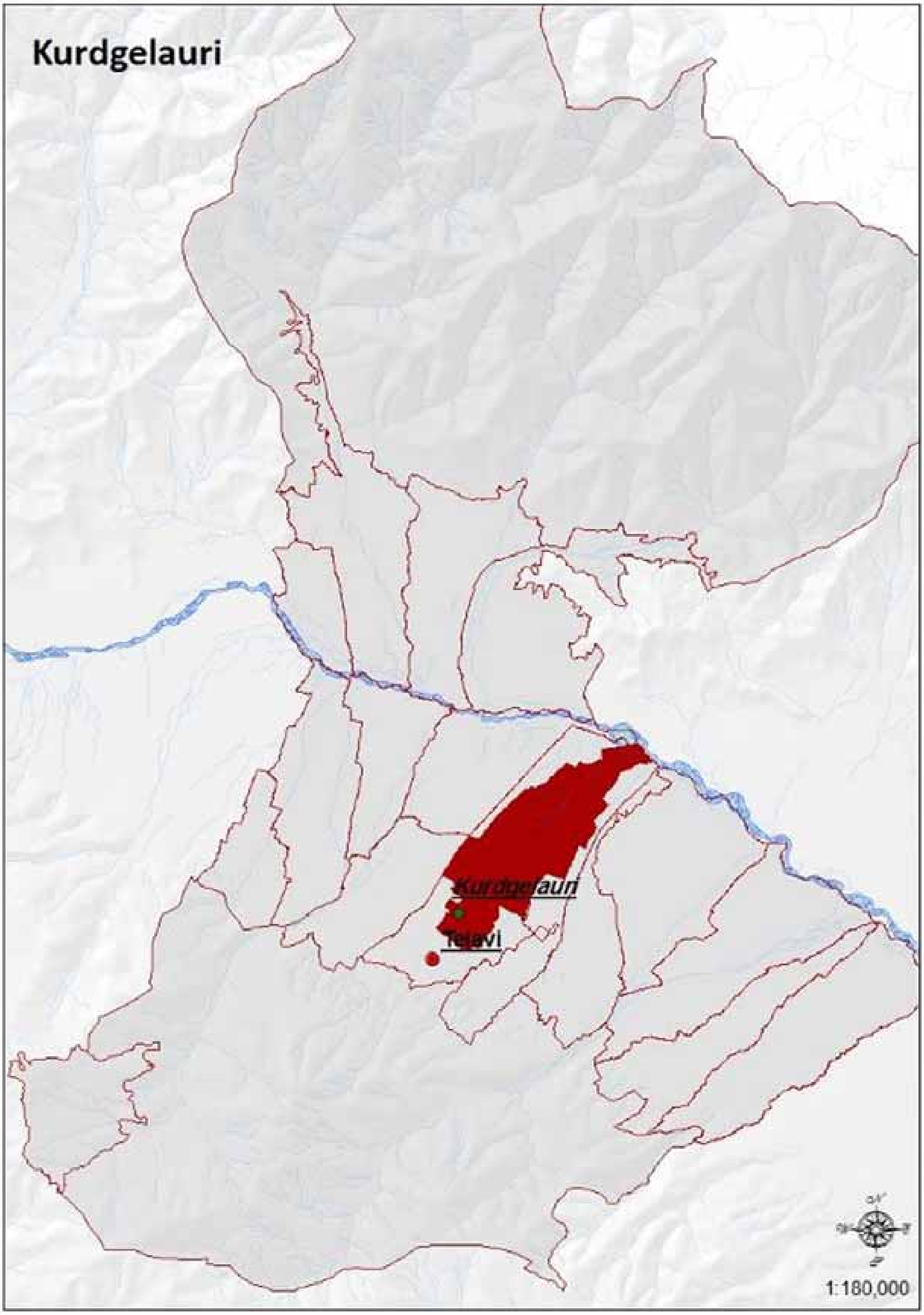


Below a detailed description of the natural hazards present in the community is provided.

As was mentioned earlier, the main problem of the community is ***mudflow*** processes. The so-called Djinuas Khevi, passing through the center of the village, is prone to mudflows. The course of the gorge is almost entirely filled with debris. The result of this, in spring when periods of intensive snowmelt or abundant precipitation occur, is that the watercourse does not ensure passage of surplus water. The result of this is that the excess water flows over and inundates the houses and crofts of the population. The passage of mudflow streams covers up to 100 households and crofts. It is noteworthy that some of the inter-neighborhood roads of the village are constructed along this gorge. At the same time, drainage channels constructed along the roads are entirely filled with debris. Accordingly, mudflow streams damage a large part of this road (almost 2.5 km). Almost every year cleaning works are conducted on the road. Also, the village power communication system is based near the gorge, so high voltage transmission masts and the village power transformer are endangered. Mudflow streams also endanger the village church.

The nameless gorge passing between the village of Kurdghelauri and Telavi town is also mudflow prone. The watercourse of this gorge is entirely filled with debris material. Accordingly, the watercourse cannot ensure passage of surplus water, the result of which is that houses and crofts of 30 households, as well as an 800 m segment of the inter-neighborhood road are being damaged. On the northern periphery of the village, the gorge opens and the mudflow stream damages agricultural lands (approximately 30 ha) on the territory adjacent to the civic airport.

Mudflow streams and floods are characteristic also the so-called Telavis Khevi, passing in the northwestern periphery of the village. The watercourse of the mentioned gorge is also filled with debris material, the result of which, in periods of abundant precipitation, is that water flows over the banks and damages agricultural lands located in this territory. In total, up to 60 ha of lands are being damaged (flooded and covered with mudflow debris).


Kurdgelauri
Kurdgelauri
Telavi
1:180,000

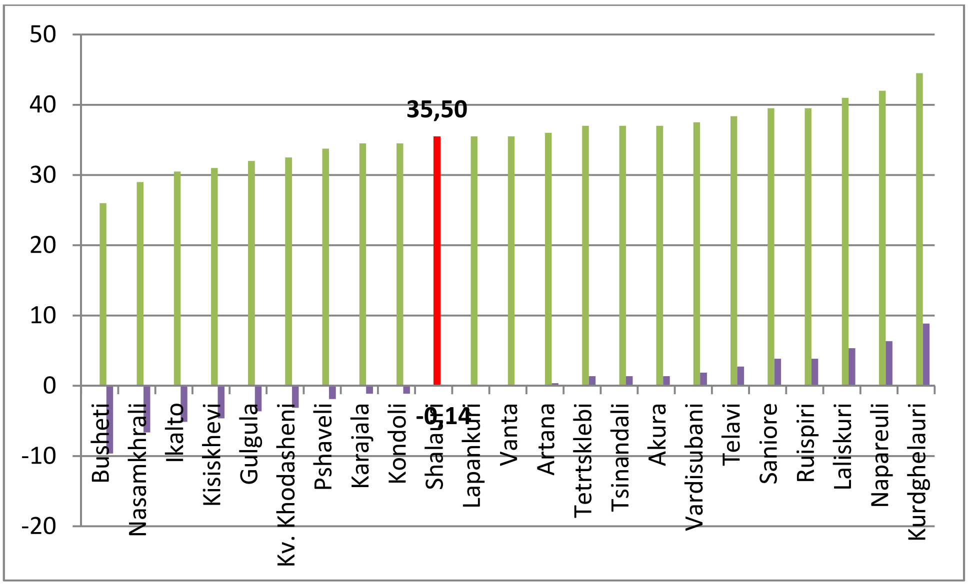
2.2.2.10 Shalauri Community

Shalauri community is located in the central part of Telavi Municipality, occupying a narrow longitudinal band between Telavi town and Kisiskhevi community. The northern part of the community borders the right bank of the Alazani River, where the agricultural lands of the community are located.

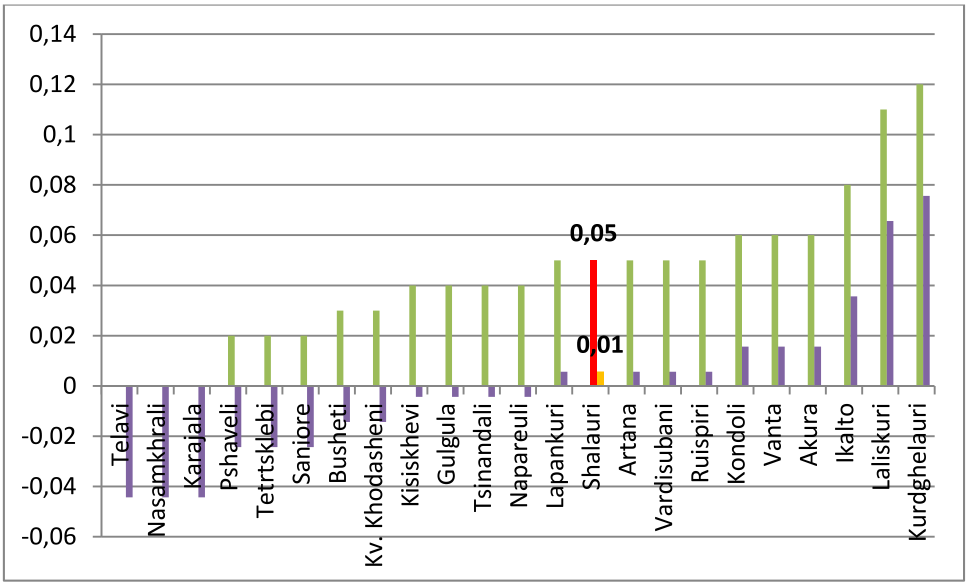
Shalauri community is comprised of the village of Shalauri, which is immediately connected with Telavi town. The border between them is conventional. The distance from Telavi town does not exceed 3 km.

The result of research is that mudflow processes were registered among hazardous natural processes in the territory of the community.

Based on the data obtained from the research conducted within the framework of the program, the vulnerability of the community was assessed to be 35.50 points. This indicator roughly coincides with the average for the municipality. The difference from the municipal average is insignificant and equals -0.14 point (see the graph). In general, on the scale of the target scope of the program, the vulnerability of the community was assessed as the average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



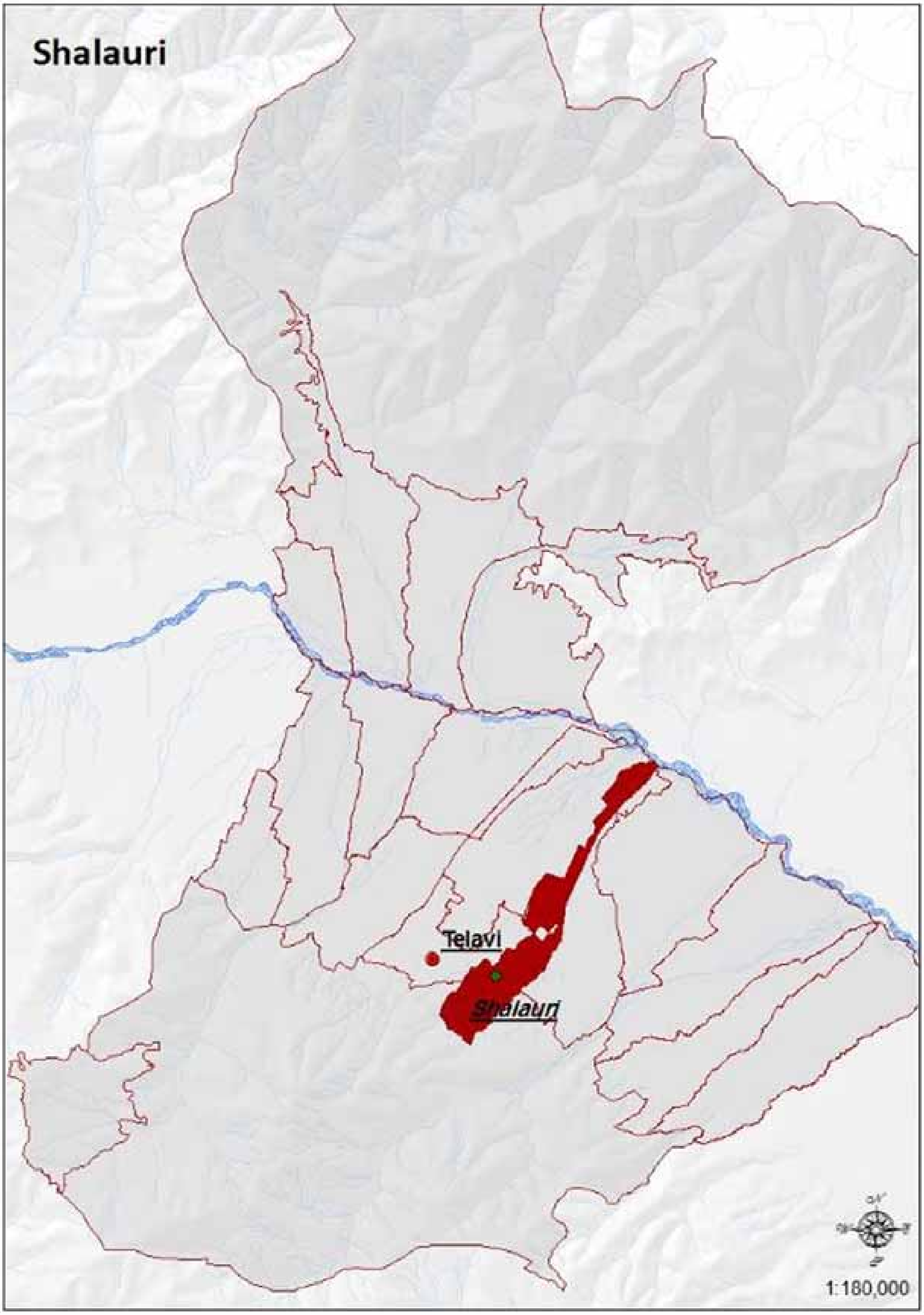
The level of risk for Shalauri community was assessed at 0.05 points. This indicator is higher than the municipal average by 0.01 point. In general, it can be stated that the level of risk of the community is practically same as the average of the municipality. On the scale of the target scope of the program, the level of risk of Shalauri community was assessed as an average level of risk (see the map – Assessment of Natural Disaster Risks of Telavi Municipality).



A detailed picture of the situation of the community in respect of natural disasters follows:

The Shalauris Khevi gorge, passing through the village, is ***mudflow*** prone and mudflow streams developed in its course endanger houses and crofts of the population. 30 households are particularly endangered; cases of inundation of their houses as a result of mudflows have been registered in previous years. Mudflow streams pose threats also to the main water supply system building of the village, inter-neighborhood roads and the two churches located in the village. On the northern periphery of the village, the watercourse of the Shalauris Khevi is crumbling, which results in mudflow debris damaging agricultural lands.

Also the Svianaant Khevi, passing through the central part of the village, is mudflow prone. There, a mudflow was registered at the end of May in 2009. As a result of heavy rainfall in 2011, a mudflow stream formed instantaneously at the headwaters of the Svianaant Khevi River and its nameless tributary. A mudflow channel constructed in the southwestern end of the village, in the area of intersection between the gorge and the motor-road, did not ensure passage of the material transported by the low density rocky-watery mudflow stream. The stream filled and the narrow and shallow watercourse of the gorge was entirely filled; this resulted in the passage of a high speed watery-rocky stream over the mudflow channel. The volume of the material carried by the single mudflow event was 1,000 m^3. Crofts and houses of 10 households are still in the high risk zone.


Shalauri
Telavi
Shalauri
1:180,000

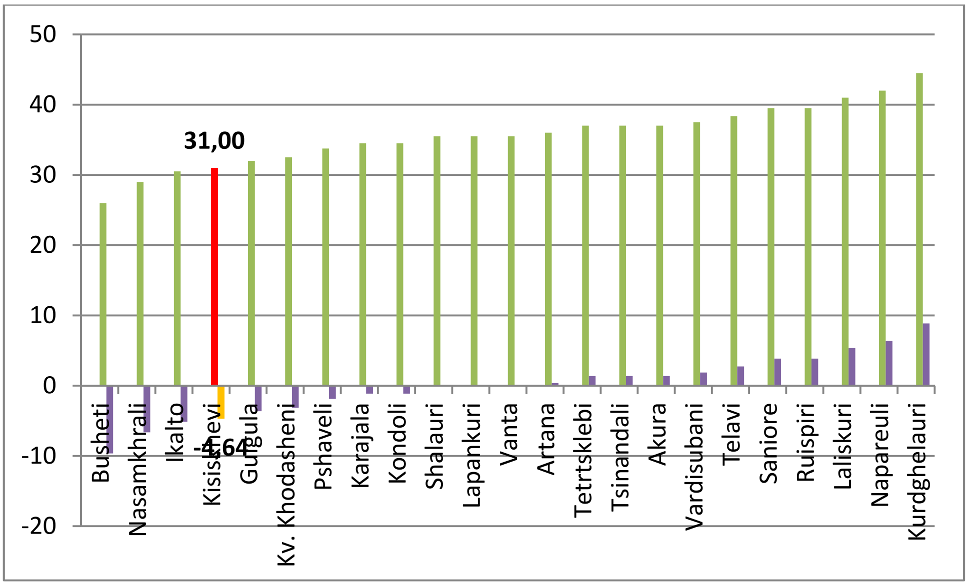
2.2.2.11 Kisiskhevi Community

Kisiskhevi community is located in the central part of Telavi Municipality, on the slopes of the northern foothills of Gombori Range. The main river of the community is a right tributary of the Alazani River, the Kisiskhevi River. The community is located on the left bank of the Kisiskhevi River. The river gathers its waters on northern slopes of Gombori Range. The first settled territory crossed by the river is the Kisiskhevi community. The river crosses the eastern part of Kisiskhevi community, flows into Tsinandali community and merges into the Alazani River on its territory.

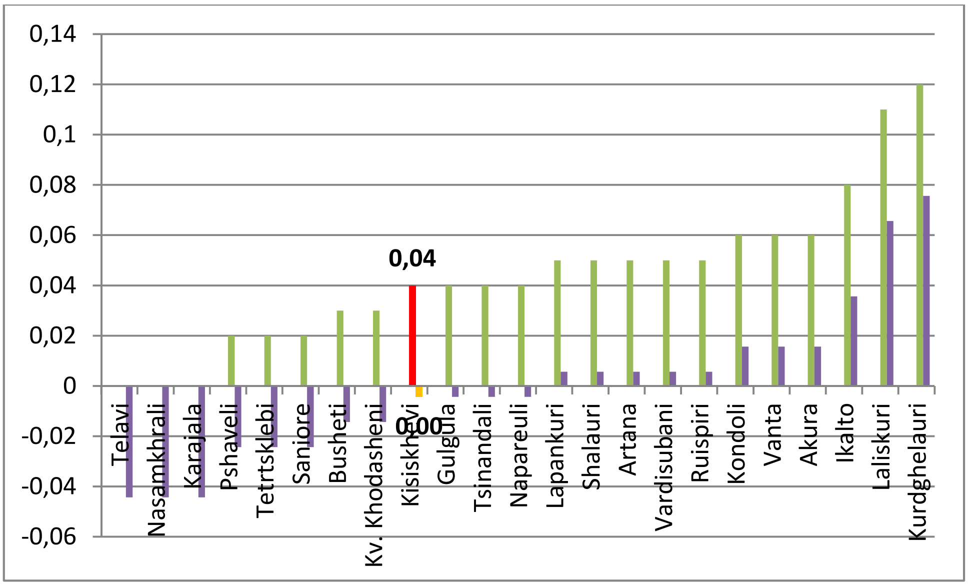
The community is composed of one village only – the village of Kisiskhevi. The distance of the village from the municipal center is 7 km.

The main problems of the community detected in course of the field research, in respect of hazardous natural phenomena, are caused by floods and mudflow processes.

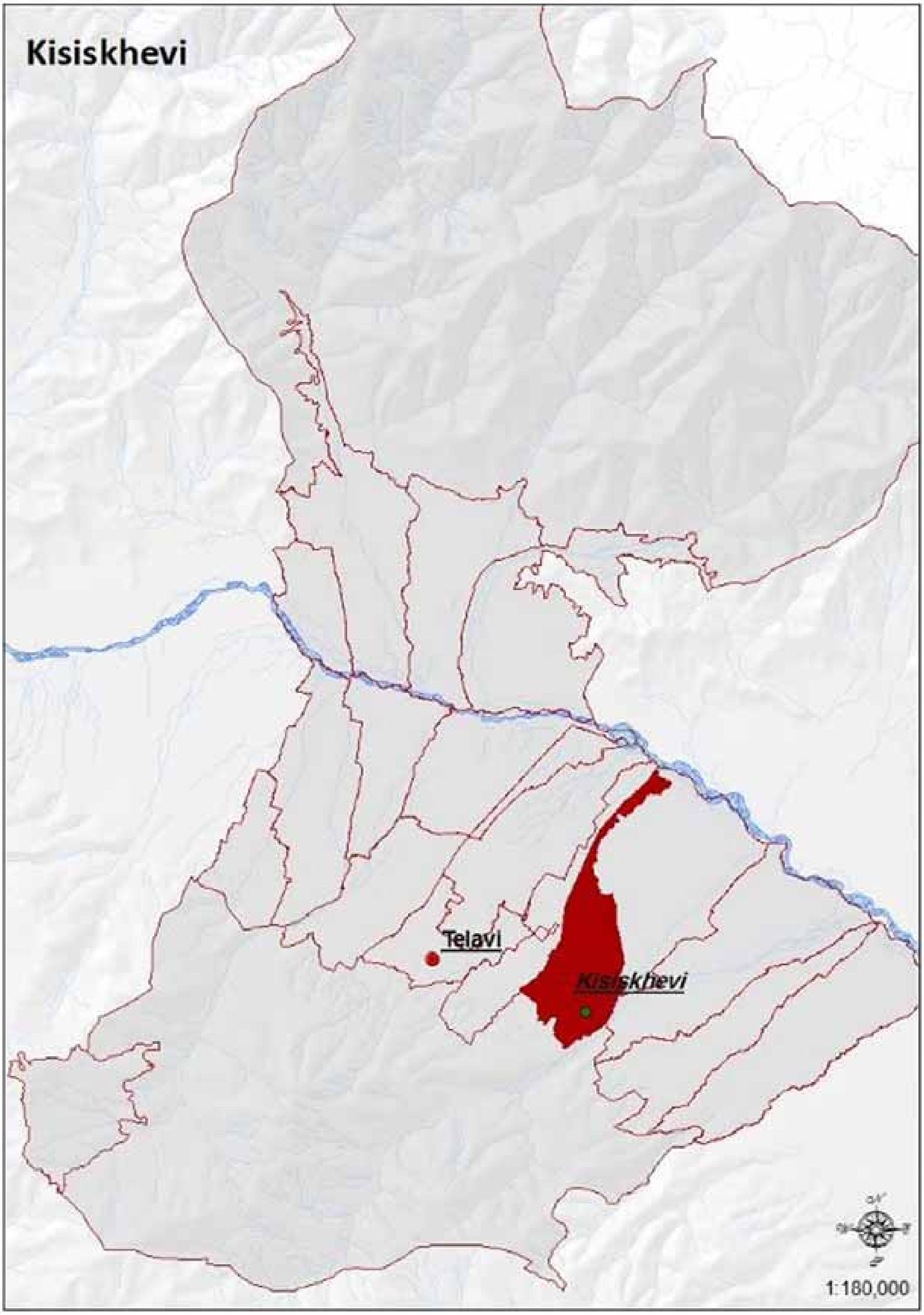
According to the data obtained from the research conducted within the framework of the program, the vulnerability of the community is assessed at 31.00 points, which is low compared to the average indicator for the municipality. The difference from the average for the municipality is -4.64 points (see the graph). On the scale of the target scope of the program the vulnerability of Kisiskhevi community was assessed as lower than the average vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



Based on the research conducted within the framework of the program, the level of risk was assessed as 0.04 point. This indicator coincides precisely with the average indicator for the municipality. Accordingly, it can be stated that Kisiskhevi community is not distinguished from other communities of the municipality with regards to levels of risk. On the scale of the target scope of the program, the level of risk of the community was also assessed as a lower than the average level of risk (see the map – Assessment of Disaster Risks of Telavi Municipality).



As was mentioned earlier, in course of field research, only passing of ***mudflow*** streams were registered in the community. In this respect, the Kisiskhevi River is remarkable. Its watercourse is filled with debris within the boundaries of the village, the result of which is that it cannot contain a surplus mass of water. As a result of this crofts of the population (15 households) and agricultural lands (approximately 3 ha) are being inundated. Inner roads of the village as well as a 2 km segment of the road connecting to the forest are also being damaged. Mudflow mass also endangers the main water colletion construction (water collector basin) of the drinking water supply system of the village.


Kisiskhevi
Telavi
Kisiskhevi
1:180,000

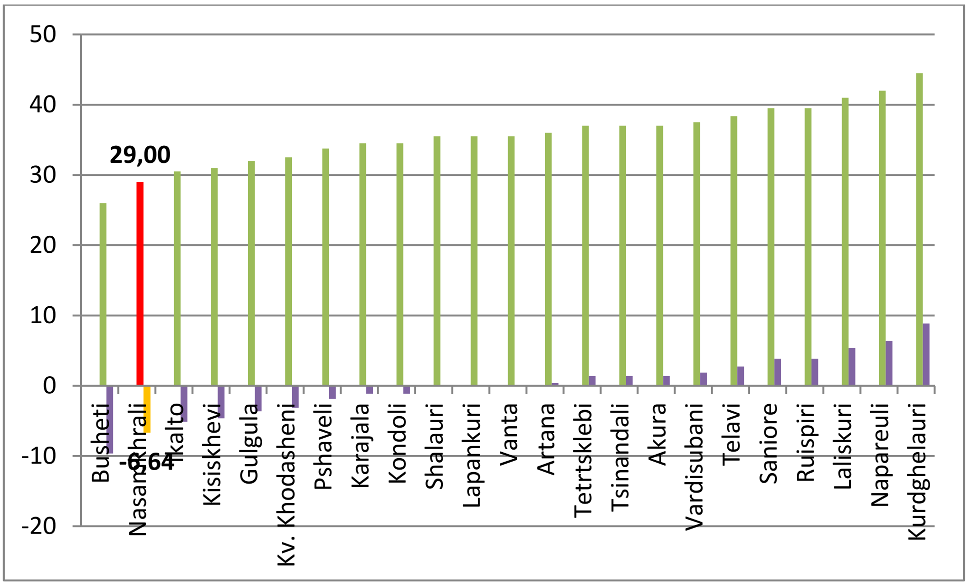
2.2.2.12 Nasamkhrali Community

Nasamkhrali community is located in the central part of Telavi Municipality, bordering the Kisiskhevi, Kondoli, and Shalauri communities.

The community comprises one village – the village of Nasamkhrali. It is noteworthy that, until 2010, the village of Nasamkhrali and the village of Kisiskhevi comprised one community – that of Kisiskhevi. Since 20102, after the new statute of the municipality was adopted, the community of the village of Nasamkhrali was established as an independent unit[6]. The distance of the village from the municipal center does not exceed 3 km.

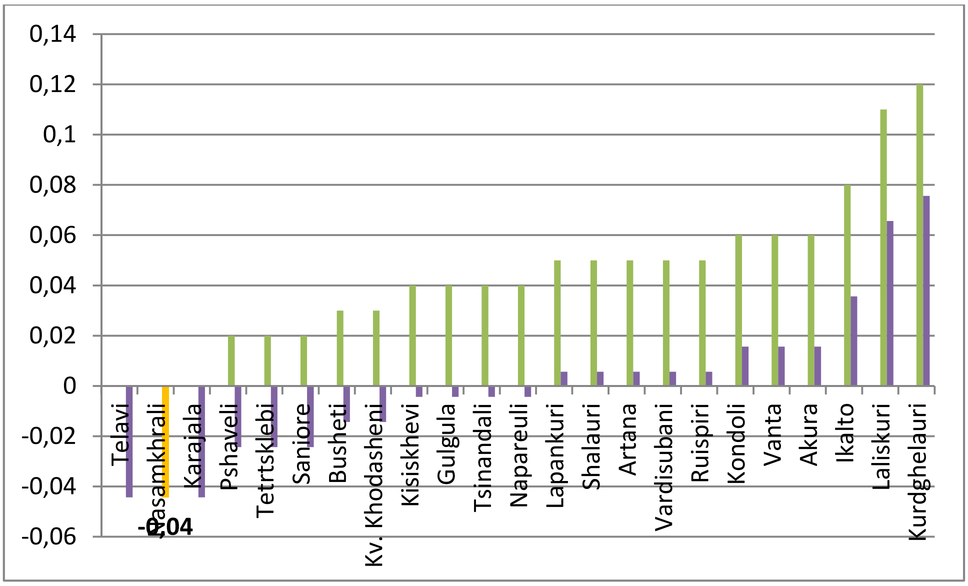
It is noteworthy that in course of the field research, as well as in reports of the National Environmental Agency, no hazardous natural phenomena were registered in the territory if the village of Nasamkhrali.

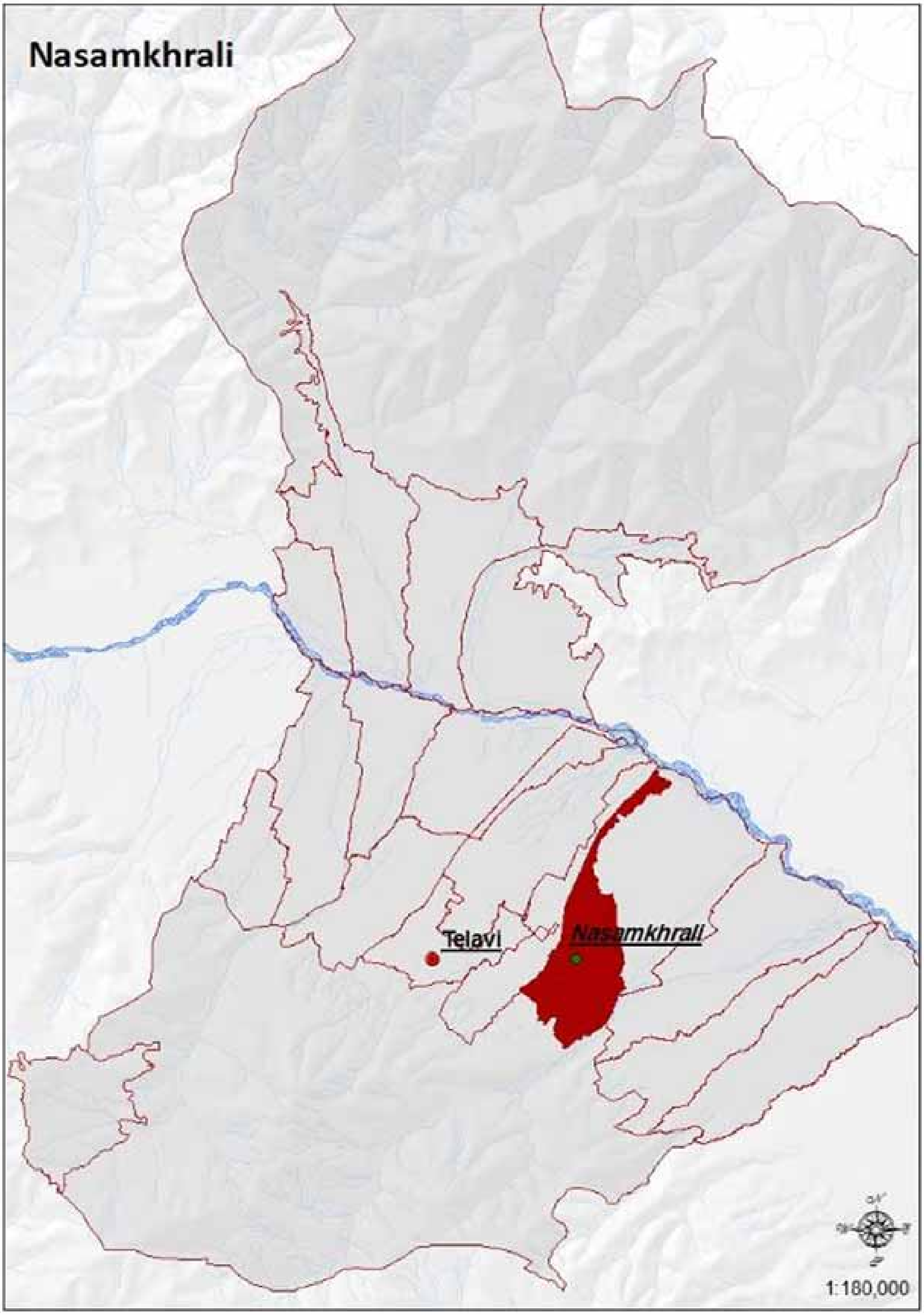
According to the data obtained from the research conducted within the framework of the program, the vulnerability of the community was assessed at 29.00 points, which is one of the lowest indicators on the scale of the whole municipality. The difference from the average municipal indicator is -6.64 points. Such a low indicator is determined, primarily, by the absence of hazard zones in the village. On the scale of the whole target region of the program, the vulnerability of Nasamkhrali community was assessed as a lower than the average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



As was already mentioned, no sources employed in the research (the National Environmental Agency, field studies, population survey) revealed any natural hazards in the territory of the community. Accordingly, the level of risk of the community was assessed as 0. Therefore, on the scale of the whole target region of the program, the level of risk of the community was assessed as a very low level of risk (see the map – Assessment of Disaster Risks of Talevi Municipality).

[6] See the resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.


0,14
0,12
0,1
0,08
0,06
0,04
0,02
0
-0,02
-0,04
-0,06
-0,04
Telavi
Pasamkhrali
Karajala
Pshaveli
Tetrtsklebi
Saniore
Busheti
Kv. Khodasheni
Kisiskhevi
Gulgula
Tsinandali
Napareuli
Lapankuri
Shalauri
Artana
Vardisubani
Ruispiri
Kondoli
Vanta
Akura
Ikalto
Laliskuri
Kurdghelauri

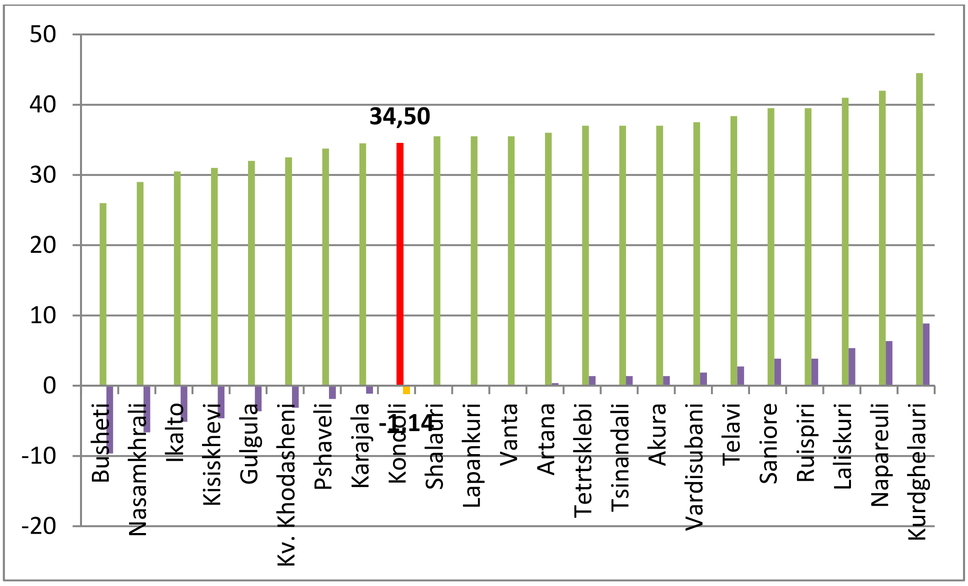

Nasamkhrali
Telavi
Nasamkhrali
1:180,000

2.2.2.13 Kondoli Community

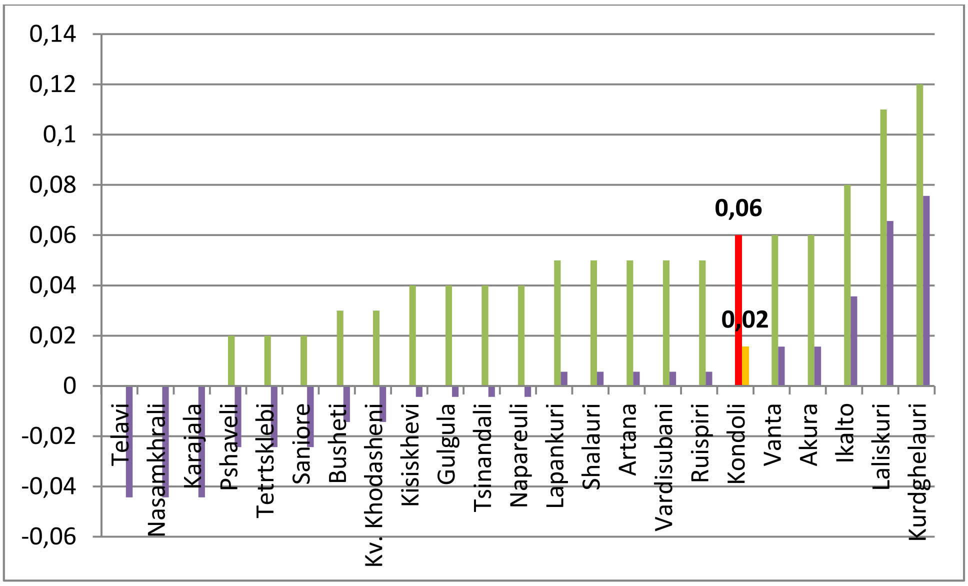
Kondoli community is located on the right bank of Alazani River, in the central part of Telavi municipality. The territory of the community is crossed by several small rivers, which are right tributaries of Alazani River. It must be noted that on a limited territory, the South-Easternmost border is delineated by River Kisiskhevi. Over the course of the field research the identified problem with regards to natural hazards were flood and coastal erosion, related to River Kisiskhevi.

The only village of the community is the village of Kondoli (its distance from the municipal center is 8 km).

According to the data of the research conducted within the framework of the program, the vulnerability of Kondoli community was assessed as 34.50 points. This index is less than the average municipal index. The difference from the average for the municipality is -1.14 points (see the graph). On the scale of the whole target scope of the program, the vulnerability of Kondoli community was assessed as of average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).

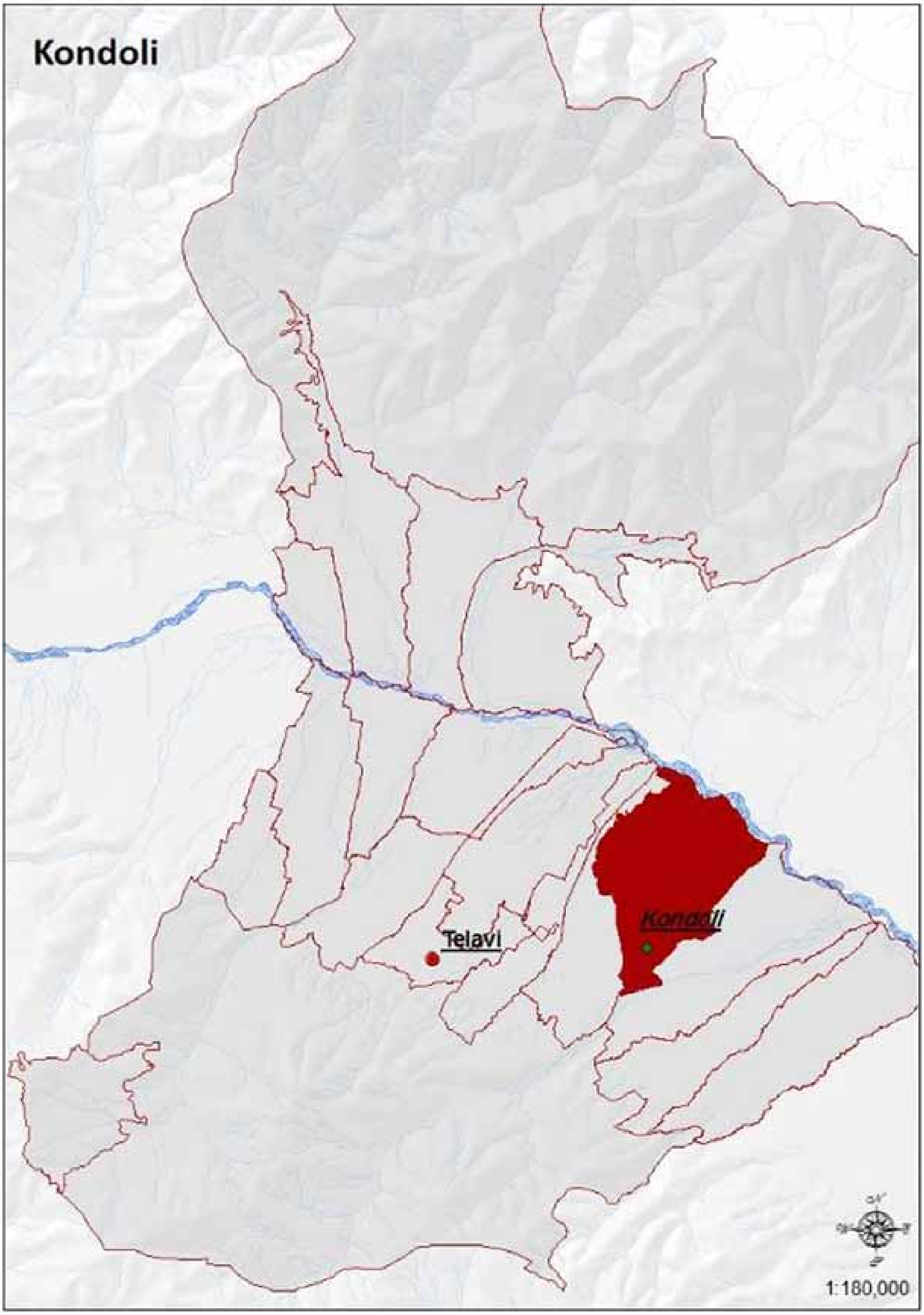


The risk of the community is determined by 0.06 unit. The difference from the average municipal index consists of 0.02 unit (see the graph). On the scale of the target scope of the program, the level of risk of the community was assessed as a average level of risk (see the map – Assessment of Disaster Risks of Telavi Municipality).



As it has been noted, out of natural hazards, the population of the community identified the problem of coastal erosion along River Kisiskhevi, which might trigger floods. Due to the erosive effect of River Kisiskhevi, a 300-meter section of concrete enbankment alongside the main bridge is damaged. In case of continued damage of the enbankment, the floods might threaten the central road of the village, as well as the nearby agricultural lands.

It should be noted that the dam was constructed in 1972 after a large scale floodings, when the water covered a large part of the rural houses and almost completely, the agricultural plots. Construction of the safety dam minimized the risk of catastrophic floods. However, nowadays along with the damage of safety dam is being increased the probability of large scale floodings. In case of safety dam damage the residential houses, personal plots and agricultural plots will be under the risk.

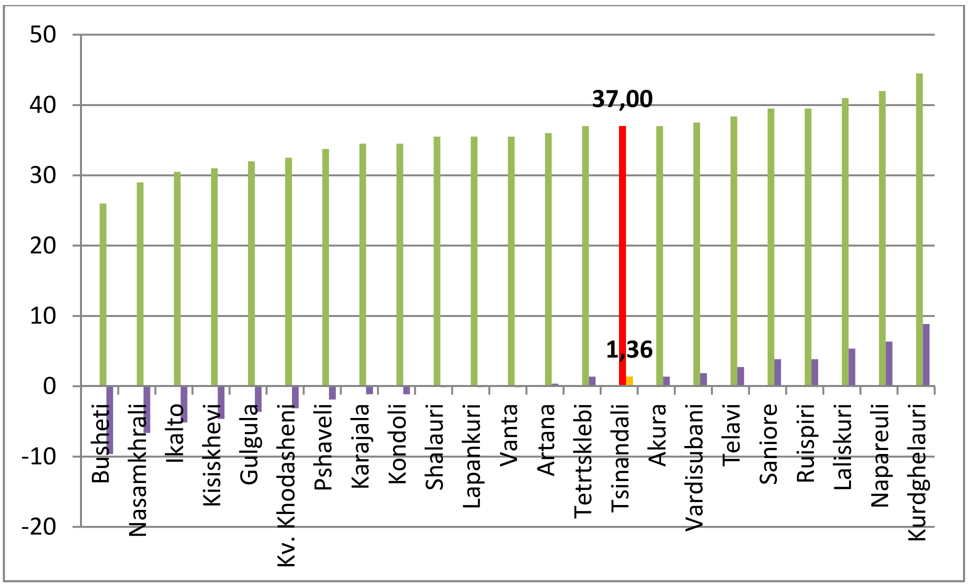

Kondoli
Telavi
Kondoli
1:180,000

2.2.2.14 Tsinandali Community

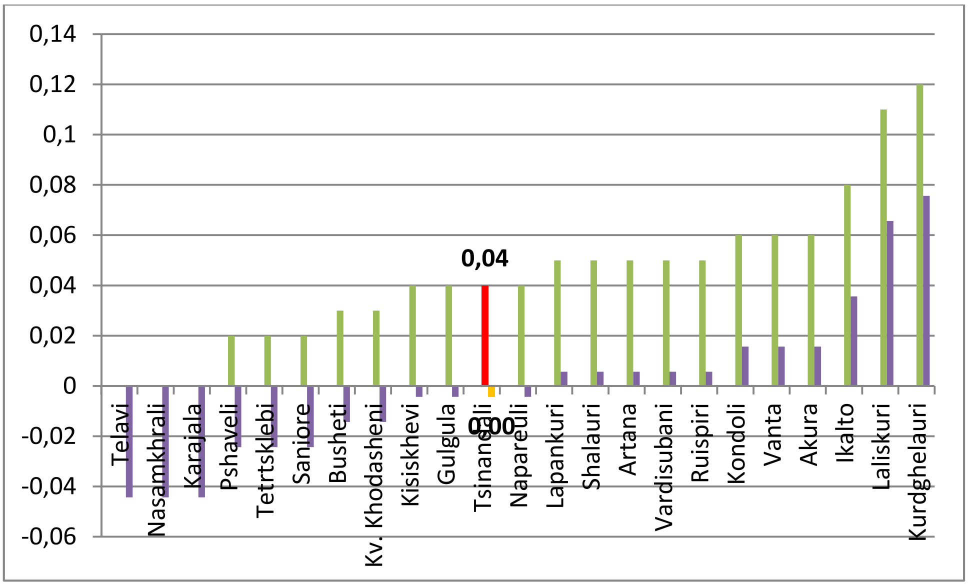
Tsinandali community is located in the eastern part of the municipality, on the right bank of the Alazani River. The only village of the community is the village of Tsinandali (its distance from the municipal center is 9 km). The village itself occupies the south-westernmost part of the community. In the northern part of the community, along the Alazani River, the agricultural lands of the village are located. The community is crossed from the south to the north by the Kisiskhevi River, a right tributary of the Alazani River, which gathers its waters in the northern foothills of the Gombori Range, crosses the territory of the Kisiskhevi community and merges with the Alazani River in its lower course in the territory of Tsinandali community.

Over the course of the field research the main problem with regards to natural hazards, indicated by the population, was mudflow processes.

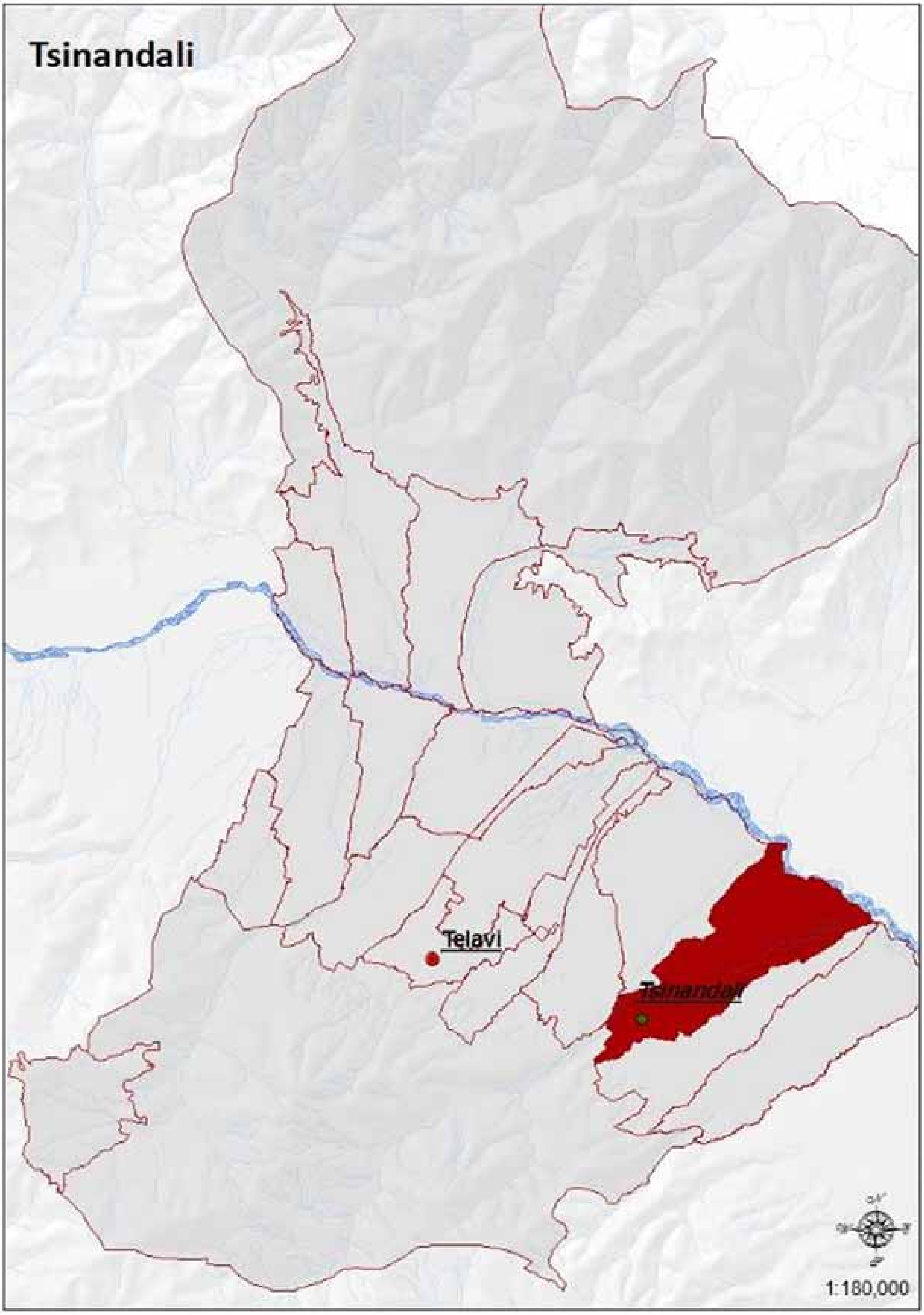
According to the data of the research conducted within the framework of the program, the vulnerability of Tsinandali community was assessed as 37.00 points. With this indicator, the community is close to the average vulnerability of the municipality, which is 35.64 points. The difference from the average for the municipality is 1.36 (see the graph). On the scale of the whole target scope of the program, the vulnerability of Tsinandali community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



Based on the data of the research, the level of risk of the community was assessed as 0.04, which is exactly the same as the average for the municipality (see the graph). Based on this it can be concluded that the community is not distinguished by a particularly high indicator of risks among other communities. On the scale of the target scope of the program, the level of risk of the community was assessed as a lower than the average level of risk (see the map – Assessment of Disaster Risks of Telavi Municipality).



The detailed situation in the village with respect to existing natural hazards is the following: The Kisiskhevi River, as well as other small gorges present in the territory of the community, (for instance the Doliauri Gorge) are ***mudflow*** prone. In spring, in times of intensive snowmelt or abundant precipitation, mudflow streams form in the gorges and damage a significant part of the agricultural lands of the population (up to 120 ha in total). Also, a significant part of the roads leading to the lands are damaged.

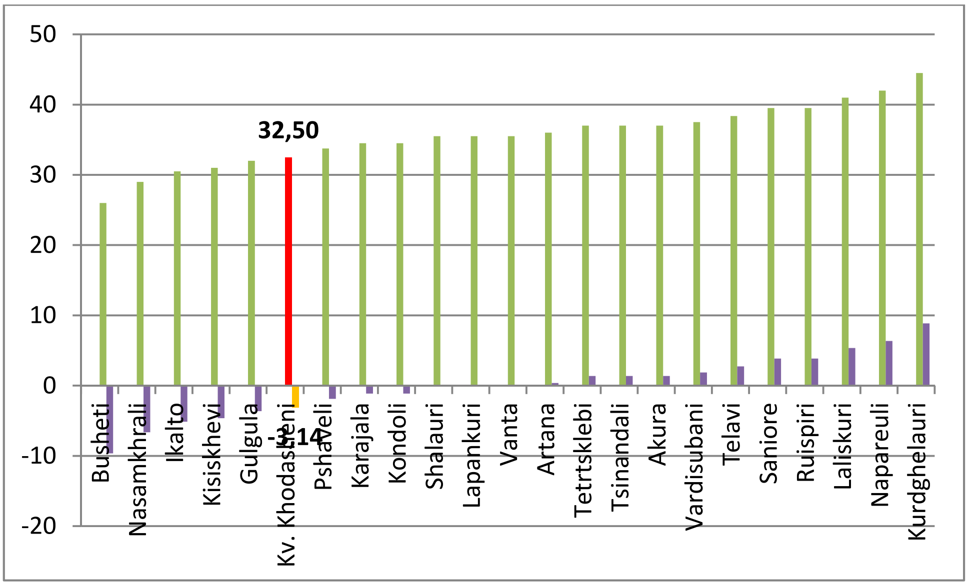

Tsinandali
Telavi
Tsinandali
1:180,000

2.2.2.15 Kvemo Khodasheni Community

Kvemo Khidasheni community is located in the eastern part of Telavi Municipality. Until 2010, the community comprised the villages of Busheti and Kvemo Khodasheni. After 2010, when the new statue of the municipality was adopted, the community was divided into two independent territorial units – the Khodasheni and Busheti communities.[7] The distance of the village of Kvemo Khodasheni from the municipal center is 9 km.

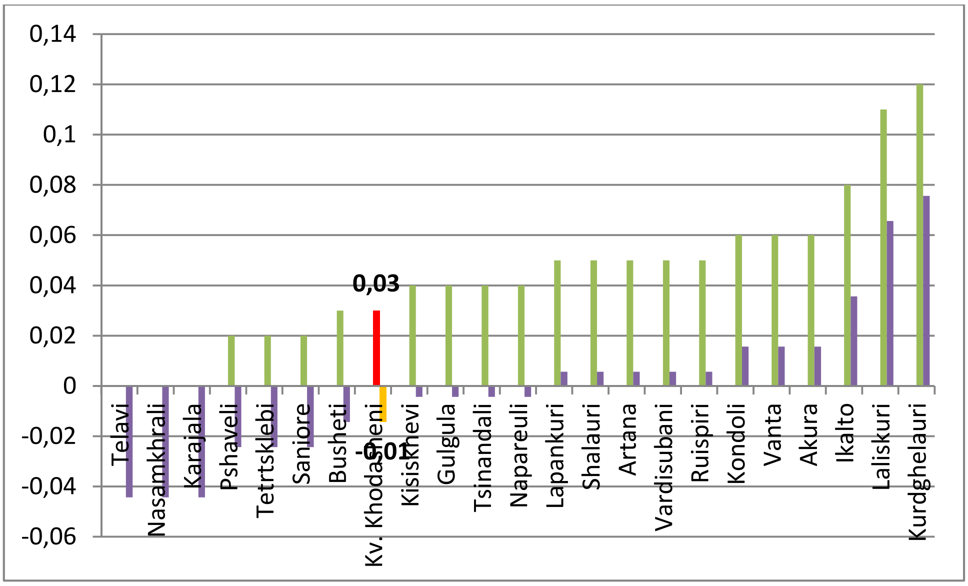
The territory of the community is crisscrossed by multiple gorges, the majority of which are mudflow prone. In this respect, the gorges of Khodasheni and Busheti are particularly noteworthy. During the course of field research, the population indicated mudflows as the main problem of the community.

According to the data obtained from the research conducted within the framework of the program, the vulnerability of the community was assessed at 32.50 points, which is lower than the average municipal indicator. The difference from the municipal average is -3.14 points (see the graph). On the scale of the target scope of the program, the vulnerability of Khodasheni community was assessed as a lower than the average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



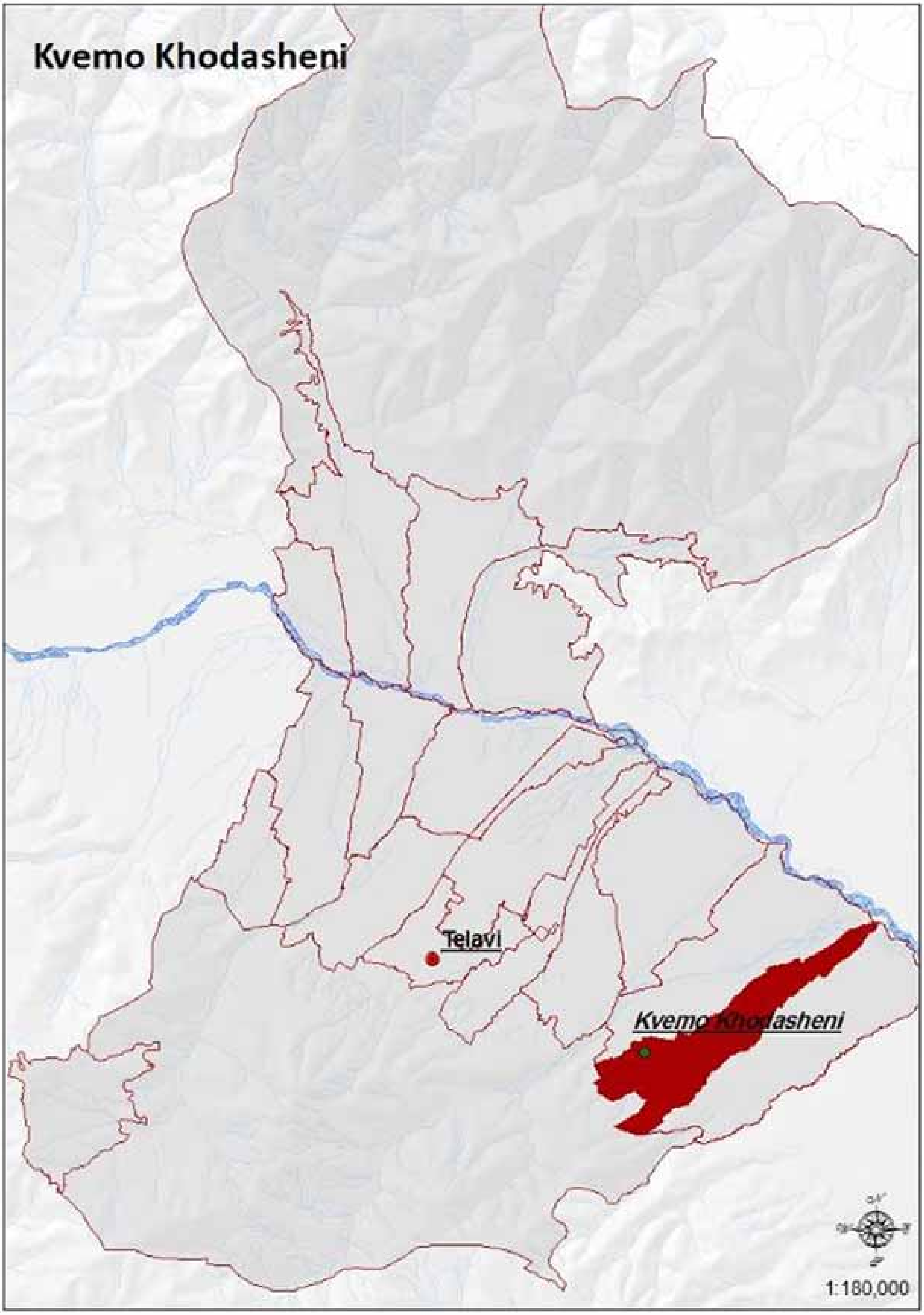
The level of risk for Kvemo Khdasheni community was assessed as 0.03 points, which is slightly lower than the average municipal indicator. The difference is only -0.01 point (see the graph). On the scale of the whole scope of the program the risk of the community was assessed as a lower than the average level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).

[7] See resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.



A detailed picture of the situation in the community with respect to hazardous natural phenomena is provided below.

Powerful ***mudflows*** are characteristic of the Khodasheni and Busheti gorges passing through the community. The Khodasheni gorge, with the debris carried in mudflows, damages the road connecting the agricultural lands to the village. At the segment of confluence of the Khodasheni and Busheti gorges, where mudflow streams carried by both gorges merge into one another, mudflow mass damages up to 50 ha area of agricultural lands. Roads leading to these lands are also being damaged. The cattle farm located by the Busheti gorge is also endangered.

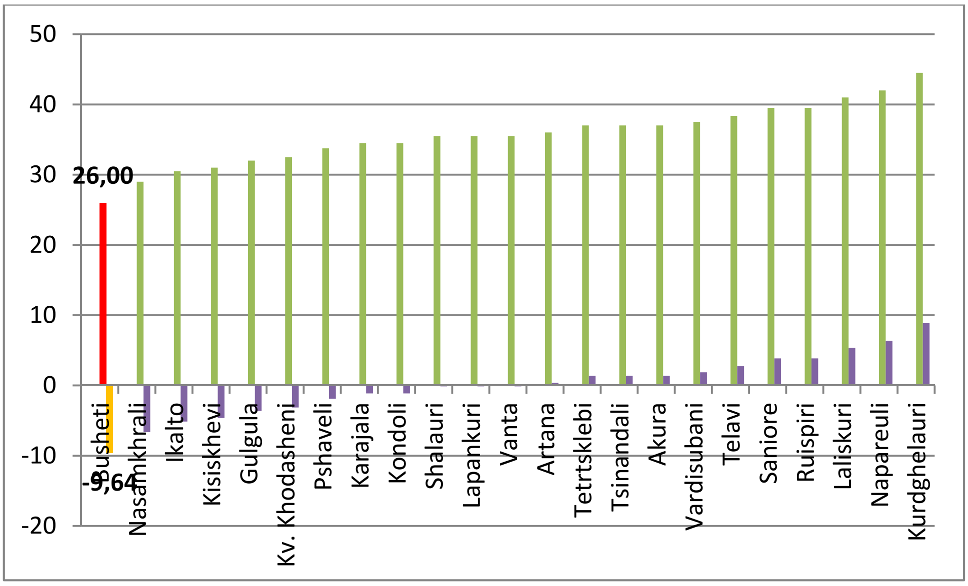

Kvemo Khodasheni
Telavi
Kvemo Khodasheni
1:180,000

2.2.2.16 Busheti Community

Busheti community is located in the eastern part of Telavi Municipality. The community consists of the village of Busheti, which was a part of Kvemo Khodasheni community until 2010. Since 2010, according to the new statute of the municipality, Busheti community has been defined as a separate territorial unit.[8] The distance of the village from the municipal center is 12 km.

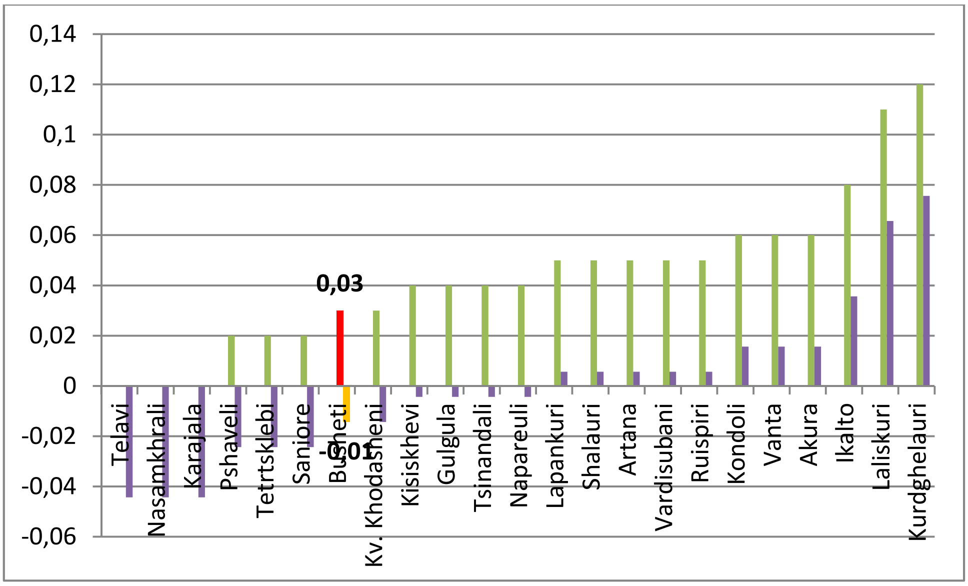
During the course of field research the main problem of the community with respect to hazardous natural events, indicated by the population, was mudflow processes. Mudflow streams are characteristic of the Busheti Gorge, which crosses the community.

As a result of the data obtained from the research conducted within the framework of the program, the vulnerability of Busheti community was assessed at 26.00 points. This indicator is one of the lowest in the whole municipality. The difference from the average municipal indicator is rather high and equals -9.64 points (see the graph). Such a low level of vulnerability was determined by the fact that according to all criteria for assessment of vulnerability, indicators for the community are lower than average indicators for the municipality. On the scale of the whole target scope of the program the level of vulnerability of the community was assessed as a lower than the average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



As a result of the conducted research, the level of risk of the community was assessed as 0.03 points, which is slightly less than the average municipal indicator. The difference is -0.01 point (see the graph). On the scale of the whole target scope of the program, Busheti community risk level was assessed as a lower than the average level of risk (see the map – Assessment of Disaster Risks of Telavi Municipality).

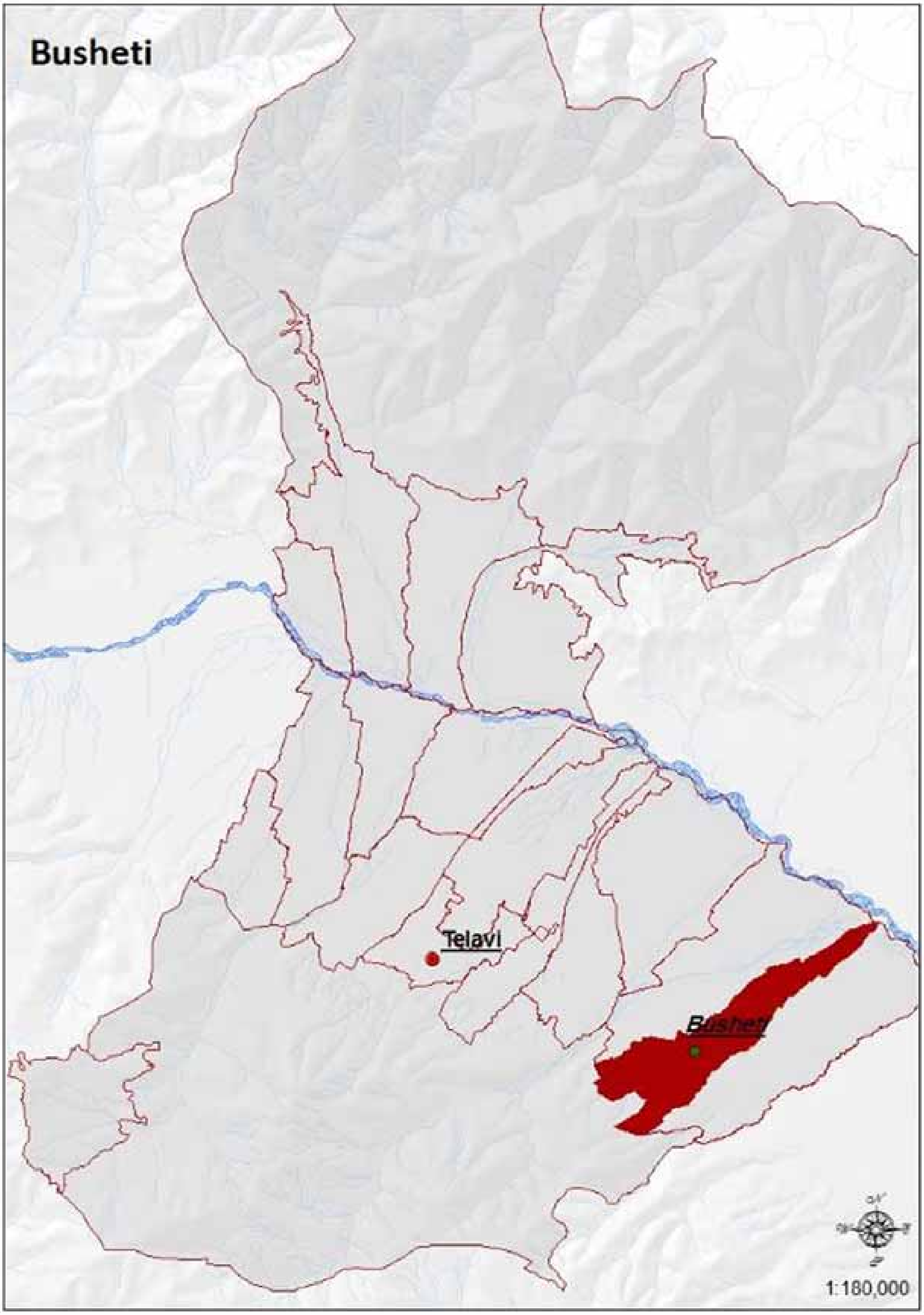
[8] See resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.



A detailed picture of the situation in the community in respect of hazardous natural phenomena is provided below.

As was mentioned, the main problem of the village is ***mudflow*** processes, which are related to mudflow streams formed by the Busheti Gorge passing through the village. The watercourse is filled with debris and, therefore, the gorge cannot host surplus water. The resultof this is thatmudflow mass overflows and damages houses and crofts of 3 households in the so-called Kaloebis neighborhood. Also a 40 m segment of neighborhood roads in the village are being damaged. Mudflow streams also endanger the main building of the drinking water supply system.

On the northern periphery of the village, where main agricultural lands of the village are located, mudflows formed on the Busheti gorge damaged agricultural lands (area of 8 ha) and the road leading to these lands. Mudflow streams also endanger a 50 m segment of the railway.


Busheti
Telavi
Busheti
1:180,000

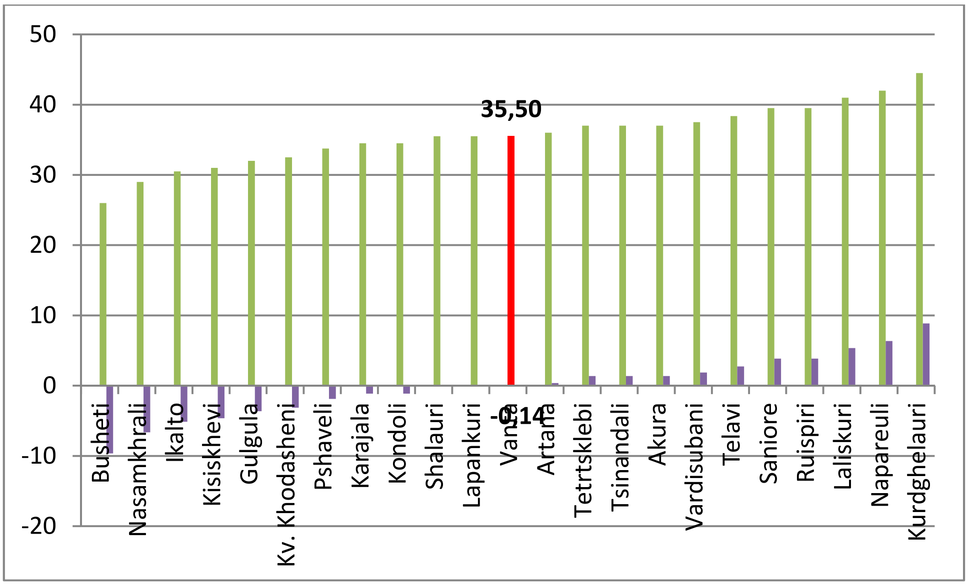
2.2.2.17 Vanta Community

Vanta community is located in the eastern part of Telavi Municipality, on the right bank of Alazani River. The community consists of one big village, the village of Vanta. Until 2010, the village, together with the village of Akura, made up the Akura community. After 2010, according to the new statute of the municipality, Vanta community was established as a different territorial unit.[9] The villages of Vanta and Akura are divided by the Vantiskhevi River passing between them. The Vantiskhevi River gathers its waters on the northern slopes of Gombori Range, crosses the territories of Vanta and Akura communities and merges into the Alazani River on its right.

The distance between the village of Vanta and the municipal center is 15 km.

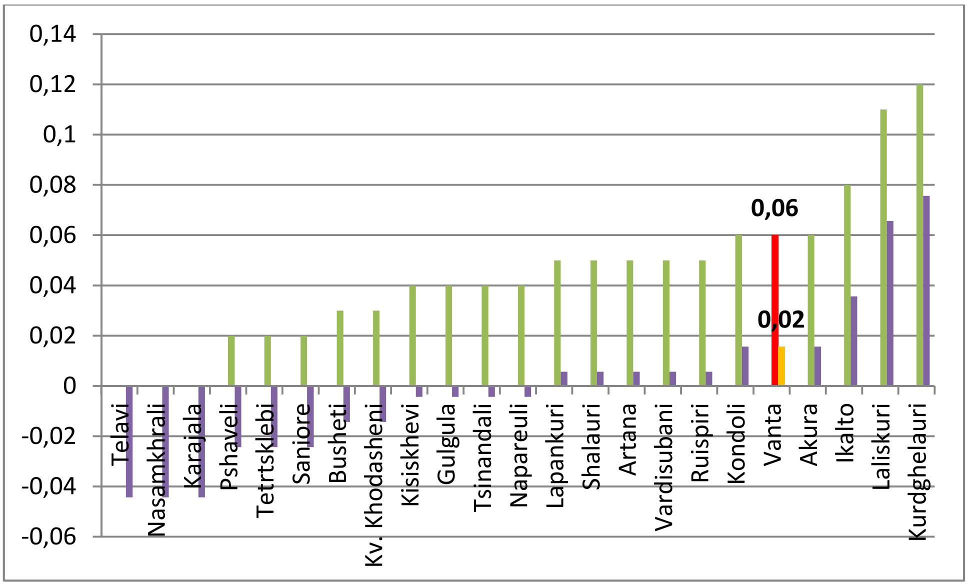
The result of field research found that mudflow processes were detected in the community, which is related to mudflow streams forming periodically in the Vantiskhevi River watercourse.

According to the results of the research conducted within the framework of the program, the vulnerability of the community was assessed at 35.00 points. This indicator is almost the same as the average for the municipality. The difference from the average for the municipality is insignificant and equals -0.14 points (see the graph). On the scale of the target scope of the program, the vulnerability of the community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



The level of risk of Vanta community, based on the results of the conducted research, was assessed as 0.06 points. This indicator is rather high on the scale of the municipality (the difference from the average for the municipality is 0.02, see the graph). On the scale of the whole target scope of the program, the level of risk of the community was assessed as an average level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).

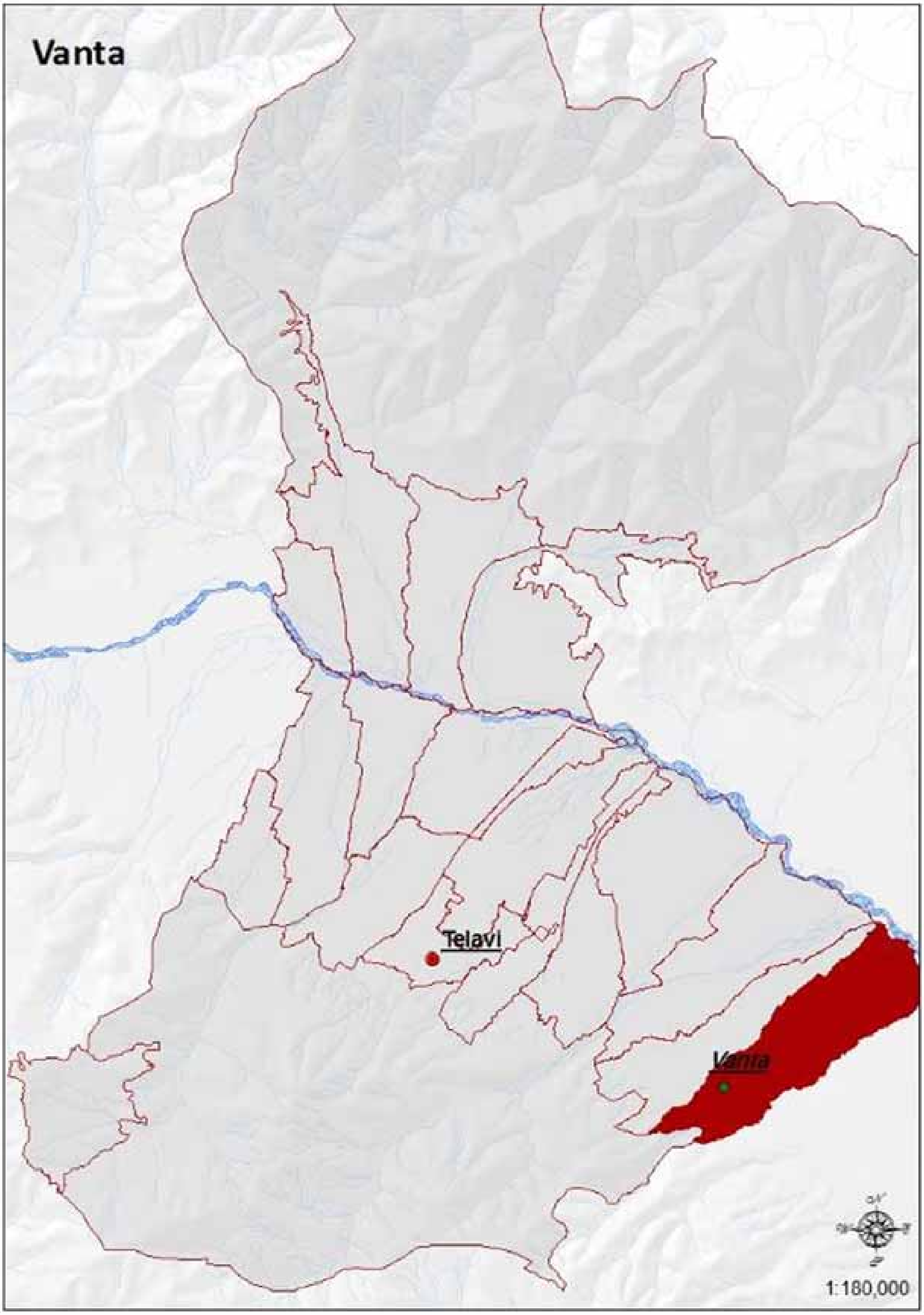
[9] See resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.



A detailed picture of the situation of the community, in respect of natural hazards, is presented below.

The main source of the village problems, with respect to hazardous natural processes, is ***mudflow*** processes developed in the Vantiskhevi River. The watercourse is filled with debris, as a result of which the riverbed is elevated to the extent that it exceeds the height of the adjacent territories (where agricultural lands of the village are located). In spring, during periods of intensive snowmelt and abundant precipitation, water and debris from the Vantiskhevi River damage the agricultural lands of the village (approximately 60 ha), it also damages the railway (a segment of approximately 30 m) and the road leading to agricultural lands.

An identical problem is present at the head of the village (the southernmost periphery of the village), where mudflow streams endanger the houses and crofts of the population. Also the school, along with segments of the central and neighborhood roads are endangered.


Vanta
Telavi
Vanta
1:180,000

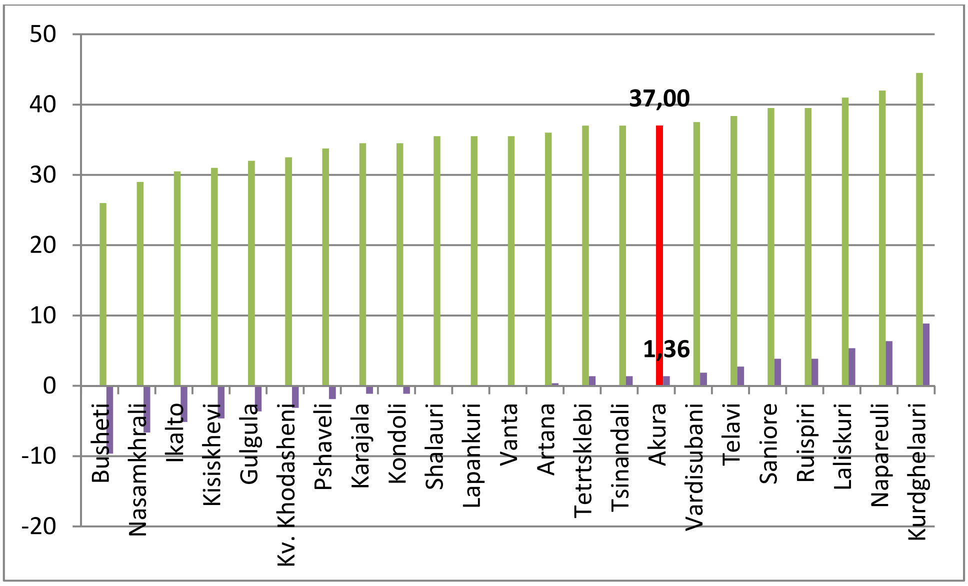
2.2.2.18 Akura Community

Akura community is located in the easternmost part of Telavi Municipality. It immediately borders Gurjaany Municipality on the east side. The community occupies the right bank of the Alazani River. The village consists of only one village – the village of Akura, which constituted Akura community together with the village of Vanta until 2010. Since 2010, according the the new statute of the municipality, the village of Vanta was separated from Akura community and two territorial units – that of Vanta and that of Akura were formed.[10] The border between these two communities is the Vantiskhevi River, which gathers its waters on the northern slopes of Gombori range, crosses the territories of Vanta and Akura municipalities and merges into the Alazani River from its right. There is another big river in the territory of the community – the Akuriskhevi River, a right tributary of the Alazani River, which forms the border between the Telavi and Gurjaani municipalities.

The distance of the village of Akura from the municipal center is 15 km.

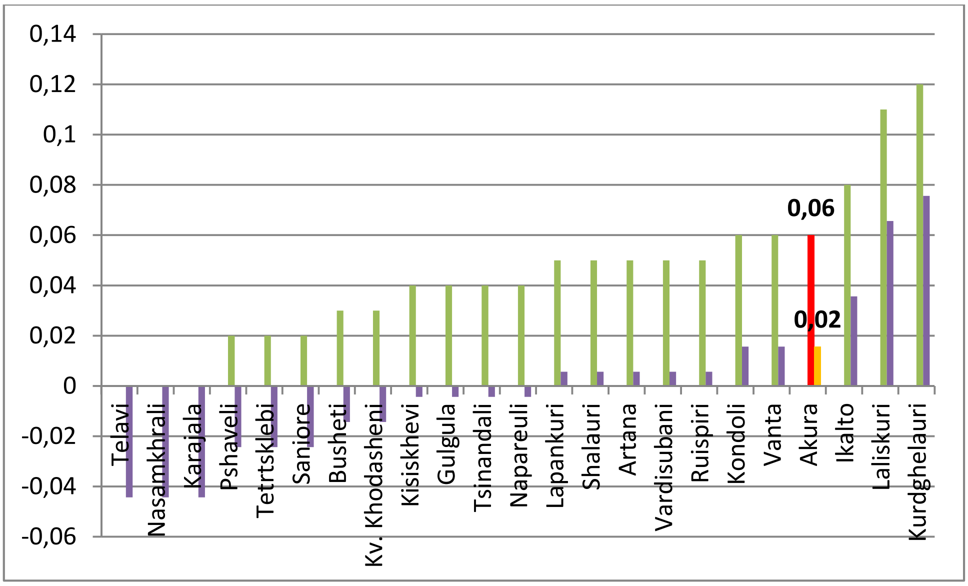
As a result of field research, mudflow processes were detected in the community. These are related to mudflow streams that form periodically in the watercourse of the Vantiskhevi River.

According to the results of the research conducted within the framework of the program, the vulnerability of Akura community was assessed at 37.00 points, which is higher than the average for the municipality, equaling 35.64 points for Telavi municipality. The difference from the average for the municipality, accordingly, is 1.36 points (see the graph). On the scale of the target scope of the program, the vulnerability of Akura community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



The level of risk of Akura community, according to the results of the conducted research, was assessed as 0.06 points. This is high on the scale of the municipality (the difference from the average fro the municipality is 0.02 points, see the graph). On the scale of the whole target scope of the program, the level of risk of the community was assessed as an average level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).

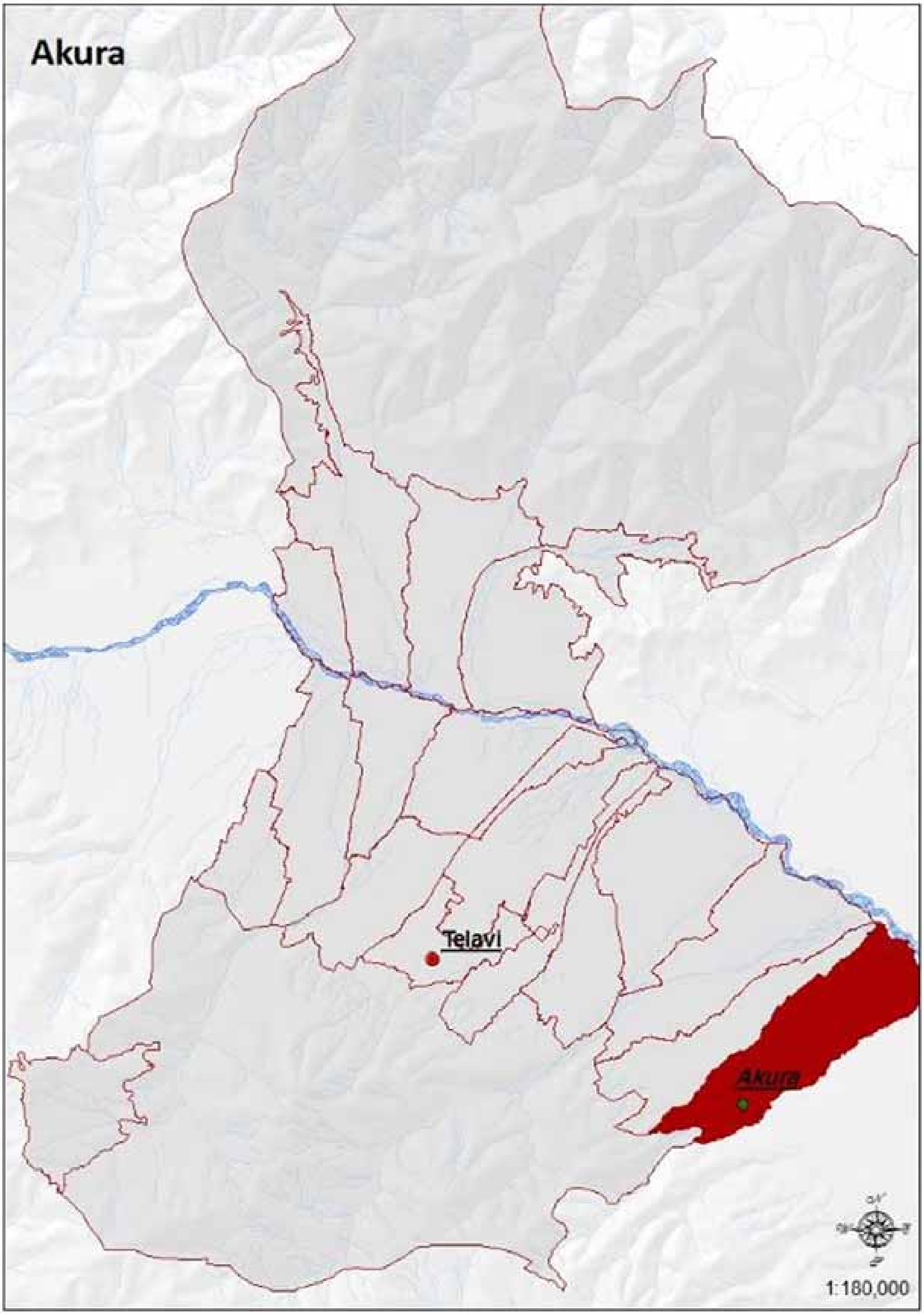
[10] See resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.



The information on natural hazards detected in the community as a result of the field research is presented below.

The main problem of the village, with regards to hazardous natural processes, is ***mudflow*** steams, formed on the Vantiskhevi River. At the top of the village (the southern periphery of the village, the northern hillside of Gombori Range), surplus water and mudflow streams damage crofts of the population (5 households) and the ambulance of the village. In case of a relatively powerful mudflow, the mini-football pitch, gas station and the power transformer of the village are also endangered.

On the northern periphery of the village, along the Alazani River, where the main agricultural lands of the village are located, the watercourse of the Vantiskhevi River exist. Accordingly, mudflow streams coming from the watercourse flow over the banks and damage or endanger a significant part of the agricultural lands of the village (approximately 100 ha area is damaged to varying degrees). Also, the road leading to these agricultural lands is being damaged.


Akura
Telavi
Akura
1:180,000

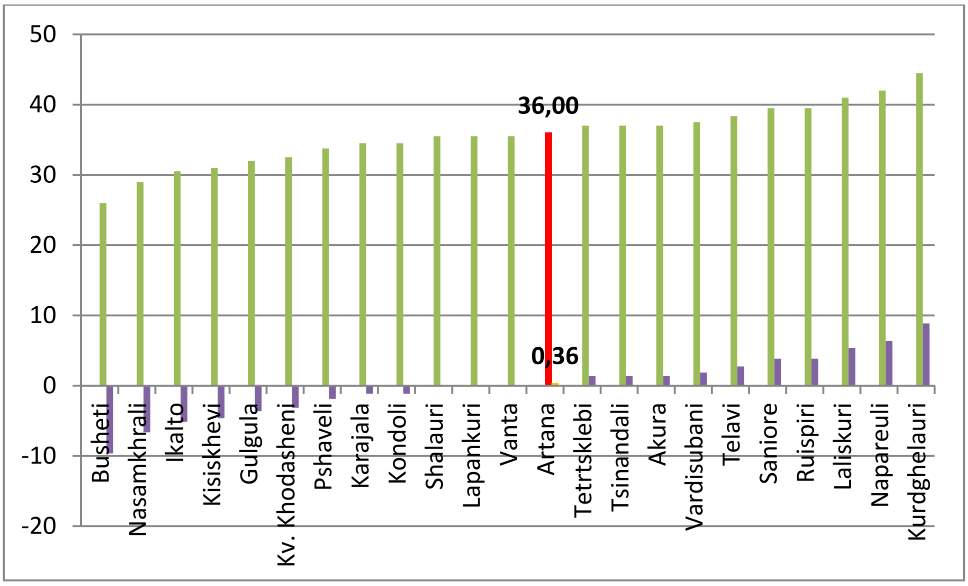
2.2.2.19 Artana Community

Artana community is located in the central part of Telavi Municipality, in the upper course of the Lopota River (a left tributary of the Alazani River), and the gorge of its right tributary, the Didkhevi River. A small portion of the territory of the community is crossed by the Lopota River too, on the right bank of which many agricultural lands of the village are located.

Artana community is comprised of Artana village only. Until 2010, the village of Artana was a part of Saniore community. After 2010, according the new statute of the municipality, the village of Artana was separated from Saniore community and was established as an independent territorial unit.[11] The distance of the village from the municipal center is 27 km.

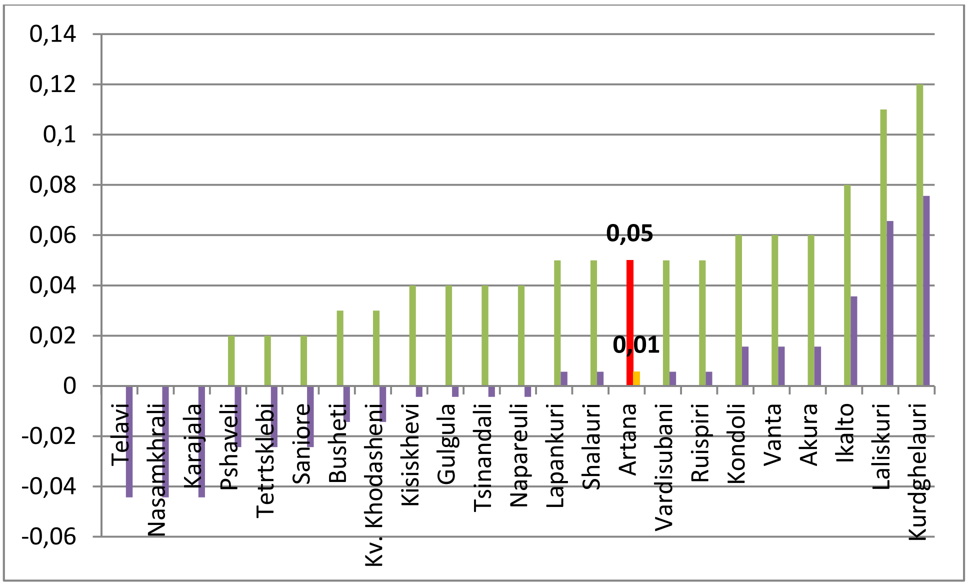
During the course of the field research, mudflows and floods were detected among the local natural disasters, and are accompanied by the intensive washing of riverbanks. A landslide process was also registered.

According to the results of the research conducted within the framework of the program, the vulnerability of Artana community was assessed as 36.00 points, which is slightly higher than the average for the municipality. The difference form the municipal average is 0.36 points (see the graph). In general, on the scale of the target scope of the program (target watersheds), the vulnerability of Artana community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



The level of risk for Artana community was 0.05 points. This indicator is higher than the average for the municipality (the difference is 0.01 point, see the graph). Accordingly, it can be concluded that the level of risk of Artana community is higher than the average level of risk for Telavi municipality. On the scale of the whole target scope of the program, the level of risk of the community was assessed as an average level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).

[11] See resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.



A detailed picture of the situation of the community with respect to hazardous natural events is presented below.

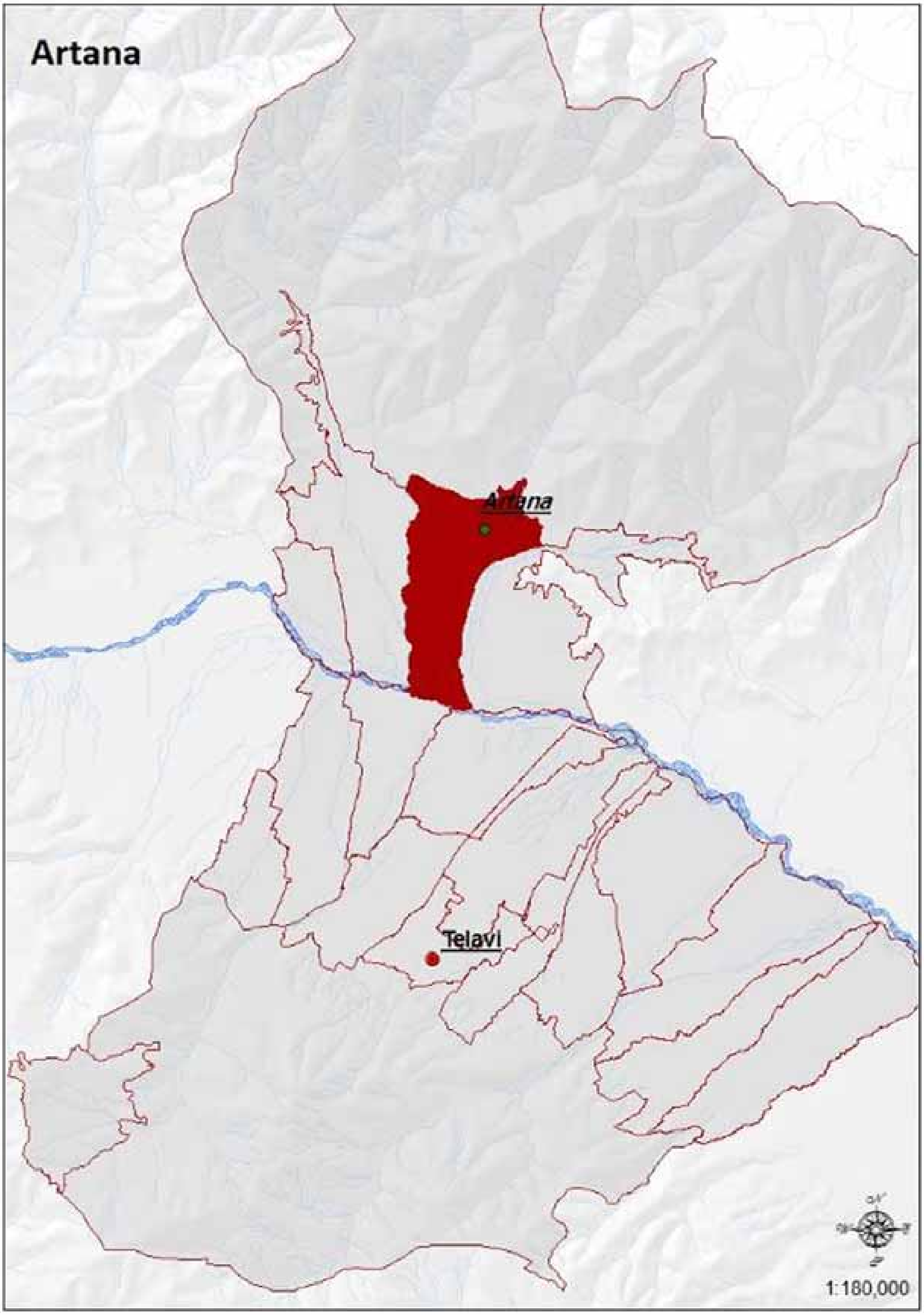
Powerful ***mudflow*** streams and ***floods***, accompanied by intensive washing of riverbanks, are characteristic of the Didkhevi River flowing in the eastern part of the village.

The gorge of the river has an open shape with bilateral first floodplain terraces, which rise 3-5 m over the riverbed. Along the motor road, on the right bank of the river, a gabion was constructed, which was damaged and is now submerged in water; it, however, is ineffectual for shore protection. The river washes banks intensively. Below the motor road, the right bank of the river is being washed along a 500 m segment, endangering houses. On the left bank of the river, washing damages vineyards. On this segment, the width of the riverbed is 25-30 m; the flow speed is high.

At the same time, cases of mudflow streams and floods are also frequent. In May of 2005 a flood occurred in the Mamukaant neighborhood, two houses with their crofts were damaged, and poultry were killed. If a mudflow stream such as this occurs again, houses and crofts (of 4 households) will be endangered. The bridge, segments of neighborhood roads, roads connecting the village with its fields and high voltage transmission masts will be also endangered.

During the course of the field research, a ***landslide*** body was also detected in the northern periphery of the village, in the gorge of the Didkhevi River. The landslide is presumably related to the erosion of the river, which carried away the support of the left bank, this is where the landslide has developed. Further activation of the landslide process may cause blockage and flooding of the river, which, in turn, may lead to the formation of a powerful mudflow stream, endangering part of the village and agricultural lands. The situation can be evaluated with the aid of the satellite image, in which the interrelation of the landslide center, the river and the settled part of the village is clearly seen (the landslide affected area is marked red).


Google earth


Artana
Artana
Telavi
1:180,000

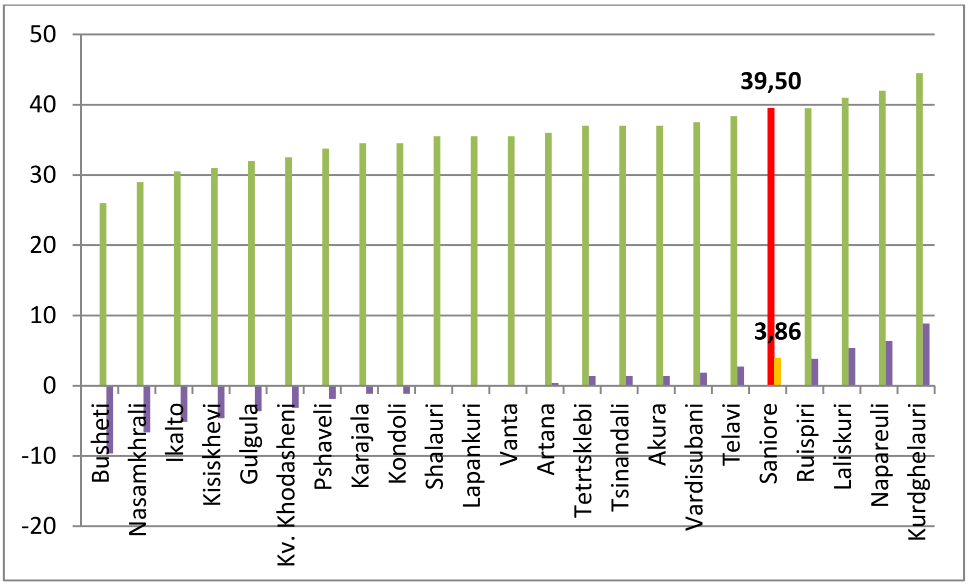
2.2.2.20 Saniore Community

Saniore community is located in the central part of Telavi Municipality, on the left bank of the Alazani River and on the right bank of the Lopota River. The Lopota River gathers its waters on the southern slopes of the Caucasus Watershed Range, crosses the Lapankhuri community, and forms a natural border between the Saniore and Napareuli communities in its lower course before merging into the Alazani River from the left.

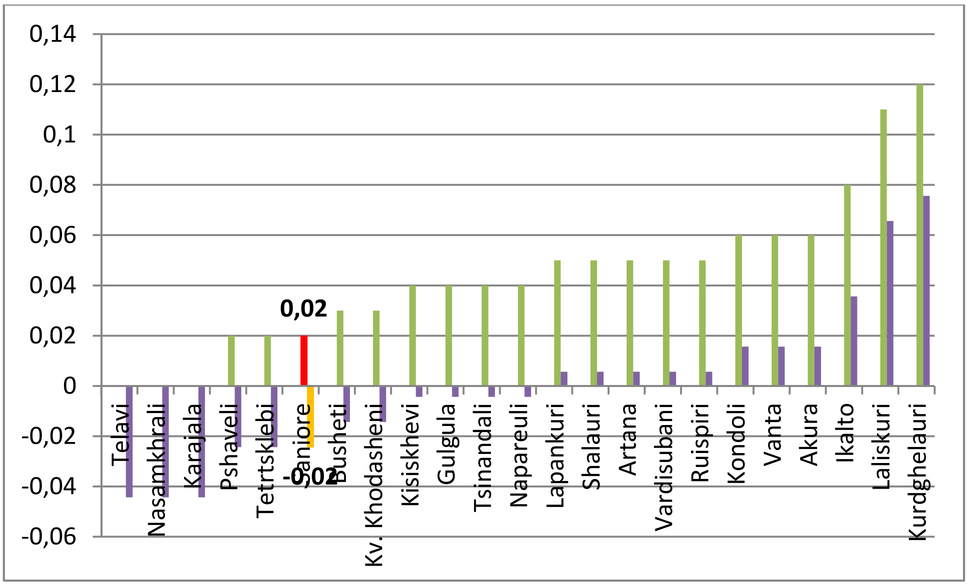
Saniore community consists of two villages – the villages of Saniore and Jughaani. The average distance of the villages from the municipal center is 26 km.

Hazardous natural events detected in the community during the course of the field research are mainly related to mudflow streams developed on the Lopota River.

According to the results of the research conducted within the framework of the program, the vulnerability of the community was assessed at 39.50 points, which is higher than the average indicator for the municipality. The difference from the municipal average is 3.86 points (see the graph). Accordingly, the community is distinguished by a relatively high vulnerability. On the scale of the target scope of the program (target river basins) the vulnerability of Saniore community was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



The level of risk of Saniore community was assessed as 0.02 points, which is somewhat lower than the average municipal indicator, which is 0.04 point for Telavi municipality. The difference from the municipal average is -0.02 points (see the graph). On the scale of the target region of the program, the level of risk of the community was assessed to have a lower than the average level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).

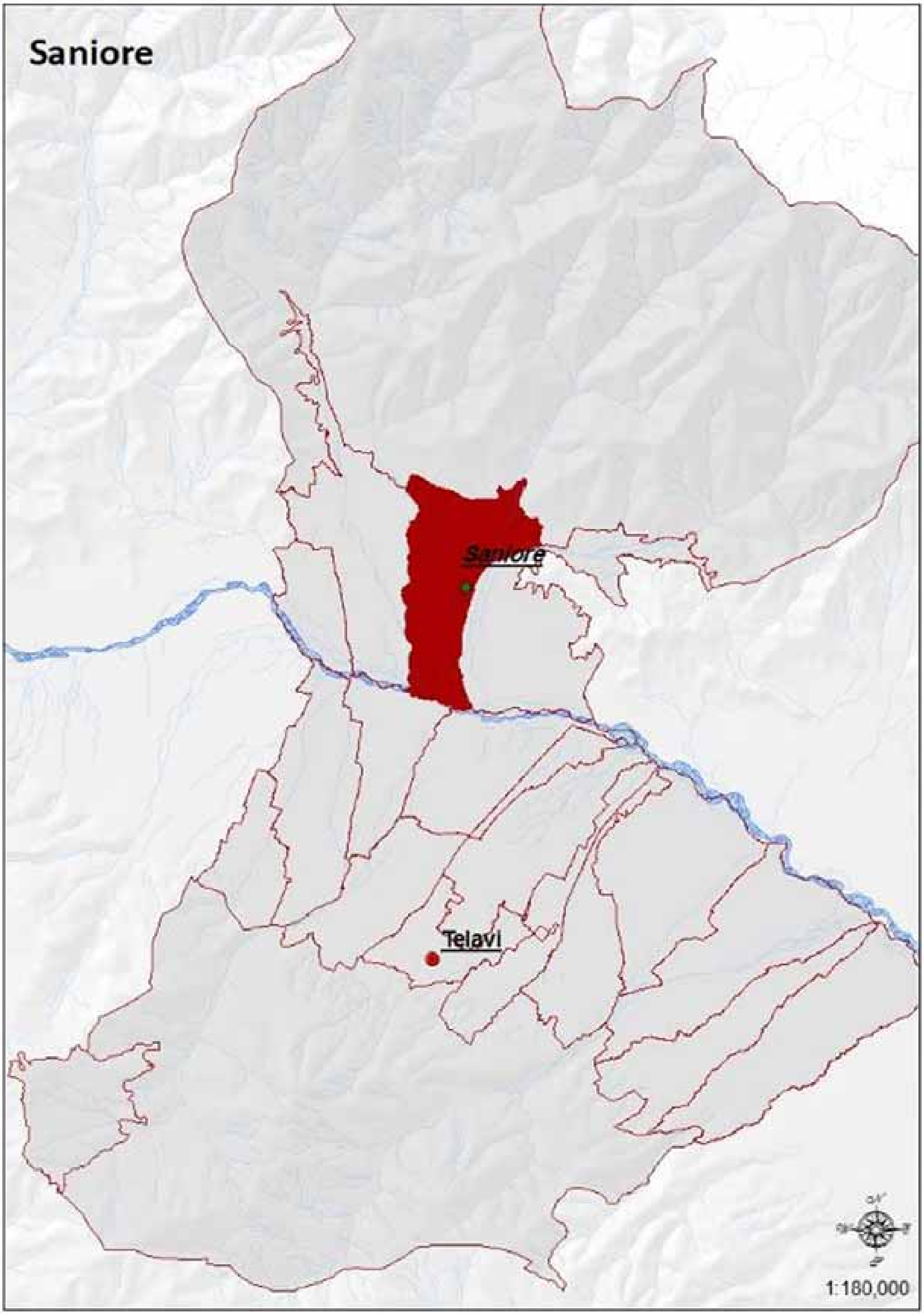


The situation in the community, with respect to hazardous natural phenomena, is presented below. It should be mentioned here than in the course of field research, such phenomena were detected only in the village of Saniore.

The main problem of Saniore village is related to ***mudflows*** and ***floods***, formed on the Lopota River, the intensive washing of riverbanks is also a problem in the territory.

In the territory of the village, the Lopota River washes its banks intensively. On the right bank, a terrace reaching up to 5 m in height, composed of pebbles and sandy-clay fillers, is being washed. Along the right bank, a shore protecting construction with concrete tiles and the dumped soil dam have been entirely washed away. The population living in the zone close to the floodplain and the nearby building materials factory are endangered. On the right bank of the river, 8 houses are inside the hazard zone.

On the northern periphery of the village, near the confluence of the rivers Didkhevi and Lopota, due to the damaged shore protection construction, the river flows over the watercourse and floods crofts of the population (4 households). High voltage transmission masts and neighborhood roads (the reserve road connecting Artana and Saniore) are also endangered.

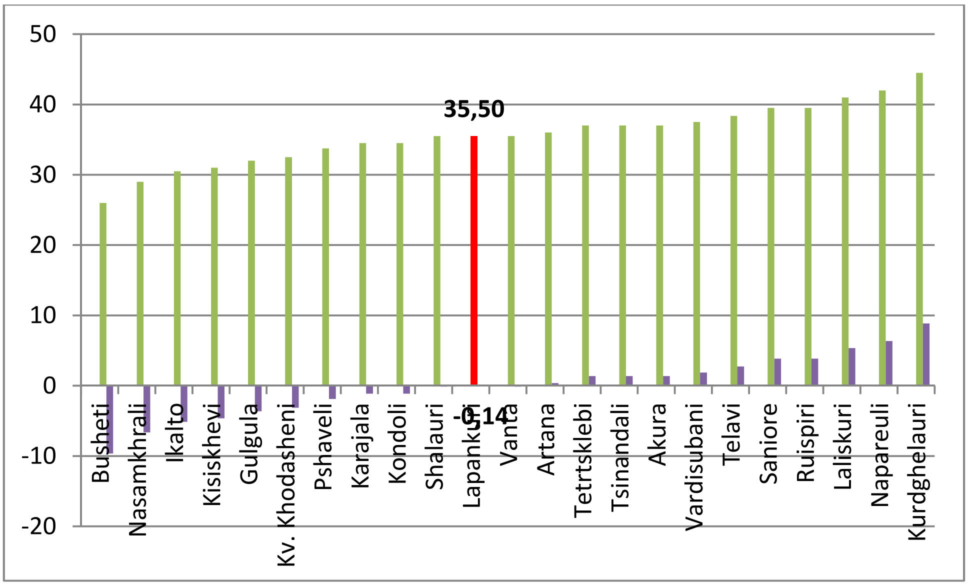

Saniore
Saniore
Telavi
1:180,000

2.2.2.21 Lapankhuri Community

Lapankhuri community is located in the north-easternmost part of Telavi Municipality. The territory of the community immediately borders the southern slopes of the Main Caucasus Watershed Range. The main river of the community is the right tributary of the Alazani River, the Lopota River. Lapankhuri is the highest settled unit in the basin of this river. The village of Lapankhuri was a part of Napareuli community until 2010. After 2010, according to the new statute of the municipality, the village of Lapankhuri was separated from Napareuli community and was established as an independent territorial unit.[12] The distance of the village from the municipal center is 33 km.

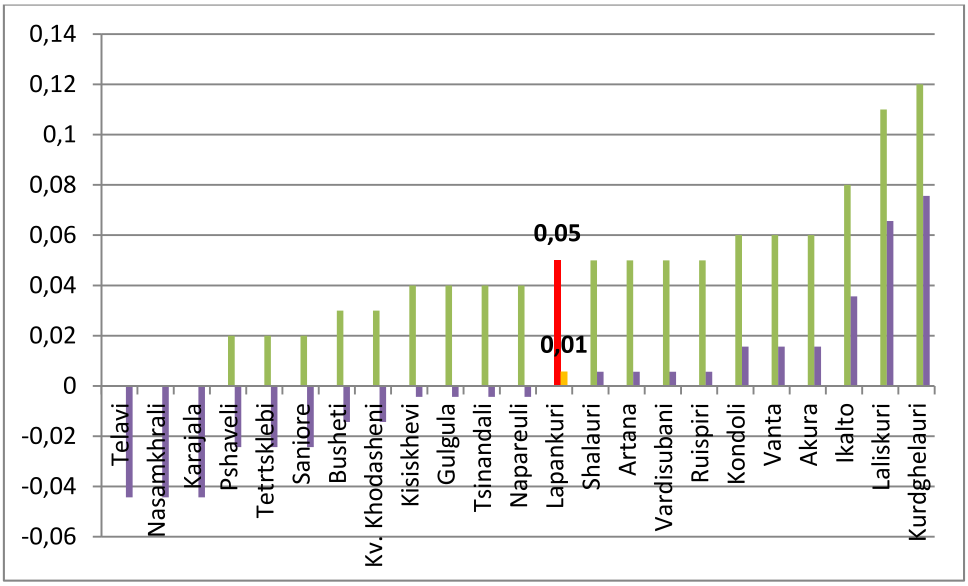
During the course of field research, flood and riverbank washing were identified as natural hazards in the village.

According to the results conducted within the framework of the program, the vulnerability of Lapankhuri community was assessed at 35.50 points. This indicator is almost equal to the average of the municipality. It minimally (by -0.14 point) exceeds the average municipal indicator (see the graph). On the scale of the target scope of the program, the vulnerability of the municipality was assessed as an average level of vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



The level of risk of Lapankhuri community is 0.05 point. This indicator is higher than the average municipal indicator (the difference is 0.01 point, see the graph). On the scale of the whole target scope of the program, the level of risk of the community is assessed as an average level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).

[12] See the resolution #19 of Telavi Municipality Council – "Concerning the Approval of the Statute of Telavi Municipality Adinistration", September 14, 2010.



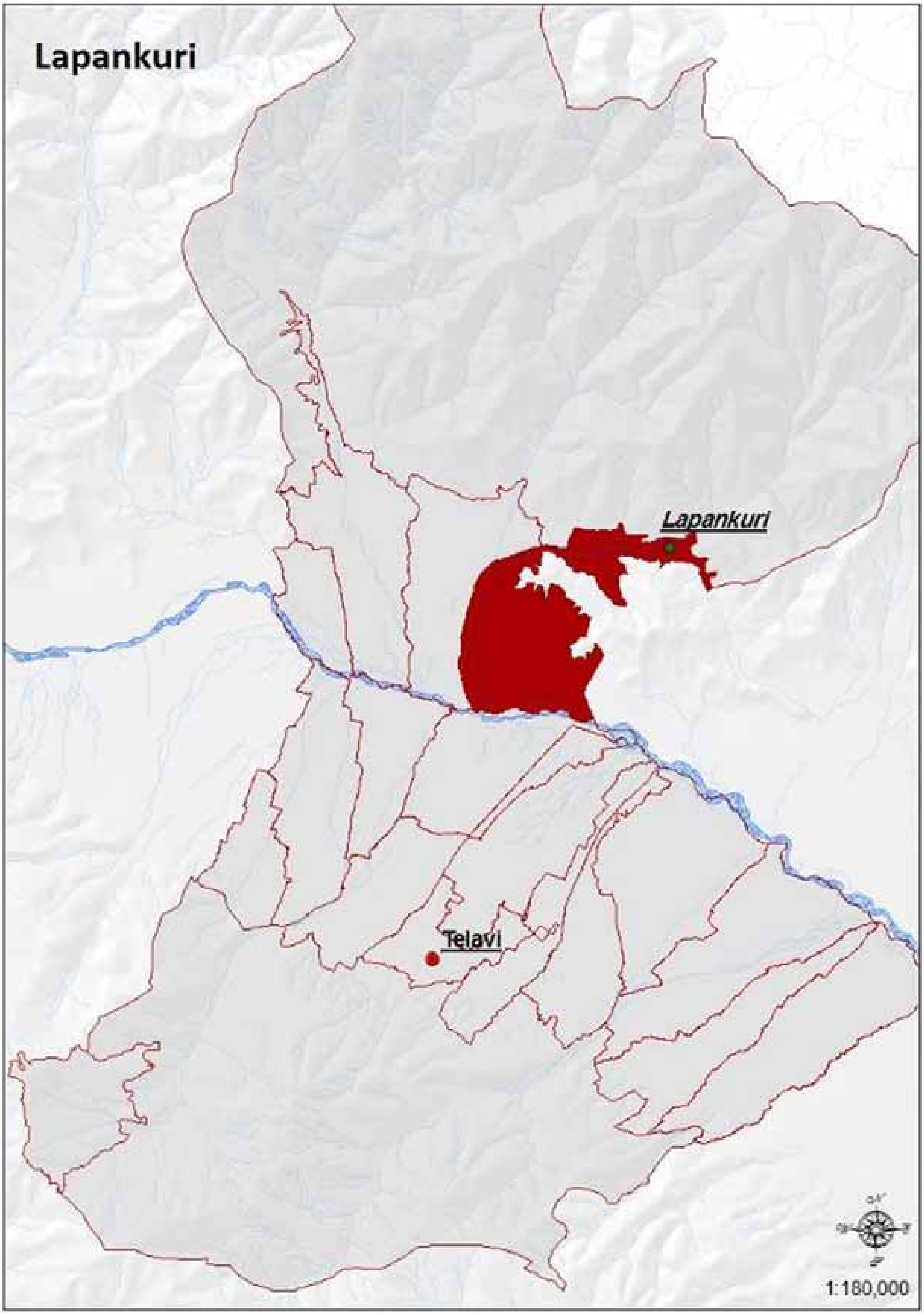
Detailed information on natural hazards present in Lapankhuri community is presented below.

As was mentioned, the main problems faced by the community are ***floods*** and ***mudflows*** developed on the Lopota River. These are accompanied by the washing of riverbanks.

Along the territory of the village, the Lopota River is asymmetric in shape. The width of the floodplain and waterbed is 80-150 m, and consists of alluvial-proluvial pebbles. The inclination of the right slope is between 30^0 and 45^0; its surface is undulating and covered with forest. The territory on the left bank is the first terrace above the floodplain. It has leveled surface, and is covered with the crofts and pastures of the local population.

The river washes intensively both banks. On the right side, floodplain forest is being damaged, while on the left side houses and agricultural lands are endangered.

Cases of floods and mudflow streams are frequent on the river. As a result of these events, houses of the population (4 households), crofts and agricultural lands (up to 7 ha), a football stadium and a power transmission masts are endangered. In the southern part of the village, the central road connecting the village to the village of Napareuli is being damaged; and in the northern part, the central bridge connecting the village with the border checkpoint, the forest and pastures of the village are all being damaged.


Lapankuri
Lapankuri
Telavi
1:180,000

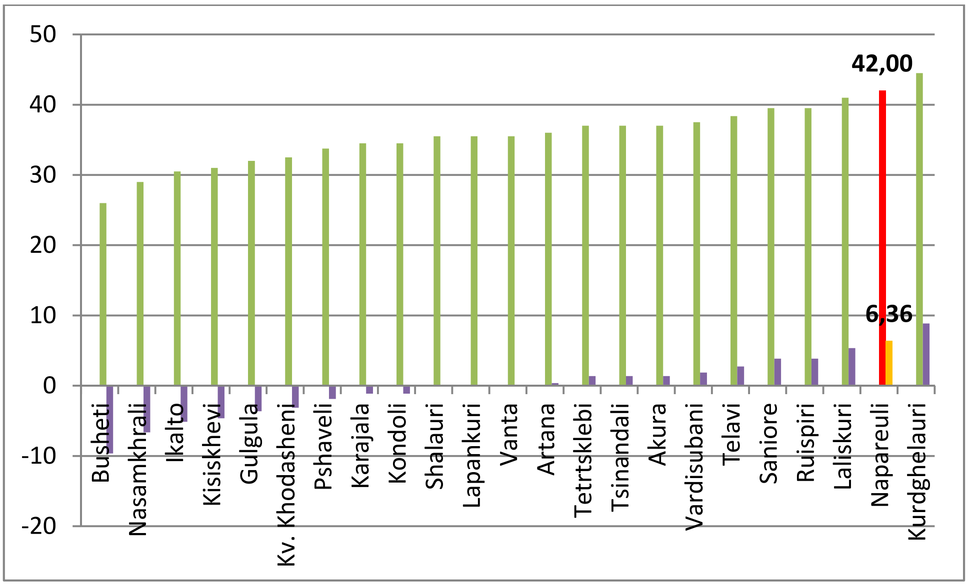
2.3.22 Napareuli Community

Napareuli community is located on the left bank of the Alazani River, in the easternmost part of Telavi Municipality. It borders Khvareli Municipality to the east. The territory of the community comprises the left bank of the Alazani River and the left bank of the Lopota River. The territory of the community also comprises the confluence of these two rivers. The Lopota River gathers its waters on the southern slopes of the Main Caucasus Watershed Range, crosses Lapankhuri community, and in its lower course forms the boundary between the Saniore and Napareuli communities.

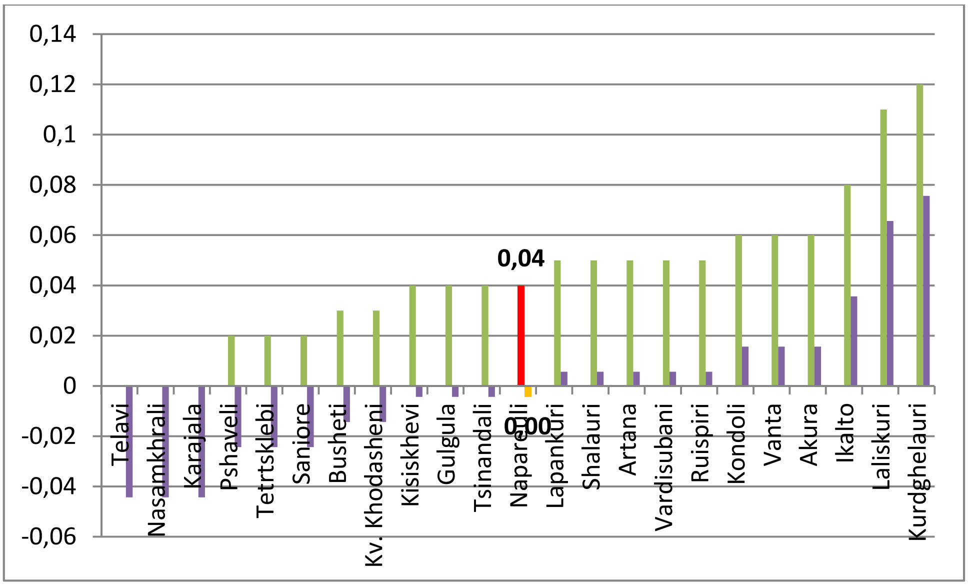
Napareuli community consists of one village – the village of Napareuli. The average distance of the village from the municipal center is 25 km. The village Napareuli itself is located in the gorge of the Lopota River, while its agricultural lands are located along the Alazani River.

Hazardous natural phenomena detected in course of field research are mainly related to floods and mudflows developed on the Lopota River. These are accompanied by intensive washing of shores.

The result of the research conducted within the framework of the program was that the vulnerability of Napareuli community was assessed at 42.00 points. This indicator is one of the highest on the scale of the whole municipality (the second highest indicator in the whole municipality). The difference from the average municipal indicator is 6.36 points (see the graph). Such a relatively high level of vulnerability is determined by the fact that practically all indicators determining the vulnerability of the municipality are significantly higher than the average municipal indicators (the only exception is the component of infrastructural and economic development). Accordingly, Napareuli community can be assessed as one of the most vulnerable communities in Telavi community. On the scale of the target scope of the program (target river basins), the vulnerability of Napareuli community was assessed as an average level vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



The level of risk in Napareuli community coincides exactly with the average municipal indicator and equals 0.04 point (see the graph). On the scale of the target scope of the program, the level of risk of in community was assessed as a low level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).



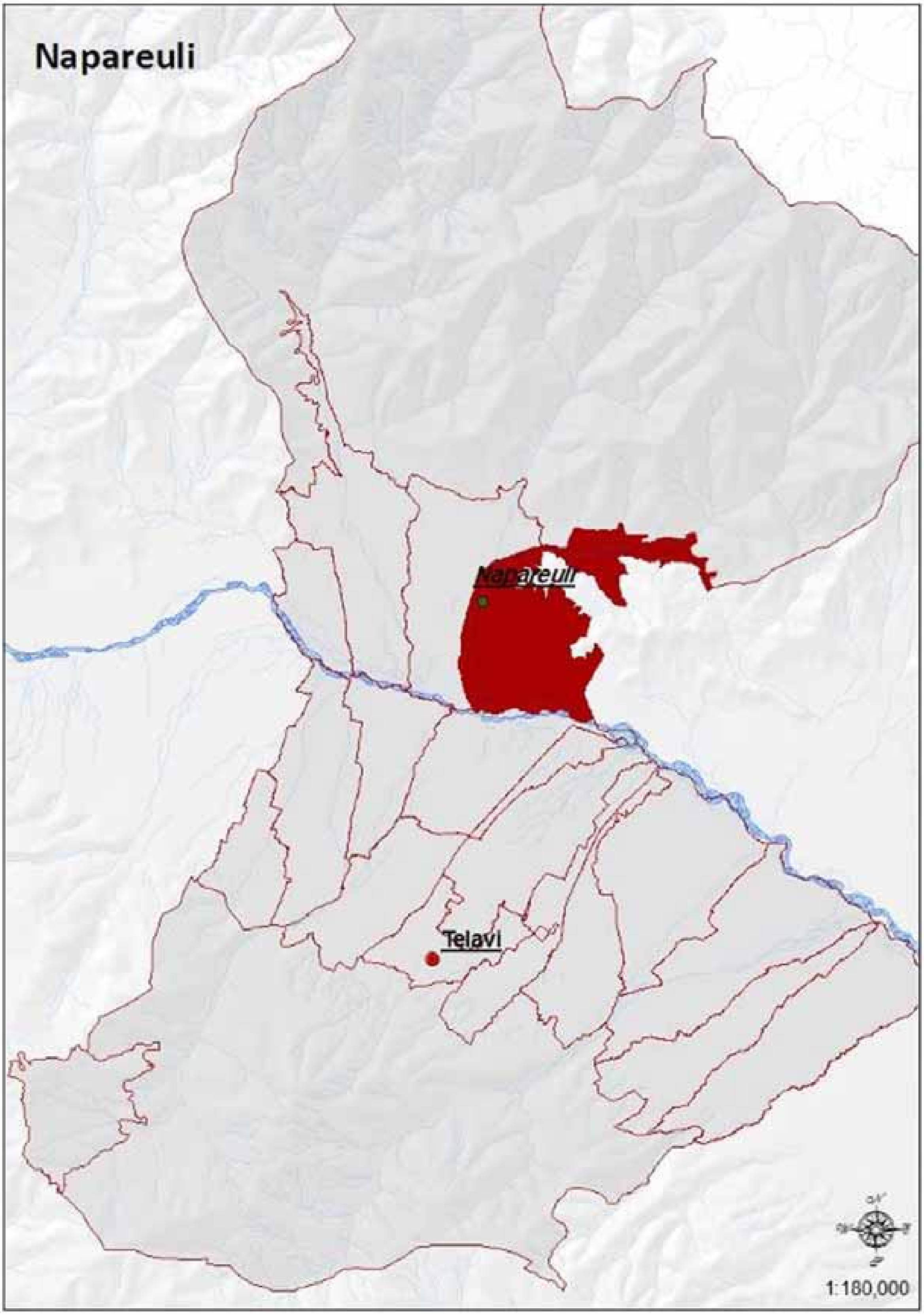
A detailed picture of the situation of the community with respect to hazardous natural processes is presented below.

As was mentioned earlier, the main problem of the community is related to ***floods*** and ***mudflow*** processes, also, intensive washing of banks by the river.

In the lower course of the Lopota River, the riverside zone of the village of Napareuli, as a result of recurring flash floods and accompanying mudflow processes, shore protecting dams are being rapidly eroded. Settled areas and agricultural lands are also being inundated with silt. Events such as these occurred in 2002 and endangered 3 households. In 2005, the mudflow stream shifted in the old riverbed, redirected itself around the shore protective dam on its right side and inundated houses and crofts of three households, as well as agricultural lands located in the riverside zone.

To protect the main bridge from these processes, the riverside zone both on the southern as well as the northern side, was entirely protected by dams constructed of concrete tiles (3 to 6 m in height). These have been erorded, damaged or ruined in many segments, while the floodplain and riverbed between the dams is completely filled with the debris and the level of the waterbed is significantly raised. Under these conditions, even in the case of activation of background diapason of flash floods and mudflow processes, destruction of shore protective dams and flooding and silting of settled areas, agricultural lands, vineyards, and pastures located in the riverside zone is likely.

Houses, crofts, agricultural lands of the population, neighborhood roads, the bridge connecting the village to the village of Saniore, the power transformer and high voltage masts are all seriously endangered.

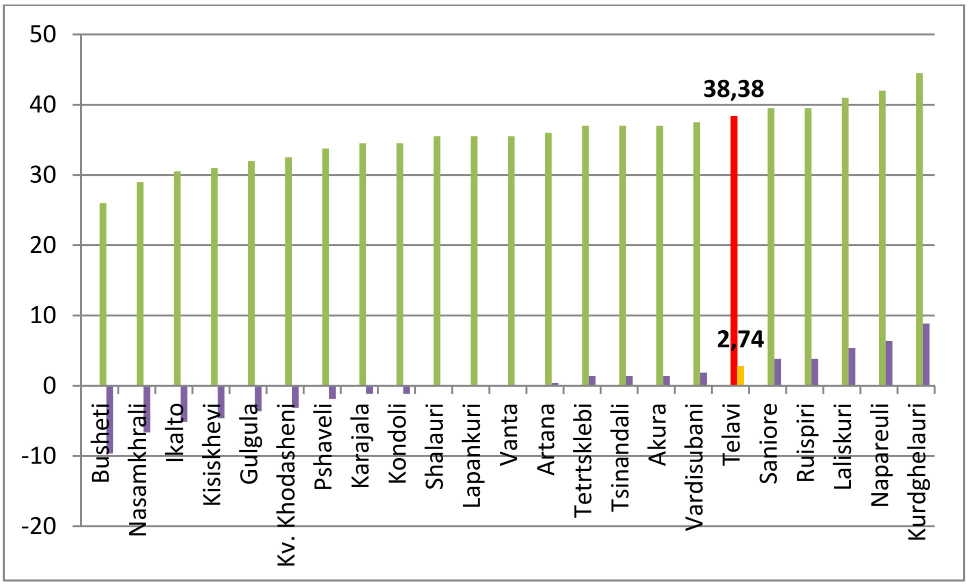

Napareuli
Napareuli
Telavi
1:180,000

2.2.2.23 Telavi Town

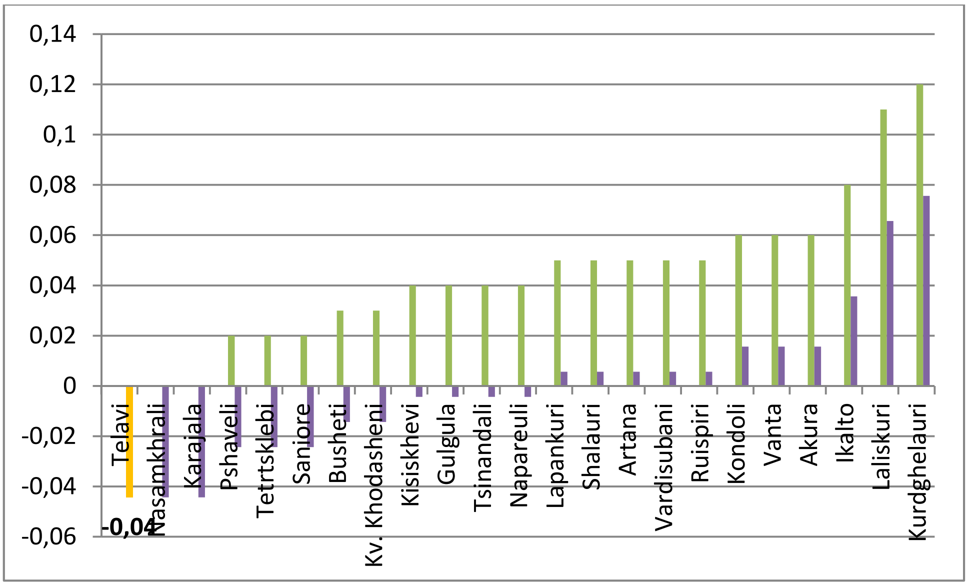
Town Telavi is located in the central part of the municipality. The territory of the town is crossed by gorges running down on the northern slopes of the Gombori Range, among which the Matsantsara gorge and Telabi gorge are noteworthy.

The main problem of the town with respect to hazardous natural processes is the hazard of formation of mudflow streams in the abovementioned gorges.

The vulnerability of the town Telavi was assessed at 38.38 points. Thei sindicator is higher than the average municipal indicator. The difference from the municipal average is 2.74 points (see the graph). With regards to the general vulnerability in relation to the target scope of the program, the territory of the town Telavi is classified in the category of an average vulnerability (see the map – Assessment of the Vulnerability of Telavi Municipality).



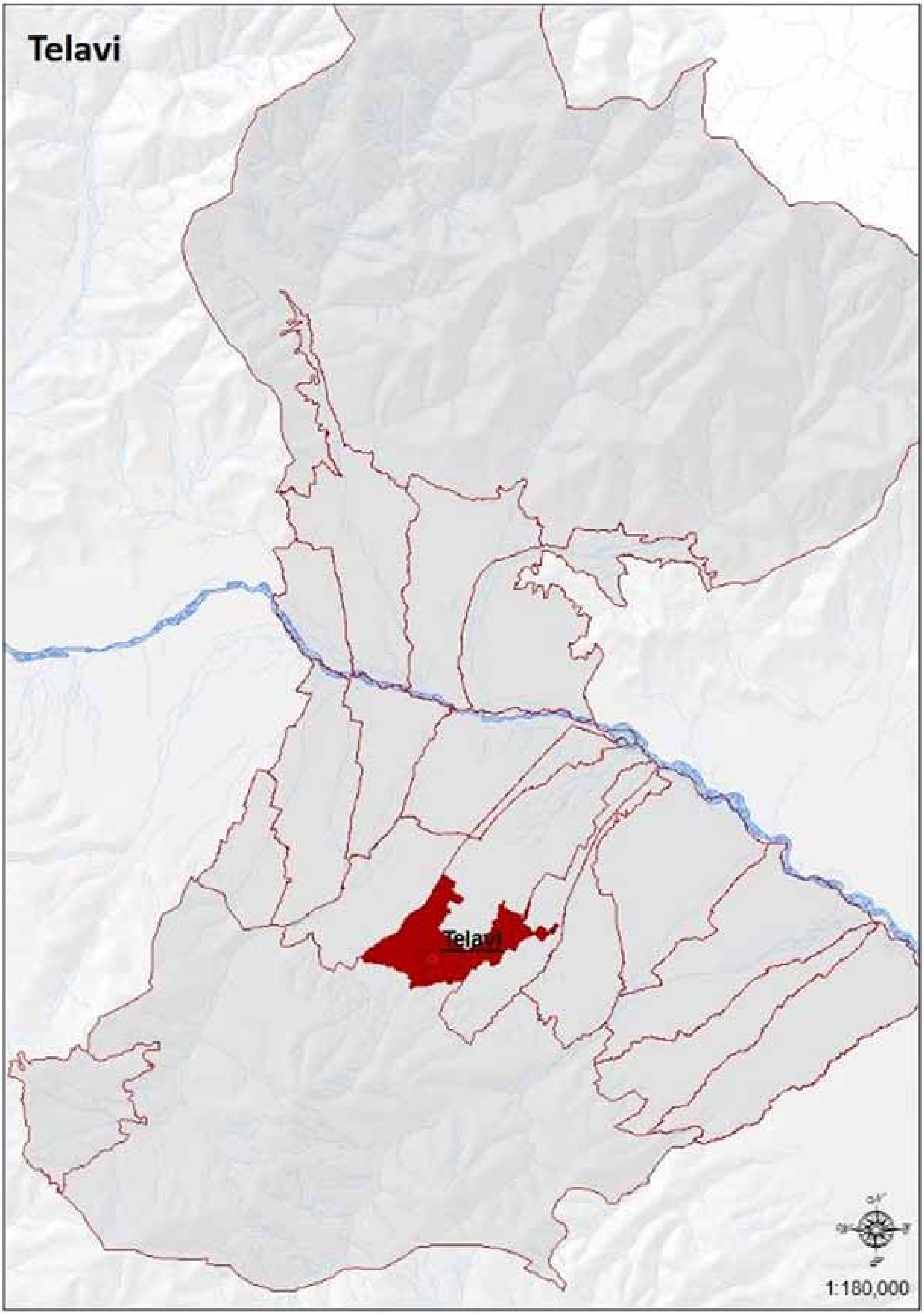
The relatively small scale of hazards detected in the territory of the town determined the assessment of the level of risk of the town as a minimal indicator; equaling 0 (see the graph). On the scale of the target scope of the program, the level of risk of the town Telavi was assessed as a very low level of risk (see the map – Assessment of the Disaster Risks of Telavi Municipality).



Natural hazards in the town are mainly related to the possibility of the development of ***mudflow*** streams in its southern part, in the gorges running down from the Gombori Range. In this respect, the Telaviskhevi River is remarkable. Mudflows formed periodically in it, in formation of which erosive washings caused by heavy rainfalls and mudflows caused by landslide are dominant factors, may endanger the town Telavi. To avoid this danger, three mudflow breaker constructions have been installed in the gorge, which are now damaged and require rehabilitation works to prevent further complications (see the pictures – mudflow breaker constructions; constructed by I. Kherkheulidze).

The satellite image displays the location of the mudflow breaker in relation to the town (the location of the construction is marked red).

The situation analogous to that in Telaviskhevi is present also in the Matsantsariskhevi River gorge, where mudflow-breakers require repair and rehabilitation works.


Telavi
Telavi
1:180,000

2.2.3 Conclusions

A summary of the natural hazards detected in the territory of Telavi municipality is given in the table 2.2.1, in which natural hazards detected in the communities of the municipality are presented in a generalized way.

Table 2.2.1. A summary of natural hazards detected in the territory of Telavi Municipality

Community		Natural Hazard			
		Flood	Mudflow	Wash of banks	Landslide
1	Laliskhuri	+	+	+	+
2	Pshaveli	+			
3	Ikalto		+	+	+
4	Tetri Tskhlebi				+
5	Ruispiri		+	+	
6	Vardisubani	+	+		
7	Kharajala	+			
8	Gulgula	+			
9	Kurdghelauri		+		
10	Shalauri		+		
11	Kisiskhevi	+	+		
12	Nasalkhrali				
13	Kondoli	+		+	
14	Tsinandali	+	+		
15	Kvemo Khodasheni		+		
16	Busheti		+	+	
17	Vanta		+		
18	Akura	+	+		
19	Artana		+	+	+
20	Saniore	+	+	+	
21	Lapankhuri	+		+	
22	Napareuli	+	+	+	
23	Akhmeta Town		+		

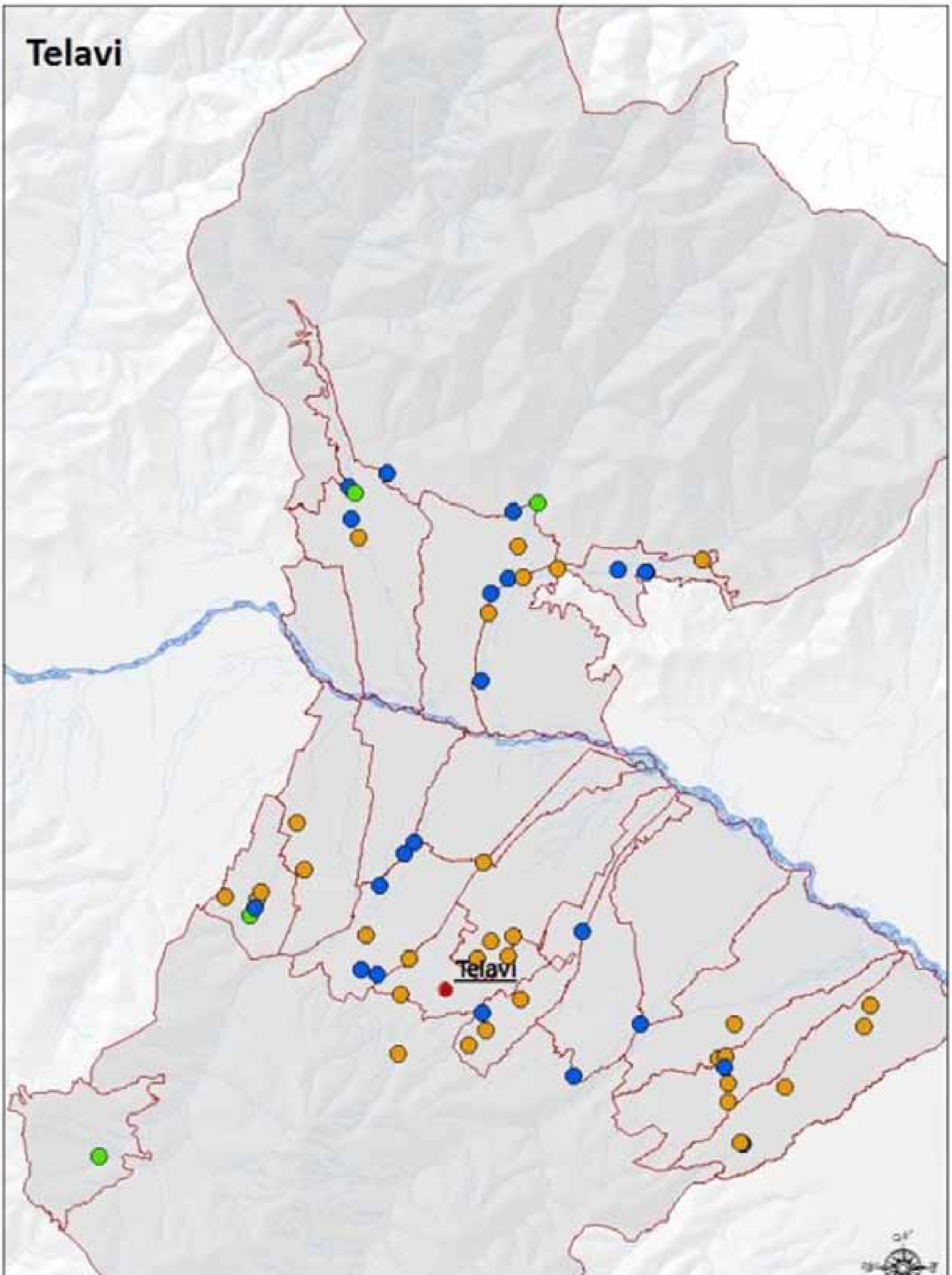
As is obvious from the table the main problem of Telavi municipality, with respect to natural hazards, is the processes developed along the rivers of the municipality. Among theses, mudflows are paticularly significant, as they affect an absolute majority of the communities of the municipality (70 % of the communities). Also, significant problems are posed by floods. This is accompanied by intense river-erosion process, which is manifested in the washing of local river banks. It should be mentioned that floods and mudflows, as well as the erosion of riverbanks are essentially reflections of one problem, the degradation of the natural environment of the river basins in the municipality. Therefore, in communities where the only detected hazard is flooding, as a rule, mudflow streams cause problems too (most of the rivers in the municipality are mudflow prone), albeit on a lesser scale. Accordingly, both floods and mudflows are characteristic of practically all of these communities. In the summary table only the main problems are presented, based on their scale. It is also remarkable that the municipality is relatively less affected by landslide processes, which were detected in the territories of only a few communities.

Among the communities of the municipality, Leliskhuri community is distinguished with regards to natural hazards; many different kinds of natural hazards are present there. In Nasamkhrali community, on the other hand, has no natural hazards according to the filed research or the information obtained from other sources. In other communities of the municipality, 1 to 3 natural hazards are usually present.[13]

Information about natural hazards obtained in result of the field research is presented on map 2.2.1. On the map, landslide areas are marked green, floods/wash of banks are marked in blue, and mudflows are marked in brown.

[13] In this case the strength of the natural hazard is not considered. The table only provides the information on the presence or absence of a given kind of natural hazard, detected during the course of the field research conducted within the framework of the program, or based on other sources of information.

Map 2.2.1. Natural Hazards Detected on the Territory of Telavi Municipality in Result of Field Research



An analysis of the map affords the conclusion that natural hazards, as river related processes, are mainly characteristic of the upper and middle course of the basins and tributaries of the Alazani River. It should be also considered that an absolute majority of settled areas of the municipality are located in this very zone. Agricultural lands of the municipality are located in the lower course of the basins of these rivers, segments of the confluences of these rivers and the Alazani River. It is noteworthy that processes developed in the upper course of the river basins, through the formation of floods and mudflow streams, negatively affect the lower course, where agricultural lands are located. The main economic industry of Telavi municipality is agriculture. Accordingly, disasters developed in the riverbeds of the rivers of the municipality affect mainly this economic foundation. This, in its turn, increases the vulnerability of the municipality to possible climate changes and natural disasters.

The information obtained as a result of the field research was integrated with the information obtained form other sources and, on the basis of GIS analysis, a map of the possible distribution of natural hazards of Telavi municipality was created (see the map 2.2.2 – The probability of Distribution of Natural Hazards in Telavi Municipality).

Within the framework of the program an assessment of the vulnerability of the communities of the municipality was also undertaken. Vulnerability was assessed mainly based on various socio-economic parameters of the villages comprising a community. Natural hazards present in the villages were also taken into consideration. The results of the assessment are presented in map 2.2.3 – The Vulnerability of the Communities of Telavi Municipality – and table 2.2.2 – Distribution of the Communities of Telavi Municipality According to the Degree of Vulnerability.

An analysis of the map and the table makes it obvious that an absolute majority of the communities in the municipality fall into categories of lower than average and average vulnerability. It is noteworthy that there is no community in the municipality with higher than the average or high vulnerabilities, which is determined by functional infrastructure and communications system of the municipality, compared to other municipalities.

Within the municipality, an analysis of the components constituting vulnerability has revealed that the main factors determining the vulnerability of the communities to natural hazards and climate changes are: hard economic situation in communities, low level of readiness for possible disasters and climate changes (lack of information and necessary skills and abilities). The indicator of vulnerability was also affected by the number of communications, economic means (fields), and total population living in hazard zones.

Table 2.2.2. Distribution of the communities of Telavi Municipality by the Level of vulnerability

Community		Level of Vulnerability				
		Low	Lower than the Average	Average	Higher than the Average	High
1	Laliskhuri			+		
2	Pshaveli		+			
3	Ikhalto		+			
4	Tetri Tskhlebi			+		
5	Ruispiri			+		
6	Vardisubani			+		

7	Kharajala		+			
8	Gulgula		+			
9	Kurdgelauri			+		
10	Shalauri		+			
11	Kisiskhevi		+			
12	Nasamkhrali		+			
13	Kondoli		+			
14	Tsinandali					
15	Kvemo Khodasheni		+			
16	Busheti		+			
17	Vanta			+		
18	Akura			+		
19	Artana			+		
20	Saniore			+		
21	Lapankhuri			+		
22	Napareuli			+		
23	Telavi Town			+		

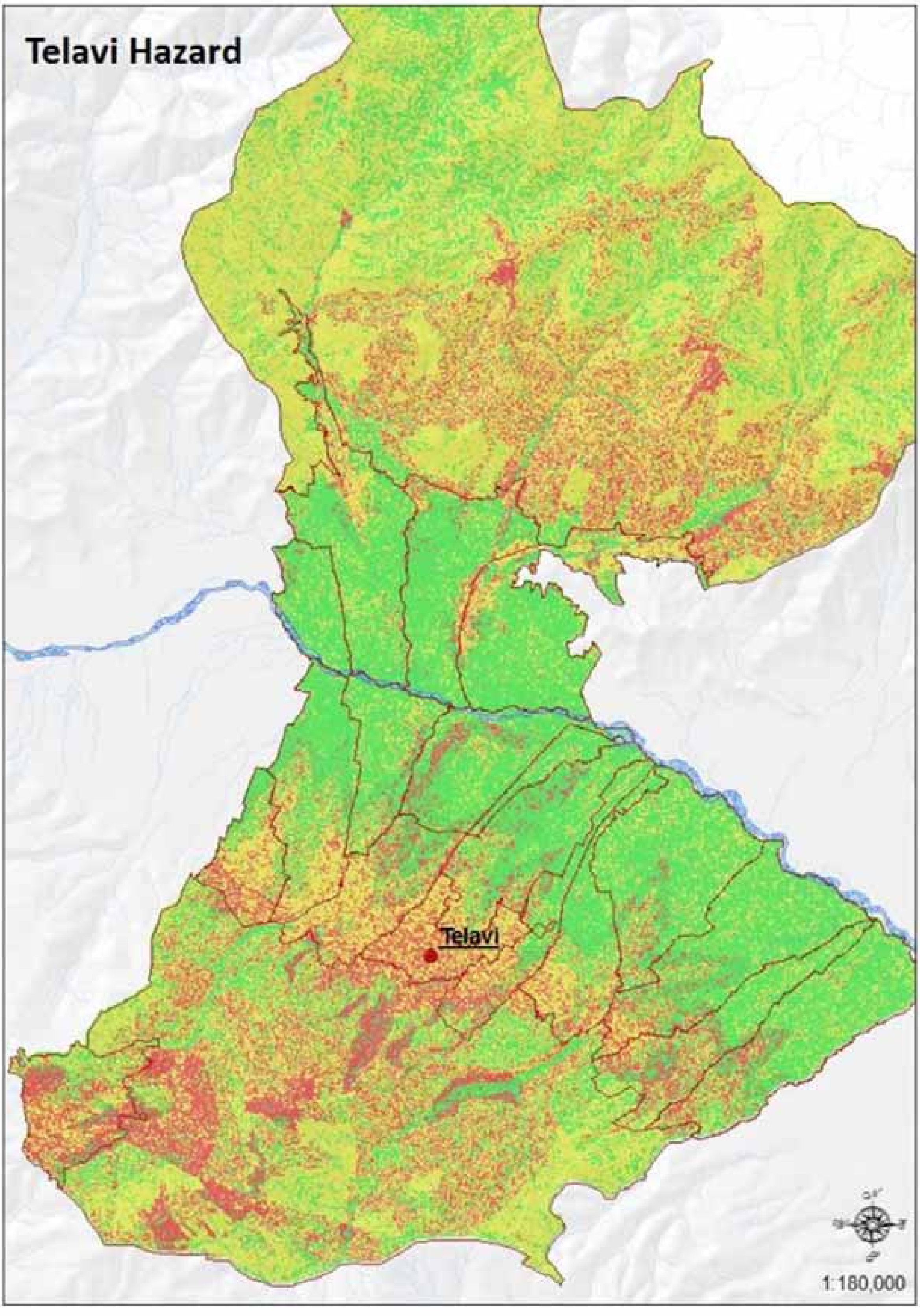
Assessment of the vulnerability, together with the assessment of hazards, was used for the calculation of the level of risk of the communities (see the map 2.2.4. – The Risk of the Communities of Telavi Municipality to Natural Disasters). As we can see in the map, communities with higher risk levels, compared to other communities of the municipality, are mainly located in the upper course of the basins of the tributaries of the Alazani River. In this respect, the basins of the rivers running down from the northern foothills of Gombori Range are particularly noteworthy. As was already mentioned, processes developed in these gorges seriously affect agricultural lands located in lower courses of the rivers (territories adjacent to the confluences with the Alazani River), and, therefore, economic situation of the municipality in general. This fact is directly related to the general vulnerability of the whole municipality. This provides a good basis for planning risk mitigation measures. It is important, in the course of planning risk mitigation measures, to pay a considerable attention to the improvement of the situation in the upper course of the basins of the Alazani River tributaries (with respect to the sustainable management of resources). This, together with a consideration of the facts revealed by the field research, may play an important role in the mitigation of risks for the municipality. The assessment of risks in the communities is presented in the table 2.2.3.

Table 2.2.3. Distribution of the communities of Telavi Municipality according to the level of risk

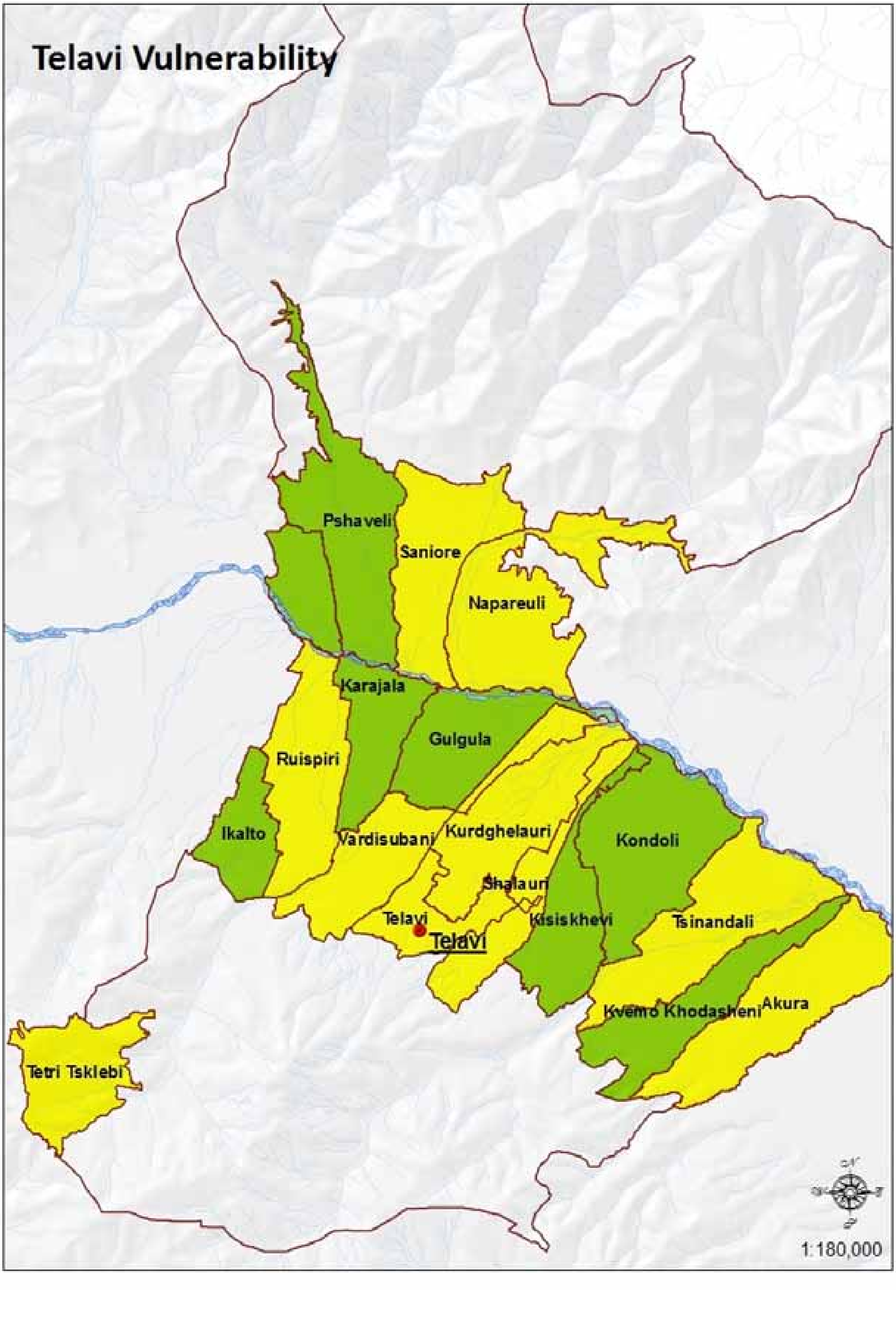
Community		Level of Risk				
		Low	Lower than the Average	Average	Higher than the Average	High
1	Laliskhuti				+	
2	Pshaveli		+			
3	Ikalto			+		
4	Tetri Tskhlebi		+			
5	Ruispiri			+		
6	Vardisubani			+		
7	Kharajala	+				
8	Gulgula		+			
9	Kurdghelauri				+	
10	Shalauri			+		
11	Kisiskhevi		+			
12	Nasamkhrali	+				
13	Kondoli			+		
14	Tsinandali		+			
15	Kvemo Khodasheni		+			
16	Busheti		+			
17	Vanta			+		
18	Akura			+		
19	Artana			+		
20	Saniore		+			
21	Lapankhuri			+		
22	Napareuli		+			
23	Telavi Town	+				

Based on the table and the map, it can be stated that majority of the communities in Telavi municipality belong to the category of average and lower than the average levels of risk. Accordingly, the level of risk of the whole municipality can be assessed as having an average level of risk with respect to natural disasters and climate change.

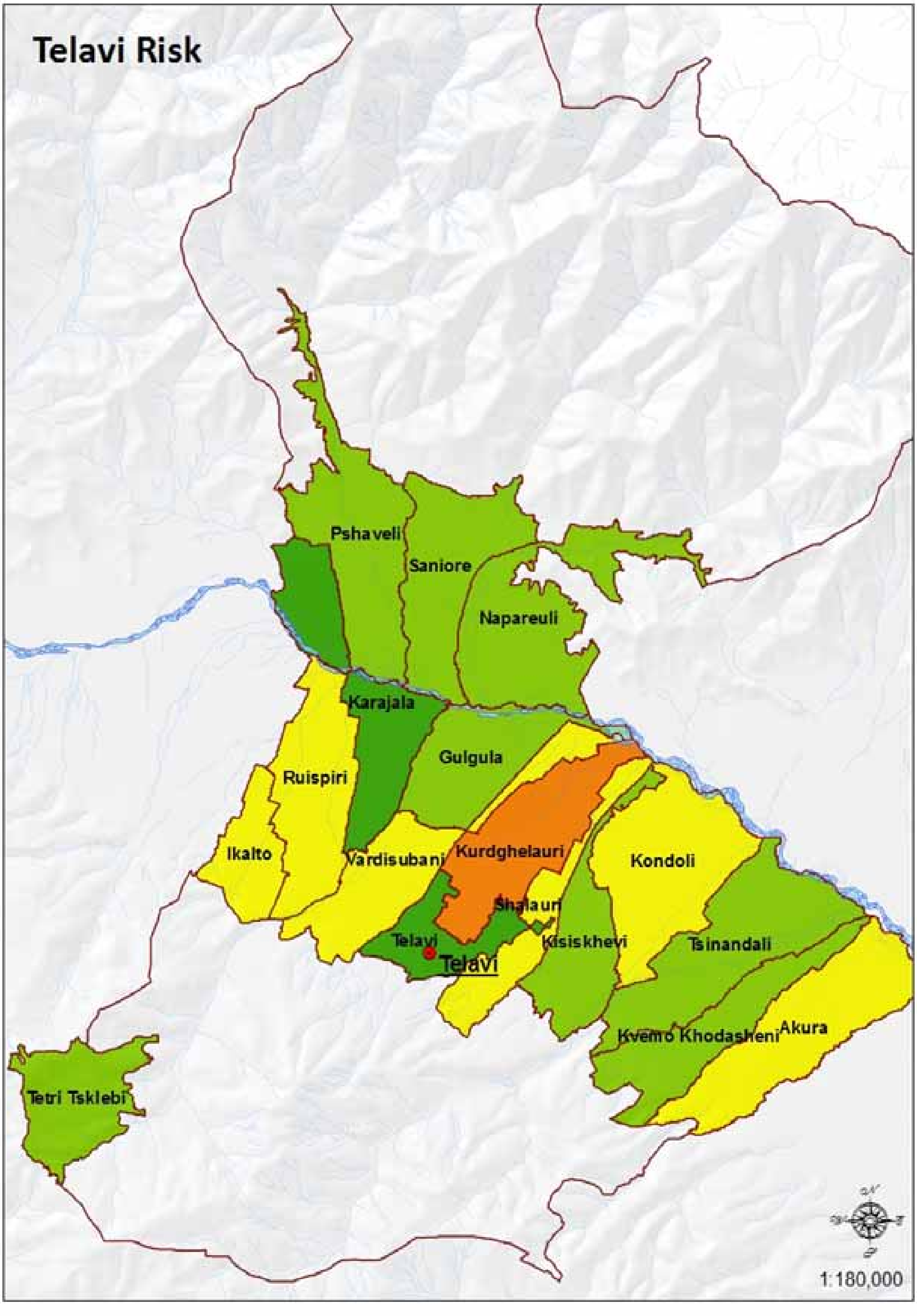
Map 2.2.2. Probability of Distribution of Natural Hazards in Telavi Municipality



Map 2.2.3. Vulnerability of the Communities of Telavi Municipality to Natural Disasters



Map 2.2.4. The Level of Risk of the Communities of Telavi Municipality to Natural Disasters



3 Problems Related to Expected Climate Changes for the years 2020 to 2050 and Respectiv Adaptation and Mitigation Measures

3.1 Akhmeta municipality

A list of measures was developed based on the vulnerability assessment of Akhmeta Municipality, this is significant in order to reduce its vulnerability and increase its resilience to natural disasters and climate change.

It should be noted that the list of measures developed is somewhat general due to the scale of implemented activities – the assessment covered the entirety of Akhmeta Municipality. The expert group assessed the situation in terms of the municipality, field surveys were carried out in every village of the municipality. Thus, the recommendations developed on the basis of the survey are, idiomatically, recommendations at the municipality level, which exclude place specifications (community, village or a part of the village) with regards to a specific problem. At the next stage of the program, the program activities are planned to be scaled down at the community level whilst using the present survey outcomes. This will allow the elaboration of a community action plan with the maximum involvement of the local population which will reflect specific activities for risk reduction and resistance increase.

Below are detailed the main problems caused by the expected changeability of meteorological elements and necessary adaptation activities for their mitigation in accordance to the future climate change scenario in Akhmeta Municipality boundaries. Furthermore, activities for the mitigation and adaptation to the problematic aspects identified as during the field survey are listed for each community.

3.1.1 Spatial Planning

It is necessary to delimitate areas highly prone to dangerous natural phenomena, so called "hot spots" of the municipality territory, the management of which will be executed in accordance to the existing risks.

The risks faced by the municipality communities are not only influenced by the dangers existing on the territories but also by the vulnerability level of these communities. It is important to implement activities to decrease vulnerability since these will in turn increase the resistance of the communities towards possible natural disasters and the negative influence of climate change. To decrease a community's vulnerability, it is important:

- To improve the social infrastructure of the municipality's communities' population;
- To improve the road communication connecting villages to increase the every village's accessibility throughout every season;
- To increase the readiness of the communities as well as of the entire municipality in terms of possible natural disasters. In this regards it is important:
    - To strengthen the regional rescue service through proper training and equipment,
    - To elaborate a municipal response plan that will adequately reflect the dangers the municipality faces, will elaborate alternative development scenarios and will elaborate an

action plan according to these scenarios taking into consideration the community's vulnerability levels,

  - Periodical training for the population of appropriate reaction to catastrophes and awareness raising campaigns in this regard;

- To improve the economic well-being of the population through strengthening various prospective sectors (tourism, agriculture) that will help decrease the vulnerability level.

The abovementioned results will become a baseline for the introduction of a spatial planning of elements in the municipality management that will ensure the minimization of the risks faced by the municipality through the most effective use of existing resources. In this regard, 'Spatial planning' is the main recommendation in terms of adaptation to climate change and to increase readiness. Therefore, the work performed while preparing the present document may provide a significant assistance to the municipality administration.

3.1.2 Landslide Processes

The implementation of landslide prevention activities on the territories damaged by landslides, which means:

- Construction of drainage channels on the surface of the landslides (to remove surface and ground water);
- Construction of protective pile walls on the landslide surfaces;
- Construction of folding or massive mounting walls of monolithic reinforced concrete blocks on the landslide surfaces;
- Application of anti-landslide bioengineering technologies including:
  - Terracing the landslide surface,
  - Relevant groundwork on the landslide slopes (cutting slopes, exposure of ground etc.),
  - Turfing of the landslide surface and surrounding territories,
  - Plantations of a variety of trees on certain selected areas.

Also,

- Restriction of water use for the population (irrigation of the landslide slopes, construction of water reservoirs at landslide prone territories etc);
- Permanent monitoring of the landslide territories;
- Prohibition of any construction without detailed study of the respective geological-geomorphologic conditions of the landslide prone territories;
- Permanent informing and periodical training of the population on the significance of the necessary landslide prevention measures;

- Involvement of the population in the landslide prevention activities in the territories where their crofts are threatened.

3.1.3 Floods and Flash Floods

For the mitigation of the floods and flash floods related problems, taking into consideration the current climate change scenario, the following activities should be implemented

Introduction of bioengineering practices, which implies:

- Afforestation, restoration and preservation of the forests on the slopes to reduce the surface runoff in the watershed basins of the Alazani and Ilto rivers and their tributaries, especially to reduce the maximum discharge;
- Planting of perennial grasses to create turf on certain areas of the woodless slopes;
- Setting strict control on uncontrolled forest cutting;
- Elaboration and implementation of forest fire prevention measures;
- Improvement of overall forest management.

In terms of river channel management, it is significant:

- To ensure the flow of the maximum discharge through the river channels by straightening the crooked sections and removing excess solid sediments from the channels;
- To construct coastline dams, levees to direct flows, retaining walls etc;
- To permanently informing Akhmeta Municipality population on flood and flash flood risks, and to involve them in the implementation of flood prevention activities;
- To establish a permanent monitoring on floods and flash floods and create an early warning system.

3.1.4 River runoff and Mudflow Processes

In order to avoid that the rural population's agricultural lands, communication and other engineering constructions, to be covered by mudflow sediments and breakdowns, as well as to reduce or eliminate the negative results of mudflows and ravine erosion in general, it is important to implement the following activities territories identified as being subject to mudflows, mudflow hotbeds as well as degraded mudflow hazardous slopes:

- The implementation of phyto-amelioration activities in mudflow ravines, degraded slopes of mudflow hotbeds – mainly by restoration of forests;
- The regular cleaning of the filled channels of mudflow ravines and drainage channels from the excess sediments;

- The construction of mudflow-preventive, mudflow-conductive and mudflow retaining walls and dams at mudflow generating hotbeds along mudflow ravines and drainage streams connected to it;
- The straightening of the transit sections of the mudflow ravines and drainage streams;
- The construction of mudflow stream fences and dams to regulate liquid and solid runoffs in mudflow ravines;
- The restriction, and in some cases prohibition, of agricultural and construction activities in mudflow generating areas and mudflow ravines;
- The permanent informing of the population of the areas under the mudflow risk and surrounding territories;
- The involvement of the population in the implementation of mudflow prevention activities;
- The establishment of a permanent monitoring of the mudflow processes and creation of an early warning system.

3.1.5 Forest Ecosystems

To protect and stimulate the adaptation of the municipality's ecosystems to the expected climate change scenarios, it will be necessary to:

- Implement unconditional control of unsystematic and uncontrolled forest logging;
- Implement reforestation activities;
- Elaborate activities to prevent forest fires and their organized application when necessary;
- Improve the overall forest management.

3.1.6 Sub-Alpine and Alpine Meadows

To mitigate or eliminate the degradation of sub-alpine and alpine ecosystems, pastures and relevant hay lands it is necessary to take into consideration the expected changes of the meteorological elements (air temperature and total annual and seasonal precipitation) within Akhmeta municipality boundaries for 2020-2050. Indeed, sub-alpine and alpine vegetation (and respectively their pastures and hay lands) are vulnerable to climate condition changes. One of the reasons is that the development of the vegetations of the abovementioned zones is influenced by the snow cover present a large part of the year. Therefore for the protection of sub-alpine and alpine ecosystems – in particular, their vegetation, it is necessary to unconditionally follow the exploitation norms. It is also important –

- Compliance with the pre-determined optimal load of the pastures;
- To take into consideration grazing calendar;
- Equal use of pasture lands;

- To implement a rotation between used plots of lands;
- To terrace steep slope pastures to reduce erosion;
- Implementation of the practice of pasture-rotation

Together with the above mentioned it is necessary to implement the following activities:

- Pastures and hay land cultivation – frequent weeding of the plots and plantation of high nutrition value vegetables and grain plants (bent, white clover, meadow clover);
- Reconstruction of the damaged roads leading to the pastures.

A summary list of adaptation measures to be implemented is presented in the table 3.1.1.

Table 3.1.1. Summarized list of the adaptation measures to be implemented in Akhmeta Municipality

Problem	List of Measures
Landslide Processes	• Construction of drainage channels on the surface of the landslides (to remove surface and ground water); • Construction of protective pile walls on piles on the landslide surfaces. • Construction of folding or massive mounting walls of monolithic reinforced concrete blocks on the landslide surfaces; • Application of anti-landslide bioengineering technologies including: o Terracing the landslide surface; o Ground work on landslide slopes (cut off slopes, exposure of ground etc) o Turfing of the landslide surface and surrounding territories; o Plantation of a variety of trees on certain selected areas. • Restriction of the population's water use (irrigation of the landslide slopes, construction of water reservoirs on landslide prone territories etc); • Permanent monitoring of the landslide territories; • Prohibition of any construction without detailed study of the respective geological-geomorphologic conditions on landslide prone territories; • Permanent informing and periodical training of the population on the significance of the necessary landslide prevention measures; • Involvement of the population in landslide prevention activities on the territotires where the crofts are threatened.
Floods and Flash Floods	• Afforestation, restoration and preservation of water-regulating forests and those previously leveled-off on the slopes to reduce surface runoff in the watershed basins of the Alazani, the Ilto rivers and their tributaries rivers, especially to reduce the maximum discharge;

	• Planting of perennial grass to create turf on certain woodless slopes; • Strict control on uncontrolled forest cutting; • Elaboration and implementation of forest fire prevention measures; • Improvement of overall forest management; • Straightening of the crooked sections and removal of excess solid sediments from the channels to ensure the maximum flow through the river channels; • Construction of coastline dams, levees directing flows, retaining walls, etc; • Permanent informing of Akhmeta Municipality population on flood and flash flood risks, and ensure their involvement in the implementation of flood prevention activities; • Establishment of a permanent monitoring of floods and flash floods and creation of an early warning system.
River Runoff and Mudflow Process	• Implementation of phyto-amelioration activities in mudflow ravines and degraded slopes of mudflow hotbeds – mainly by restoration of forests; • Regular cleaning of the filled channels of mudflow ravines and drainage channels from the excess sediments; • Construction of mudflow-preventive, mudflow-conductive, mudflow retaining walls and dams at mudflow generating hotbeds along mudflow ravines and drainage streams connected to it; • Straightening of the transit sections of the mudflow ravines and drainage streams; • Construction of mudflow stream fences and dams to regulate liquid and solid runoffs in mudflow ravines; • Restriction, and in some cases prohibition, of agricultural and construction activities in mudflow generating areas and mudflow ravines; • Permanent informing of the population of the areas prone to mudflows and surrounding territories at risk of mudflow processes; • Involvement of the population in the implementation of mudflow prevention activities; • Establishment of a permanent monitoring on mudflow processes and creation of an early warning system.
Forest Ecosystem Degradation	• Unconditional implementation of the control of unsystematic and uncontrolled cutting of the forest; • Implementation of reforestation activities at postforest territories; • Elaboration of activities to prevent forest fires and organized application when necessary; • Improvement of the overall forest management
Sub-alpine and Alpine Meadows	• Calculation and implementation of the optimal load of the pastures ; • Elaboration of calendar terms for grazing;

	• Ensure equal use of pasture lands between populations; • Implement rotation system between pastures; • Terracing of steep slope pastrues to reduce erosion; • Reduce amount of pastures; • Cultivate pastures and hay land; • Reconstruction of damaged road leading to the postures

3.1.7 Activity Plan for Akhmeta Municipality Communities

The described activities need to be specified according to the problems identified for each community. Thus, below is given a preliminary list of activities for each community and villages within the community, which will ensure the strengthening of the communities against natural catastrophes and future climate change. The activities are summarized in Table 3.1.2. Each problem is assessed respective to its significance (H – high, M – medium, L – low). The assessment was made on the basis of the field survey materials and data collected from other sources. In assessment, determination of the problem's significance level depended on the problem's influence scale (size of the territory affected by the problem, population influenced and infrastructure). The assessment is preliminary and does not represent an outcome of the problem detailed analysis thus the probability of error is quite high, however, we believe it gives an approximate image of the current situation. As for the list of activities, it is also developed based on the preliminary assessment. Implementation of a specific project is associated with detailed, large-scale research. In addition, the specific action plan should be developed on the site with the direct engagement of the community in which the action plan was developed.

Table 3.1.2. Summarized list of adaptation and risk reduction measures to be carried out in the communities of Akhmeta Municipality

Community	Village	Problems	Scale of Problems (L; M; H)	Executive Measures[14]	Cost Range (USD)	Time line[15] (ST; MT; LT)	Responsible Agent	Potential Source of Funding
Jokolo	Jokolo	Mudflow / Washing of banks[16]	**H**	• Construction of bank stabilizing gabions on the Alazani river; • Regulation of the Alazani river channel – periodical removal of solid sediments to increase its capacity. • Permanent informing of the population of the area prone to mudflows on mudflow threat processes; • Establishment of a permanent monitoring of mudflow processes and creation of an early warning system; • Improvement of the village forest management.	50,000 – 100,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.

[14] The measures were defined for the problems estimated as problems of average or high importance. The list of measures was worked out according to the preliminary estimations. The implementation of concrete activities should be in connection with additional thorough research and assessment.
[15] "Short-term"(ST) implying the period of time up to 1 year; "midterm" (MT) – 1-5 years; "long-term" (LT) – > 5 years.
[16] Wash of banks (river erosion), is a problem for all the communities where floods/flash floods and mudflow problems were identified.

	Birkiani	Mudflow / Washing of banks	**H**	• Reconstruction of strongly damaged flow directing gabions on the right side of the Alazani river (to the east side of Birkiani village). • Regulation of the Alazani river channel – periodical removal of solid sediments to increase its capacity; • Construction of bank stabilizing gabions on the Alazani river opposite to Omalo village; • Permanent informing of the population of the area prone to mudflows on mudflow threat processes; • Establishment of permanent monitoring on mudflow processes and creation of early warning system; • Improvement of the village forest management.	50,000 – 100,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Khalatsani	Omalo	Floods	**M**	• Regulation of the Alazani river as well as small Omaloskhevi channels – cleaning/deepening, removal of excessive sediment, straightening; • Implementation of large scale	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.);

		Washung of banks	H	bank protection engineering activities (especially on the Alazani river), including – arrangement of flow directing gabions; • Application of bank protective, bioengineering methods at relevant locations.			Regional development and infrastructure; NEA).	• Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Dumasturi	Floods	L	• Regulation of the Alazani river channel and arrangement of bank protection constructions; • Application of bank protective, bioengineering methods if possible.	< 50,000	ST	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Zemo Khalatsani	Floods	L	• Straightening of the Khalatsani river channel, arrangement of bank protection construction, (especially at the village footbridge);	< 50,000	ST	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Shua Khalatsani	Floods	L→M	• Regulation of the Khalatsani river channel, arrangement of a bank protection construction to protect the village bridge;	< 50,000	ST	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Kvemo	Floods	M→L	• Regulation of the Alazani river	< 50,000	ST	• Municipal government;	• Local budget;

	Khalatsani	Washing of banks	M→H	channel – cleaning/deepening, removal of excessive sediment, straightening; • Implementation of bank protection engineering activities; • Application of bank protective, bioengineering methods at relevant locations.			• Regional government.	• Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Landslide	M→H	• Regulation of the Alazani river channel to reduce side erosion; • Implementation of bank protection activities; • Stabilization of the landslide slope using bioengineering methods.	< 50,000	ST	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Duisi	Duisi	Floods	H	• Regulation of the channels of the Alazani river as well as the Chobioskhevi, Dedispheruli ravines flowing on the village territory– cleaning/deepening, removal of excessive sediment, straightening; • Implementation of bank protection engineering activities on the ravine banks; • Implementation of large scale bank protection activities on the Alazani river, including the	50,000 – 100,000	ST	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Washing of banks	M					

				arrangement of bank protective gabions.				
	Tsinubani	Floods	**M**	• Bank protective activities on the Alazani river; • Cleaning and fixing the village drainage channels; • Application of bioengineering methods to regulate surface streams; • Afforestation on the village ravine slopes with watershed purpose and restoration-reservation of the forests leveled-off before; • Improvement of the village forest management.	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Washing of banks	**M**					
Sakobiano	Kvareltskali	Floods	**L→M**	• Afforestation of the village ravines – Kvareltskliskhevi and Sarue – with the purpose of the restoration and preservation of water-regulating forests and those previously leveled-off in order to reduce surface runoff, especially its maximum discharge; • Implementation of bank protection activities on the Aghnuli ravines.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

	Sakobiano	Floods	**L→M**	• Regulation of the Alazani river channel: cleaning/deepening, removal of excessive sediment, straightening; • Implementation of bank protection engineering activities: restoration of the damaged bank protective dams; • Application of bank protective, bioengineering methods at relevant locations.	50,000 – 100,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Washing of banks	**L→M**					
	Bakilovani	Landslide	**M→H**	• Terracing the landslide slopes • Filling in, ramming of the clefts on the landslide; • Revegetation of the landslide slopes with hydrophilic trees and plants with deep roots; • Regulation of the surface runoff; • Filling and ramming of newly formed landslide clefts with clay and turfing of the landslide; • Permanent informing of population living in the area prone to landslide threat and periodical training on the importance of landslide prevention measures ;	< 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				• Involvement of the population in prevention activities in the territories where their crofts are threatened.				
	Kutsakhta	Washing of banks	**M**	• Destruction of islands created by the excess accumulation in the Alazani river channel and removal of excess solid sediments; • Implementation of engineering bank protection activities, including the placement of flow directing gabions.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Koreti	Washing of banks	**L**	• Regulation of channels and construction of bank protection buildings; • Application of bank protective, bioengineering methods at relevant locations.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Matani	Matani	Floods	**M**	• Regulation of the Alazani, Kurtanadzeuli, Matniskhevi river channels: cleaning/deepening, removal of excessive sediment, straightening; • Implementation of the bank protection engineering activities along the Kurtanadzeuli, Matniskhevi and Alazani river channels;	50,000 – 100,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Wash of	**M**					

		banks		• Reconstruction of the village drinking water supply station; • Regulation of the Kurtanadzeuli river channel through the removal of excessive sediment.				
Maghraani	Maghraani	Floods	**M**	• Regulation of the Macharula river channel: cleaning/deepening, removal of excessive sediment, straightening; • Placement of bank protection gabions on the mentioned river; • Application of bank protective, bioengineering methods at relevant locations.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Kvemo Alvani	Kvemo Alvani	Floods	**L**	• Regular cleaning and deepening of the Alazani river channel, removal of excessive sediments from the channel to increase the river capacity; • Implementation of bank protection activities on the Alazani river; • Construction of flow directing and bank protection gabions on 2-3 km section from Alaverdi bridge.	50,000 – 100,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Washing of banks	**M→H**					

Zemo Khodasheni	Charekauli	Washing of banks	**L**	• Implementation of bank protection (including bioengineering) activities on the village ravine (so called Udziro Khevi); • Fortification of the bridge on the ravine.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Atskuri	Floods	**L**	• Regular cleaning and deepening of the Berkhevi river channel. Removal of excessive sediments from the channel to increase the river's capacity; • Implementation of bank protection activities.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Zemo Khodasheni	Floods	**L**	• Regular cleaning and deepening of the Shavkaba and Khodasheni river channels, removal of excessive sediments from the channels to increase the river's capacity; • Implementation of phyto-amelioration activities at	50,000 – 100,000	**MT**	• Municipal government; • Regional government.	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

		Mudflow	**M**	Khodasheni ravine and on the degraded slopes of mudflow hotbeds; • Regular cleaning of the Khodasheni ravine from excessive sediments; • Permanent informing of the population of the area under the mudflow risk on mudflow threat processes and about the territories at risk; involvement of the population in the implementation of mudflow prevention activities in the areas prone mudflow in the village's surrounding;				
		Washing of banks	**L→M**	• Implementation of bank protection activities on the relevant sections of the channels of the mentioned ravines; • Reconstruction of bank protections on the Khodasheni ravine existing in the past (the Alazani river);				
Ozhio	Ozhio	Floods	**L**	• Removal of excessive sediments from the channel of the village ravine (so called Berkhevi) to increase the river capacity; • Regular cleaning of the mentioned ravine from its	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.);

				excessive sediments.				• NGOs.
	Alaverdi	Washing of banks	L→M	• Implementation of bank protection engineering activities: reconstruction of the existing bank protection and arrangement of new bank protection gabions; • Reconstruction of the left bank's protection, near the village bridge.	< 50,000	ST	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Alaverdi Monastery territory	Mudflow	H	• Cleaning of the Zemo Khodasheni ravine's old channel: deepening of the places where the water flows in other directions and construction of ground banks (approx. 1 km); • Arrangement of gabions in the mentioned locations (at least on 200 m) to avoid flash floods in the direction of the Alaverdi monastery and to reduce the water flow.	50,000 – 100,000	ST	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Kistauri	Kistauri	Floods	L	• Cleaning-deepening of the so-called Mkrala ravine: removal of excessive sediments from its channels (until the Alazani river) to increase capacity; • Regular cleaning of the ravine	50,000 – 100,000	ST	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.);

		Mudflow	H	from its excessive sediments; • Implementation of bank protection engineering activities: reconstruction of bank protection dams; • Application of bank protective and bioengineering methods at relevant locations.			infrastructure; NEA).	• NGOs.
	Akhshani	Floods	L	• Cleaning of the Akhshniskhevi channel (on the west from the village) from its excessive sediments; • Implementation of phyto-amelioration activities at the mentioned ravine and on thedegraded slopes of mudflow hotbeds; • Implementation of bank protective, bioengineering methods in relevant locations.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Mudflow	**M→L**					
	Arashenda	Floods	L	• Periodical cleaning and restoration of the village's drainage channels;	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

Akhmeta City	Chartali	Floods	**L**	• Regular cleaning and deepening of the Ilto river channel; • Implementation of phyto-amelioration activities on the degraded slopes of the mudflow hotbeds; • Permanent informing of the population of areas prone to mudflows about mudflow threats and about the territories at risk; involvement of the population in the implementation of mudflow prevention activities where needed; • Implementation of bank protection activities on the respective sections of the Ilto river channel.	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Mudflow	**L**					
		Washing of the banks	**L**					
	Shakhvetila	Floods	**L**	• Arrangement of bank protection constructions on the Ilto river; • Application of bank protective, bioengineering methods at relevant locations.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Landslide	**M**	• Construction of a drainage channels on the landslide surfaces (to remove surface and ground water)	< 50,000	**MT**	• Municipal government; • Regional government; • Central government	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida,

				• Regulation of surface water and filling of the landslide clefts; • Arrangement of protective engineering constructions on the landslide surfaces; • Application of anti-landslide bioengineering methods in some sections.			(Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	etc.); • NGOs.
	Naduknari	Floods	**L→M**	• Arrangement of bank protection constructions on the Ilto river; • Application of bank protective, bioengineering methods at relevant locations.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Vedzebi	Landslide	**M**	• Construction of a drainage channels on the landslide surfaces to regulate surface and ground water; • Organization of a permanent monitoring of the landslide processes; • Detailed study of the geotechnical and geological conditions at the landslide section;	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Chachkhriala	Washing of banks	**L**	• Arrangement of the bank protection constructions on the Ilto river;	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies

				• Application of bank protective, bioengineering methods at relevant locations.				(USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Akhmeta (city)	Washing of banks	**L**	• Rehabilitation of the existing and damaged bank protection constructions on the Alazani river; • Arrangement of flow directing gabions.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
	Akhmeta (city) – Chartali village road	Mudflow Washing of banks	**H** **H**	• Cleaning of the Ilto river channel from the landslide banks, straightening and thorough strengthening of the right bank. Not doing so could result in a disruption of the road traffic and of the water supply system, and could threaten the populations of Naduknari and Shakhvetila, as well as their crofts and power transmission lines; • Cleaning, widening and straightening of the Ilto river channel; • Fortifying the right bank of the river, which includes: 1. Deepening and widening of the river channel, straightening and placement in the central part of the	100,000 – 1,000,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.

				grove-channel; 2. Arrangement of dump sites using the inert material from along the right bank and strengthening with bank protection constructions; 3. Construction of bank fortification taking into consideration the erosive wash depth, arrangement of flow directing constructions to protect the bank protections. 4. The high voltage towers and Akhmeta's (city) main water supply should be moved from the zones of river erosion and sediment accumulation; • The bank protection and flow directing gabions are to be arranged near the Naduqnari village along the right bank of the Ilto river, on its entire length, up unto the populated area.				

3.1.8 Akhmeta municipality - Climate Change Mitigation Activities

Within the program, greenhouse gas emission analysis for different sectors has been conducted. The sectors, which emit greenhouse gases into the atmosphere, have been identified. Furthermore, the volumes of emitted gases in Akhmeta municipality has been calculated.

The obtained results by sector are presented in a generalized manner in the table 3.1.3.

Table 3.1.3. – Emission of greenhouse gases into the atmosphere from the territory of Akhmeta Municipality

Sector		Tons CO2 eq / Year
Agriculture	Enteric Fermentation	31,378.2
	Soil Management	9,300
	Manure Management	6,727.3914
Total agricultural emissions		**47,405.59**
Landfill		**18,004.6**
Pipelines		**4,998**
Residential / Stationary		**4,004.33**
Transport		**17,730.25**
Total		**92,142.77**

Based on the performed analysis, a list of mitigation activities is recommended. Sepcifically:

Recommendations

To reduce the quantity of GHG Emissions from the municipality of Akhmeta, the following activities are recommended:

Akhmeta Municipality is characterised by high transport and landfill emissions, medium level agricultural and stationary emissions and low gas pipeline emissions. The following can be recommended:

- Workshops on manure management techniques (storage and application practices);
- Management of landfill sites (covering, composting practices);
- Insulation of municipal and public buildings;
- Exchanging public transport and municipal vehicles with new, more efficient replacements /conversion of gasoline vehicles into gas/Diesel;
- Development of road infrastructure in the region to increase automobile efficiency;
- Improvement of transport schemes (buses routes and schedules of buses/minibuses connecting regional centre to villages inside the municipality, or outside the region).

Activity plan is presented in the form of a table in Table 3.1.4.

Table 3.1.4. – The concluding list of mitigation activities that must be performed in Akhmeta Municipality

Objectives	Measures	Scale of the measure	Cost Range (USD)	Time line[17] (ST; MT; LT)	Responsible Agent	Potential Source of Funding
Reduction in greenhouse gas emissions from Agriculture	Workshops on manure management techniques (storage and application practices)	Akhmeta municipality	5,000 - 10,000	ST	• Smallholder farmers; • Farming cooperatives; • Municipal government; • Regional government; • Central government (Ministry of Environment protection).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Reduction in greenhouse gas emissions from landfill sites	Management of landfill sites (covering, composting practices)	Akhmeta municipality	5,000 - 10,000	ST	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, ACF, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Reduction in greenhouse gas emissions from residential / stationary sources	insulation of municipal and public buildings	Akhmeta municipality	10,000 - 100,000	ST	• Municipal government; • Regional government; • Central government (Ministry of Environment protection;	• Local budget; • Central budget; • Invested gas companies; • Development agencies (USAID, UNDP, EU, GIZ, Sida,

[17] "Short-term"(ST) implying the period of time up to 1 year; "midterm" (MT) – 1-5 years; "long-term" (LT) – > 5 years.

					Ministry of Regional development and infrastructure).	etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Reduction in greenhouse gas emissions from transportation sources	Exchanging public transport and municipal vehicles with new, more efficient replacements/conversion of gasoline vehicles into gas/Diesel	Akhmeta municipality	10,000 - 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Development of road infrastructure in the region to increase automobile efficiency	Akhmeta municipality	50,000 - 100,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Improvement of transport schemes (buses routes and schedules of buses/minibuses connecting regional centre to villages inside the municipality, or outside the region)	Akhmeta municipality	10,000 - 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB,

						KfW); • NGOs.

3.1.9 Watersheds of Akhmeta Municipality Rivers

Finally, as a summary, it should be added that any measure aimed at solving problems of natural resources, should be based on the watershed approach. This implies a full realization of the fact that actions in the headwaters or upstream will unavoidably exert influence on the lower course. Accordingly, while planning or implementing activities and projects, the location of communities relative to other communities in the basin of a particular river should be taken into consideration. In addition, while assessing any problem, it is necessary to assess the situation in the upper course relative to the given territory and measure the degree of a possible impact on the emergence of the problem. Furthermore, when looking for solutions, priority should be given to those projects that are aimed at improving the situation in the upper course of the watershed, which, eventually, is a precondition for improving the situation of the whole watershed.

In this regard, a good picture of the situation in Akhmeta municipality is available in the tables 3.1.5 and 3.1.6, which represent major rivers of the municipality and communities existing in the watersheds of these rivers (table 3.1.5) and communities of the municipality, river watersheds and location of neighboring communities (table 3.1.6).

Table 3.1.5. Main rivers in the Municipality of Akhmeta and communities located in these river watersheds

<table>
<tr><th>#</th><th>River</th><th>Community (From source to confluence)</th></tr>
<tr><td>1</td><td>Dzibatkhevi</td><td rowspan="2">Jokolo</td></tr>
<tr><td>2</td><td>Batsara</td></tr>
<tr><td>3</td><td>Khaltsani ravine</td><td>Khalatsani</td></tr>
<tr><td>4</td><td>Kurtanadzeuli</td><td rowspan="2">Matani</td></tr>
<tr><td>5</td><td>Matniskhevi</td></tr>
<tr><td>6</td><td>Maghraani stream</td><td>Maghraani</td></tr>
<tr><td>7</td><td>Babaneuri stream</td><td>Maghraani → Kvemo Alvani</td></tr>
<tr><td>8</td><td>Khodashniskhevi</td><td rowspan="3">Zemo Khodasheni → Ozhio</td></tr>
<tr><td>9</td><td>Shavkabaskhevi</td></tr>
<tr><td>10</td><td>Berkhevi</td></tr>
<tr><td>11</td><td>Khorkheli</td><td>Ozhio</td></tr>
<tr><td>12</td><td>Kistauriskhevi</td><td>Kistauri</td></tr>
<tr><td>13</td><td>Ilto</td><td>Akhmetistemi (city) → Matani</td></tr>
<tr><td>14</td><td>Alazani</td><td>Jokolo → Khalatsani → Duisi → Sakobiano → Matani → City of Akhmeta → Zemo Alvani → Kistauri → Kvemo Alvani → Ojio</td></tr>
</table>

Table 3.1.6. Location of Akhmeta Municipality communities to each other, in terms of river watersheds

N	Community	River	Community Location in the watershed	Communities interconnected		Communities interconnected
				Located on the upper course of the river	Located on the upper course of the river	
1	Jokolo	Dzibatkhevi	Covers the entire basin			
		Batsara				
		Alazani	Upper stream			Uppermost stream of Alazani on the municipality territory
2	Khalatsani	Khalatsani ravine	Covers the entire basin			
		Alazani	Middle stream			
3	Duisi	Alazani	Middle stream			
4	Sakobiano	Alazani	Middle stream			
5	Matani	Kurtanadzeuli	Covers the entire basin			
		Matniskhevi				
		Ilto	Lower stream	Community of Akhmeta (city)		
		Alazani	Middle stream			
6	Maghraani	Maghraani stream	Covers the entire basin			
		Babaneuri stream	Upper stream		Kvemo Alvani community	
7	Zemo Alvani	Alazani	Middle stream			
8	Kvemo Alvani	Alazani	Middle stream			Lowermost stream of Alazani within Akhmeta Municipality boundaries together with Ozhio community
9	Zemo Khodasheni	Khodashniskhevi	Upper stream		Ozhio community	
		Shavkabaskhevi				

		Berkhevi				
10	Ozhio	Khorkheli	Covers the entire basin			
		Khodashniskhevi	Lower stream	Zemo Khodasheni ravine		
		Shavkabaskhevi				
		Berkhevi				
		Alazani	Middle stream			Lowermost stream of Alazani within Akhmeta Municipality boundaries together with Kvemo Alvani community
11	Kistauri	Kistauri ravine	Covers the entire basin			
		Alazani	Middle stream			
12	Community of Akhmeta (city)	Ilto	Covers the entire basin / upper stream		Matani community	Matani community covers the left bank the Ilto river in the lower stream, near Alazani confluence
		Alazani	Middle stream			

3.2 Telavi municipality

A list of measures was developed, based on the vulnerability assessment, that should be carried out in Telavi Municipality to reduce its vulnerability to natural disasters and climate change and to increase endurance.

It should be noted that the list of the measures developed are somewhat general due to the scales of the implemented activities – the assessment fully covered Telavi Municipality. The expert group assessed the situation in terms of the municipality and field surveys were carried out in every village of the municipality. Thus, recommendations developed in the survey framework are municipality level recommendations, which exclude local specification with regards to specific problems. At the next stage of the program framework the scale of the program activities is planned to be extended to the community level, this will use the present survey outcomes and will allow for the elaboration of community activity plans that encourage maximum involvement of the local population. These plans will reflect specific activities for risk reduction and resistance devlopment.

Below are given the major problems expected to be caused by the changeability of meteorological elements and necessary adaptation activities for their mitigation in accordance to the future climate change scenario in the Telavi Municipality boundaries. A list of the activities for the mitigation and adaptation of problematic aspects is also identified as a result of the field survey for each community.

3.2.1. Spatial Planning

It is necessary to define areas that have a high risk of natural disasters, so called “hot spots” in the municipality territory, management of which will be executed in accordance with the existing risks.

The risks faced by the municipality communities are stipulated not only by the high risk territories, but also by the vulnerability level of the municipality communities. It is important to implement vulnerability reduction activities in this regard that will in turn increase resistance of the communities towards possible natural catastrophes and negative influences of the climate change. regarding the decrease of the vulnerability, it is important:

- To improve social infrastructure for the population of the municipality communities.
- It is necessary to increase readiness of the communities, as well as for the whole municipality, for possible natural catastrophes. In this regards it is important:
    - To strengthen the regional rescue service through proper training and equipment.
    - To elaborate a municipal response plan that will adequately reflect the dangers the municipality faces, it should elaborate alternative scenarios for development and will elaborate an action plan according to these scenarios taking into consideration the community vulnerability levels.
    - Periodical training in reaction to catastrophes for the population; awareness raising campaigns.
- Improvement of the economic well-being of the population through strengthening various prospective sectors (tourism, agriculture) that will support a reduction in the vulnerability level.

The abovementioned results will become a baseline for the introduction of spatial planning elements in the municipality management that will ensure minimization of the risks faced by the municipality through the most effective use of existing resources. We believe that spatial planning is the main recommendation in terms of adaptation for climate change and increase of preparedness. The work performed while preparing the present document may provide significant assistance to the municipality administration in the future with regards to this.

3.2.2 River Runoffs and Mudflow Processes

In order to avoid the agricultural lands of the rural population, roads and varous engineering constructions being covered by mudflow sediment, as well as to mitigate or eliminate the activation of mudflows and negative results of ravine erosion, it is important to implement the following activities in the identified territories that are subject to mudflow, mudflow hotbeds as well as degraded mudflow hazardous slopes:

- Implementation of phyto-amelioration activities at slopes of mudflow hotbeds – mainly by restoration of forests.
- Regular cleaning of filled mudflow ravine channels and drainage streams of excess sediments.
- Construction of mudflow-conductive, mudflow retaining walls and dams at mudflow generating hotbeds along mudflow ravines and drainage streams.
- Straightening the transit sections of the mudflow ravines and drainage streams.
- Construction of mudflow stream fences and dams to regulate solid sediment movement in mudflow ravines.
- Restriction and in some cases – prohibition of agricultural and construction activities at mudflow generating areas, ravines and surrounding territories.
- Permanent informing of the population in the territories surrounding the area under risk of mudflows on mudflow threat processes and identification of the territories at risk.
- Involvement of the population in the implementation of the mudflow prevention activities.
- Establishment of permanent monitoring on mudflows and creation of an early warning system.

3.2.3 Landslide Processes

Implementation of landslide prevention activities in the territories damaged by the landslides, which means:

- Construction of drainage networks (channels) on the surface of the landslides to remove surface and ground water.
- Construction of protective walls on piles on the front section of landslides.
- Construction of folding or massive mounting walls of monolithic steel-concrete block on the landslide surfaces.

- Application of anti-landslide bioengineering technologies including:
    - Terracing the landslide surface.
    - Carrying out work with ground on the landslide slopes (cut off slopes, exposure of soil, etc.).
    - Turfing of the landslide surface and surrounding territories.
    - Vegetation of a variety of trees on certain selected areas.

Also,

- Restriction or prohibition of water use on landslide area (irrigation of the landslide slopes, construction of water reservoirs at the landslide prone territories, etc.).
- Permanent monitoring of the landslide territories.
- Prohibition of any construction without detailed study of the respective geological-geomorphologic conditions around landslide prone territories.
- Permanent informing and periodical training of population on necessary landslide prevention measures.
- Involvement of population in landslide prevention activities at the territories threatening their crofts.

3.2.4 Floods and River Erosion

For the mitigation of surface runoff, especially to reduce maximum discharge and floods and flash floods problem in the basin of the Alazani River and its tributaries (Stori, Lopota, Turdo) the following activities should be implemented:

- Planting of water regulating forest on postforest slopes.
- Planting of perennial grasses to create turf on certain areas of the woodless slopes.
- Setting strict controls on uncontrolled forest cutting;.
- Elaboration and implementation of forest fire prevention measures.
- Improvement of overall forest management.
- To straighten the crooked sections of the river channels and remove excessive sediments to ensure the maximum discharge by the channels.
- Construction of coastline dams, levees, directing flows, retaining walls, etc.
- Permanent informing of Telavi Municipality population about flood and flash flood risks, their involvement in implementation of the flood prevention activities.
- Establishing permanent monitoring on floods and flash floods and creation of early warning system.

3.2.5 Forest Ecosystems

For protection and adaptation to the expected climate change of the municipality ecosystems, it will be necessary to implement the following:

- Unconditional implementation of control on unsystematic and uncontrolled logging of the forest.
- Implementation of reforestation activities at postforest territories.
- Elaboration of activities to prevent forest fires and organized application when necessary.
- Improvement of overall forest management.

3.2.6 Alpine and Sub-alpine Meadows

For the mitigation or elimination of degradation process in the sub-alpine and alpine ecosystems and pastures and hay lands related to them, it is necessary to take into consideration the expected changes of the meteorological elements (temperature of the air and total annual and seasonal precipitation) within Telavi municipality boundaries for 2020-2050. As we know, sub-alpine and alpine vegetation (and their respective pastures and hay lands) are vulnerable to the climate condition changes. One of the reasons is the fact that the development of the vegetations of the abovementioned zones is connected to snow cover during a large part of the year. Therefore for the protection of sub-alpine and alpine ecosystems, in particular their vegetation, it is necessary to unconditionally follow the exploitation norms. In order to reduce or eliminate the pasture degradation, wind and water erosion of its soil, following actions are necessary:

- Chemical melioration of the pastures using gypsum.
- Adding various types of mineral fertilizers to the plots to increase pasture productivity.
- Reintroduction and implementation of plot shift, pasture rotation, pasture breaks practice.
- Practicing recession of the pasture.
- Rehabilitation of the roads leading to pastures (and hay lands).
- Unconditional fulfillment of optimal load of pastures with cattle.
- Pasture and hay land cultivation – frequent mowing of weed grasses from the plots and plantation of high nutrition value legumes and grain plants (bent, goldenrod, white clover, meadow clover, lotus etc.).
- Unconditional fulfillment of calendar terms of grazing.
- Necessary implementation of use pasture plots in turns.
- Terracing of steep slope postures to reduce erosion when possible.

3.2.7 Drought

The problem of drought is mainly reflected in the agricultural fields of the municipality. The main problem in this regard is the possible lack of irrigation water. For rational consumption of the irrigation water and reduction of waste the following is significant:

- Restriction of unplanned, frequent and excessive irrigation.
- Introduction of irrigation regime and following it.
- Selection of respective types of irrigation – surface irrigation by drift using line, line-holes, subsoil irrigation, irrigation with artificial rain, irrigation by drops.
- Fixing irrigation systems which are out of order. Improvement of their technical condition, using modern water waving equipment.

It is also significant:

- Selection of drought-resistant agricultures and study of their adaptation ability to the local climate conditions.
- Restoration of climate-regulating, water-regulating and soil-protective forest stands on postforest areas unused or rarely used for farming.
- Restoration of logged or severely degraded wind break and meadow protective forests.
- Permanent informing of local agrarian society about global warming processes, possible strengthening of droughts and efficient use of water resources.

A list of necessary adaptation measures are summarized in Table 3.2.1.

Table 3.2.1. Summarized list of the adaptation measures to be implemented in Telavi Municipality

Problem	List of Measures
River Runoffs and Mudflow Processes	• Implementation of phyto-amelioration activities at mountain slopes of mudflow hotbeds – mainly by restoration of forests. • Regular cleaning of filled mudflow ravine channels and drainage streams of excess sediments. • Construction of mudflow-conductive, mudflow retaining walls and dams at mudflow generating hotbeds along mudflow ravines and drainage streams. • Straightening the transit sections of the mudflow ravines and drainage streams. • Construction of mudflow stream fences and dams to regulate solid sediment movement in mudflow ravines. • Restriction and in some cases – prohibition of agricultural and construction activities at mudflow generating areas, ravines and surrounding territories. • Permanent informing of the population in territories surrounding the area under risk of

	mudflow on mudflow threat processes and identification of the territories at risk. • Involvement of the population in the implementation of the mudflow prevention activities. • Establishment of permanent monitoring on mudflow and creation of early warning system.
Landslide Process	• Construction of drainage networks (channels) on the surface of the landslides to remove surface and ground water. • Construction of protective walls on piles on the front section of the landslide. • Construction of folding or massive mounting walls of monolithic steel-concrete block on the landslide surfaces. • Application of anti-landslide bioengineering technologies including: o Terracing the landslide surface. o Carrying out work with ground on the landslide slopes (cut off slopes, exposure of soil etc). o Turfing of the landslide surface and surrounding territories. o Vegetation of a variety of trees in certain selected areas. • Restriction or prohibition of water use on landslide area (irrigation of the landslide slopes, construction of water reservoirs at the landslide prone territories etc). • Permanent monitoring of the landslide territories. • Prohibition of any construction without detailed study of the respective geological-geomorphologic conditions at the landslide prone territories. • Permanent informing and periodical training of population on the necessary landslide prevention measures. • Involvement of population in the landslide prevention activities at the territories threatening their crofts.
Floods and River Erosions	• Planting of water regulating forest on postforest slopes. • Planting of perennial grasses to create turf on certain areas of the woodless slopes.; • Setting strict control on uncontrolled forest cutting. • Elaboration and implementation of forest fire prevention measures. • Improvement of overall forest management. • To straighten the crooked sections of the river channels and remove excessive sediments to ensure the maximum discharge by the channels. • Construction of coastline dams, levees directing flows, retaining walls, etc. • Permanent informing Telavi Municipality population on flood and flash flood risks, their involvement in implementation of the flood prevention activities. • Establishing permanent monitoring on floods and flash floods and creation of early

	warning system.
Forest Ecosystem Degradation	• Unconditional implementation of control on unsystematic and uncontrolled logging of the forest. • Implementation of reforestation activities at postforest territories. • Elaboration of activities to prevent forest fires and organized application when necessary. • Improvement of overall forest management.
Sub-alpine and Alpine Meadows	• Unconditional follow of the traditional norms of sub-alpine and alpine vegetation exploitation. • Chemical melioration of the pastures using gypsum. • Adding various types of mineral fertilizers to the plots to increase pasture productivity. • Reintroduction and implementation of plot shift, pasture rotation, pasture breaks practice. • Practicing recession of the pasture. • Rehabilitation of the roads leading to pastures (and hay lands). • Unconditional fulfillment of optimal load of pastures with cattle. • Posture and hay land cultivation – frequent mowing of weed grasses from the plots and plantation of high nutrition value legumes and grain plants (bent, goldenrod, white clover, meadow clover, lotus, etc.). • Unconditional fulfillment of calendar terms of grazing. • Necessary implementation of use pasture plots in turns. • Terracing of steep slope postures to reduce erosion when possible.
Drought	• Restriction of unplanned, frequent and excessive irrigation. • Introduction of irrigation regime and following it. • Selection of respective types of irrigation – surface irrigation by drift using line, line-holes, subsoil irrigation, irrigation with artificial rain, irrigation by drops. • Fixing the irrigation systems which are out of order. Improvement of their technical condition, using modern water waving equipment. • Selection of drought-resistant agricultures and study of their adaptation ability to the local climate conditions. • Restoration of climate-regulating, water-regulating and soil-protective forest stands on postforest areas unused or rarely used for farming. • Restoration of logged or severely degraded wind break and meadow protective forests. • Permanent informing of local agrarian society on global warming processes, possible strengthening of droughts and efficient use of water resources.

3.2.8 Activity Plan for Telavi Municipality Communities

The described activities need to be specified according to the problems identified for each community. Thus, below is given a preliminary list of activities for each community and villages within the community, which will ensure strengthening of the communities against natural catastrophes and future climate change. The activities are summarized in Table 3.2.2. Each problem is assessed respective to its significance (H – high, M – medium, L – low). Assessment was made on the basis of the field survey materials and data collected from other sources. In assessment, determination of the problem's significance level depended on the problem's influence scale (size of the territory affected by the problem, population influenced and infrastructure). The assessment is preliminary and does not represent an outcome of the problem detailed analysis thus the probability of error is quite high, however, we believe it gives an approximate image of the current situation. As for the list of activities, it is also developed based on the preliminary assessment. Implementation of a specific project is associated with detailed, large-scale research. In addition, the specific action plan should be developed on site with the direct engagement of the community in which the action plan was developed.

Table 3.2.2. Summarized list of adaptation and risk reduction measures to be carried out in the communities of Telavi Municipality

Community	Village	Problems	Scale of Problems (L; M; H)	Executive Measures[18]	Cost Range (USD)	Time line[19] (ST; MT; LT)	Responsible Agent	Potential Source of Funding
Laliskuri	Laliskuri	Mudflow / Floods / Wash of banks[20]	**H**	• Cleaning of the Stori river channel from the small HPS to Lagodekhi-Akhmeta road bridge and bellow. • Arrangement of mudflow conductive construction on the road. • Regulation of the Stori River channel – periodical removal of solid sediments from the channel to increase its capacity. • Implementation of phyto-amelioration activities at slopes of mudflow hotbeds – restoration of degraded forests.	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
		Landslide	**M**	• Implementation of bank protection activities on the Stori	< 50,000	**MT**	• Municipal government;	• Local budget;

[18] The measures were defined for the problems estimated as problems of average or high importance. The list of measures was worked out according to the preliminary estimations. The implementation of concrete activities should be in connection with additional thorough research and assessment.
[19] "Short-term"(ST) implying the period of time up to 1 year; "midterm" (MT) – 1-5 years; "long-term" (LT) – > 5 years.
[20] Wash of banks (river erosion) is a problem for all the communities where floods/flash floods and mudflow problems were identified. The communities where the problem is particularly intensive are identified separately.

				River. • Drainage system construction on local landslide. • Stabilization of the landslide slope using bioengineering methods. • Restoration of forest cover on territory surroundingthe landslide.			• Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Pshaveli	Pshaveli	Floods	**L→M**	• Implementation of bank protection activities on the Chichakhiskhevi river. • Rehabilitation of the supply station on the Naurdali Chanel. • Construction of coastline dams, levees, directing flows, retaining walls and other bank protective construction on both banks of the Stori river (especially the east bank). • Ensure maximal discharge capacity of the rivers (Chichakhiskhevi, Stori) by straightening croocked sections and removal of excessive solid sediments from the channels.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Tetri Tsklebi	Tetri Tsklebi	Landslide	**M**	• Cleaning Tserodena ravine channel, implementation of the	50,000 –	**MT**	• Municipal government;	• Local budget;

				bank protection activities in the ravine. • Cleaning of the Turdo and the Mghvriekhevi channels, straightening the crooked sections and removal of the excess solid sediments. • Implementation of large scale landslide protective activities on 56th km of Tbilisi-Vaziani-Gombori-Telavi road. • Construction of the drainage network (channels) on the surface of the landslides to remove surface and ground water.	100,000		• Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Ikalto	Ikalto	Mudflow / Wash of banks	**H**	• Cleaning of the mudflow ravines' channels of the village. Implementation of bank protection activities on these ravines. • Permanent informing of the population of the territories surrounding the area under the risk of mudflow about mudflow threat processes and about the territories under the risk. • Establishment of permanent monitoring on mudflow and	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				creation of early warning system. • Implementation of phyto-amelioration activities at slopes of mudflow hotbeds – restoration of degraded forests.				
		Landslide	L→M	• Stabilization of the landslide slope using bioengineering methods.	< 50,000	MT	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Ruispiri	Ruispiri	Mudflow / Wash of banks	**H**	• Regulating Ikaltoskhevi and Chichkanaskhevi channels of the village – periodical removal of solid sediments from the channel to increase its capacity. • Implementation of bank protection activities on Ikaltoskhevi. • Restoration of degraded forest on upper part of the Ikaltoskhevi basin (Northern foothills of Gombori Range).	50,000 – 100,000	**MT**	• Municipal government; • Regional government.	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Vardisubani	Vardisubani	Floods / Mudflow	**M**	• Regulating channels of the Telaviskhevi, Vardisubniskhevi and small ravine flowing in the Karaulashvilebi neighborhood –	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida,

				cleaning/deepening, removal of excess solid sediments, straightening. • Implementation of bank protection engineering activities. Including the west bank of the Vardisubniskhevi.				etc.); • NGOs.
Karajala	Karajala	Floods	**L**	• Regulating the Turdo River channel and arrangement of the bank protective construction on its west bank (near the village). • Application of bioengineering methods if possible.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Gulgula	Gulgula	Floods	**M**	• Regulating the Turdo and the Telaviskhevi channels – straightening the crooked sections, cleaning/deepening, removal of excessive solid sediments. • Implementation of bank protection engineering activities. • Application of bioengineering methods in respective areas.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Kurdghelauri	Kurdghelauri	Mudflow	**H**	• Regular cleaning of the mudflow ravines of the village (Telavi ravine, Kurdghelauri ravine, Jinua ravine) and filled drainage channels from excess	50,000 – 100,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida,

				accumulated flow. • Construction of levees directing flows, retaining walls and dams along the mudflow ravines and drainage streams in mudflow generating areas. • Implementation of bank protection activities on both banks of the Kurdghelauri ravine.; • Implementation of phyto-amelioration bioengineering activities on the degraded slopes at the mudflow ravine sources – mainly restoration of degraded forests.			protection; Ministry of Regional development and infrastructure; NEA).	etc.); • NGOs.
Shalauri	Shalauri	Mudflow	**M→H**	• Cleaning and deepening of the village mudflow ravine channels – Shalauri ravine, Svianaant ravine. • Construction of high capacity one-pipe bridges on the Svianaant ravine and road crossing areas. • Prohibition of logging at basin sources and vegetation of washed areas. • The village should be subject of	< 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				geo-monitoring observation.				
Kisiskhevi	Kisiskhevi	Floods / Mudflow	**M**	• Regulation of the Kisiskhevi channel – periodical removal of solid sediments from the channel to increase its capacity. • Implementation of bank protection activities in respective areas. • Improvement of forest management near the village. • Restoration of degraded forest and vegetation of perennial grasses on specific sections of the woodless slopes creating stands in the upstream of the river basin.	< 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Kondoli	Kondoli	Wash of banks / Floods	**M→H**	• Reconstruction of the damaged 10 m section of bank protection concrete blocks near the central bridge of the Kisiskhevi River. • Periodical cleaning/deepening, removal of solid sediments, straightening of the river channel. • Implementation of bank protection activities at respective places. • Application of bank protective	50,000 – 100,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				bio engineering methods at respective areas.				
Tsinandali	Tsinandali	Floods / Mudflow	**M→H**	• Regular cleaning of the filled channels the village mudflow ravines (Kisiskhevi, Patara ravine, Doliauriskhevi) and drainage channels and streams from excessive sediments. • Construction of flow directing levees and dams to regulate movement of solid sediments in the mudflow ravines. • Implementation of bank protection activities on the Doliauri ravine. • Restoration of degraded forest at the ravine basin sources.	< 50,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Kvemo Khodasheni	Kvemo Khodasheni	Mudflow	**M**	• Regulation of the Khodasheni ravine and Busheti ravine channels – periodical removal of solid sediments from the channel to increase its capacity. • Straightening the transit sections the village mudflow ravines (Busheti, Khodasheni) and drainage channels. • Construction of levees, directing flows, retaining walls and dams along the mudflow ravines and	< 50,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				drainage streams at mudflow generating areas. • Restoration of degraded forest at the ravine basin sources.				
Busheti	Busheti	Mudflow / Wash of banks	**M**	• Cleaning-straightening of the Busheti ravine channel, especially its lower flow. • Construction of mudflow retaining walls and dams along the Busheti ravine. • Implementation of bioengineering activities on the degraded slopes at the mudflow ravine sources.	< 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Vanta	Vanta	Mudflow	**M→H**	• Cleaning-straightening of the Vantiskhevi channel, especially in its lower flow. • Regular removal of excessive sediments from the filled mudflow ravine channels and drainage channels and streams. • Construction of flow directing levees and dams to regulate movement of solid sediments in the mudflow ravines. • Implementation of bank protection activities in the respective sections of the	50,000 – 100,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				Vantiskhevi channel. • Implementation of phyto-amelioration activities at slopes of mudflow hotbeds – restoration of degraded forests.				
Akura	Akura	Mudflow / Floods	**M→H**	• Regular removal of excessive sediments from the filled Vantiskhevi channel and drainage channels and streams. • Straightening transit sections of ravines and drainage streams; also, construction of levees directing flows and dams to regulate movement of solid sediments. • Implementation of bioengineering activities on the mountain slopes of the mudflow hotbeds.	< 50,000	**ST**	• Municipal government; • Regional government.	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Artana	Artana	Mudflow / Wash of banks	**H**	• Reconstruction of bank protective construction on the mudflow ravine Didkhevi of the village. • Construction of new gabions in Didkhevi. • Straightening the transit sections of the ravine channel. • Deepening the channel and	50,000 – 100,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				cleaning of the mudflow shafts. • Implementation of phyto-amelioration activities at mountain slopes of mudflow hotbeds – mainly by restoration of forests.				
		Landslide	**M**	• Implementation of bank protection work on the landslide section of the Didkhevi. • Cleaning of the Didkhevi channel, straightening of the crooked section and removal of the excess solid sediment. • Permanent monitoring of the landslide to avoid blocking of the channel. • Stabilization of the landslide slope using bioengineering methods.	< 50,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Saniore	Saniore	Floods / Wash of banks / Mudflow	**M→H**	• Reconstruction of the damaged bank protection on the Lopota River (damaged concrete blocks and dump site dams). • Construction of flow directing levees, gabions and dams to regulate movement of the solid sediments in the river channel. • Extension of the bank protective	50,000 – 100,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.

				dam in the North-East part of the village till the Didkhevi river confluence. Restoration of the flow directing levees on the section and construction of new gabions. • Regular removal of the excess sediments from the filled channels of the mudflow ravines and drainage channels and streams.				
Lapankuri	Lapankuri	Floods / Wash of banks	**M**	• Ensure maximal discharge capacity of the Lopota rRiver channel through straightening the crooked sections and removal of the excessive solid sediments from the channel. • Construction of flood preventive channel-side dams, flow directing levees, retaining walls on the Lopota River. • Aforestation of the postforest slopes and slopes covered with degraded forests with water regulation purpose. • Vegetation of perennial grasses on specific sections of the woodless slopes creating stands.	< 50,000	**MT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Napareuli	Napareuli	Mudflow / Floods /	**H**	• Straightening of the transit	50,000 –	**MT**	• Municipal government;	• Local budget;

		Wash of banks		sections of the Lopota river. • Periodical cleaning, deepening, widening and placement in the central part of the channel. • Implementation of the large scale erosion preventive and bank protective activities – grove-channel – restoration of damaged section with accumulative gravels and finishing with concrete blocks. • Construction of the bank protective dams in the West part of the Naparauli village along the left bank. • Establishing permanent monitoring on floods, flash floods and mudflow and creation of an early warning system.	100,000		• Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • NGOs.
Telavi	Telavi	Mudflow	**L→M**	• Implementation of repair work on the damaged mudflow retaining construction in the Telavi ravine. • Regular preventitive removal of excess sediments and mudflow shafts from the filled mudflow ravine channels and drainage channels. • Implementation of bank	50,000 – 100,000	**MT**	• Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure; NEA).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.

				protection activities on the right bank of the Matsantsara River ravine (along the houses); repair of the mudflow retaining construction on this section. • Restoration of the damaged sections of the box-shaped mudflow receiver on the Telaviskhevi River within the city boundaries (the concrete blocks on the bottom of the building are damaged) – finishing and protection of the building bottom and slopes with concrete blocks.				

3.2.8 Telavi municipality - Climate Change Mitigation Activities

Within the program, greenhouse gas emission analysis for different sectors has been conducted. The sectors, which emit greenhouse gases into the atmosphere, have been identified. Furthermore, the volumes of emitted gases in Telavi municipality has been calculated.

The obtained results by sector are presented in a generalized manner in the table 3.2.3.

Table 3.2.3. Emission of greenhouse gases into the atmosphere from the territory of Telavi Municipality

Sector		Tons CO2 eq / Year
Agriculture	Enteric Fermentation	22,233.96
	Soil Management	24,445.05
	Manure Management	5,623.8
Total agricultural emissions		**52,302.81**
Landfill		**30,234.14**
Pipelines		**14,815.5**
Residential / Stationary		**21,390.81**
Transport		**34,250.58**
Total		**152,993.8**

Based on the performed analysis, a list of mitigation activities is recommended. Sepcifically:

Recommendations

To reduce the quantity of GHG Emissions from the municipality of Telavi, the following activities are recommended:

Telavi is characterised by the highest quantities of emissions from landfill emissions, stationary emissions and transport emissions. It also has a medium level of emissions from agriculture and land use activities.

Bearing this in mind the following activities are recommended:

- Rehabilitation of degraded lands including reforestation/windbreaks program
- Workshops on manure management techniques (storage and application practices)
- Promotion of bicycles, construction of tracks for them in central streets
- “Green way” in central street of Telavi-city
- Management of landfill sites (covering, composting practices)
- Energy efficiency standards for all new buildings
- Insulation of public buildings (Schools, etc.)
- Exchanging public transport and municipal vehicles with new, more efficient replacements
- Promotion of transport conversion to NG
- Improvement of roads to reduce fuel consumption

Activity plan is presented in the form of a table in Table 3.2.4.

Table 3.2.4. The concluding list of mitigation activities that must be performed in Telavi Municipality

Objectives	Measures	Scale of the measure	Cost Range (USD)	Time line[21] (ST; MT; LT)	Responsible Agent	Potential Source of Funding
Reduction in agricultural/ land use greenhouse gas emissions	Rehabilitation of degraded lands including reforestation / windbreaks program	Telavi municipality	5,000 - 20,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Workshops on manure management techniques (storage and application practices)	Telavi municipality	10,000 - 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, ACF, GIZ, Sida, etc.); • NGOs.
Reduction in greenhouse gas emissions from landfill sites	Management of landfill sites (covering, composting practices)	Telavi municipality	5,000 - 20,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, WB, KfW); • NGOs.

[21] "Short-term"(ST) implying the period of time up to 1 year; "midterm" (MT) – 1-5 years; "long-term" (LT) – > 5 years.

	Energy efficiency standards for all new buildings	Telavi municipality	10,000 - 20,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection; Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, ACF, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Reduction in greenhouse gas emissions from residential / stationary sources	Insulation of public buildings (Schools, etc.)	Telavi municipality	10,000 - 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Exchanging public transport and municipal vehicles with new, more efficient replacements	Telavi municipality	10,000 - 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Regional development and infrastructure).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, ACF, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
Reduction in greenhouse gas emissions from transportation	Improvement of roads to reduce fuel consumption.	Telavi municipality	50,000 - 100,000	**LT**	• Municipal government; • Regional government;	• Local budget; • Central budget; • Development agencies

sources					• Central government (Ministry of Regional development and infrastructure).	(USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	"Green way" in central street of Telavi-city	Telavi municipality	10,000 - 50,000	**ST**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, ACF, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Promotion of bicycles, construction of tracks for them in central streets	Telavi municipality	10,000 - 30,000	**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, GIZ, Sida, etc.); • Development banks (ADB, EBRD, WB, KfW); • NGOs.
	Promotion of transport conversion to NG	Telavi municipality		**LT**	• Municipal government; • Regional government; • Central government (Ministry of Environment protection).	• Local budget; • Central budget; • Development agencies (USAID, UNDP, EU, ACF, GIZ, Sida, etc.); • Development banks (ADB,

						EBRD, WB, KfW); • NGOs.

3.2.9 Watersheds of Telavi Municipality Rivers

As a conclusion, we would like to add that any activity aimed at solving natural resource problems should be based on a basin approach; this means a complete understanding of the fact that activities carried out at the sources of rivers/up stream will have an inevitable affect on the lower streams. Therefore, location of the communities in a specific river basin and with regards to other communities should be taken into consideration when planning/implementing activities or projects. In addition, the situation up stream of the territory should be unconditionally assessed and the level of influence on problem creation should be measured. The projects aimed at the improvement of a situation at basin sources should be prioritized when searching for solutions.This is because it is a precondition for the improvement of the entire basin situation.

In this regard, table 3.2.5 and table 3.2.6 give a clear image of the situation in Telavi Municipality. The tables show the main rivers of the municipality and the communities within (table 3.2.5). Municipality communities, river basins and the location of neighboring communities (table 3.2.6).

Table 3.2.5. Main rivers in the Municipality of Telavi and communities located in these river watersheds

#	River	Community (From source to estuary)
1	Stori	Pshaveli → Laliskuri, Saniore.
2	Chumatkhevi	Ikalto → Ruispiri
3	Turdo	Tetri Tsklebi → Ruispiri, Vardisubani → Karajala, Gulgula
4	Matsantsara	Telavi territory → Kurdghelauri
5	Telaviskhevi	Telavi territory → Kurdghelauri
6	Kisiskhevi	Kisiskhevi → Tsinandali
7	Vantiskhevi	Vanta, Akura
8	Didkhevi	Artana
9	Lopota	Lapankuri → Saniore, Napareuli
10	Alazani	Ruispiri → Karajala → Laliskuri → Pshaveli → Saniore → Napareuli → Gulgula → Vardisubani → Kurdghelauri → Shalauri → Kondoli → Tsinandali → Kvemo Khodasheni → Busheti → Vanta → Akura

Table 3.2.6. Location of Telavi Municipality communities to each other, in terms of river watersheds

N	Community	River	Community Location in the watershed	Communities interconnected		Comment
				Located on the upper course of the river	Located on the lower course of the river	

1	Laliskuri	Stori	Lower stream	Pshaveli		
		Alazani	Middle stream			
2	Pshaveli	Stori	Covers the entire basin / Upper		Saniore	Stori is dividing Pshaveli and Saniore communities in the lower stream
		Alazani	Middle stream			
3	Ikalto	Chumatkhevi	Upper stream		Ruispiri	
4	Tetri Tsklebi	Turdo	Upper stream		Ruispiri, Vardisubani, Karajala, Gulgula	
5	Ruispiri	Alazani	Upper stream			Uppermost stream of Alazani on the Telavi municipality territory
		Chumatkhevi	Lower stream	Ikalto		
		Turdo	Lower stream	Tetri Tsklebi		
6	Vardisubani	Turdo	Middle stream	Tetri Tsklebi	Karajala, Gulgula	
		Alazani	Middle stream			
7	Karajala	Turdo	Lower stream	Tetri Tsklebi, Vardisubani		
		Alazani	Middle stream			
8	Gulgula	Turdo	Lower stream	Tetri Tsklebi, Vardisubani		
		Alazani	Middle			

			stream			
9	Kurdghelauri	Telaviskhevi	Lower stream	Telavi		
		Matsantsara	Lower stream	Telavi		
		Alazani	Middle stream			
10	Shalauri	Alazani	Middle stream			
11	Kisiskhevi	Kisiskhevi	Upper stream		Tsinandali	
12	Kondoli	Alazani	Middle stream			
13	Tsinandali	Kisiskhevi	Lower	Kisiskhevi		
		Alazani	Middle stream			
14	Kvemo Khodasheni	Alazani	Middle stream			
15	Busheti	Alazani	Middle stream			
16	Vanta	Vantiskhevi	Covers the entire basin			Vantiskhevi represents a border river on the entire length between Vanta and Akura communities
		Alazani	Middle stream			
17	Akura	Vantiskhevi	Covers the entire basin			
		Alazani	Lower stream			Lowermost stream of Alazani on the municipality territory
18	Artana	Didkhevi	Covers the entire basin			Didkhevi represents the right tributary of Lopota
19	Saniore	Lopota	Lower	Lapankuri		Lopota in the lower stream

			stream			represents a border river between Saniore and Napareuli
		Alazani	Middle stream			
20	Lapankuri	Lopota	Upper stream		Saniore, Napareuli	
21	Napareuli	Lopota	Lower stream	Lapankuri		Lopota in the lower stream represents a border river between Saniore and Napareuli
		Lopota	Upper stream			
22	Telavi	Telaviskhevi	Upper stream		Kurdghelauri	
		Matsantsara	Upper stream		Kurdghelauri	

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