Natural Resources Assessment in the Lower Rioni Pilot Watershed

Republic of Georgia

Technical Report Number 15

Integrated Natural Resources Management in the Republic of Georgia Program

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List of Acronyms and abbreviations

1. ADB - Asian Development Bank
2. AEWA - Agreement on the Conservation of African-Eurasian Migratory Water birds.
3. AVHRR - Advanced Very High Resolution Radiometer BD
4. BOD_5 - biochemical oxygen demand
5. °C - degrees Celsius
6. CARE - CARE International
7. CENN - Caucasus Environmental NGO Network
8. CMS -Convention on Migratory Species
9. C:N - Soil carbon nitrogen ratio
10. Cu - Copper
11. DO - Dissolved Oxygen
12. EU – European Union
13. EWMI G-PAC - East West Management Institute – Policy, Advocacy, and Civil Society Development in Georgia
14. FAO - United Nations Food and Agriculture Organization
15. Fe - Iron
16. FIU - Florida International University
17. GDP - Gross Domestic Product
18. GEL - Georgian Lari
19. GIS - Geographic Information Systems
20. GLOWS - Global Water for Sustainability
21. ha - hectare
22. HPP - Hydro Power Plant
23. IDP - Internally Displaced Person
24. IGBP - International Geosphere-Biosphere Program
25. INRMW - Integrated Natural Resources Management in Watersheds
26. $kcal/cm^2$ – kilocalorie per square centimeter
27. km - kilometer
28. km^2 - square kilometer
29. km^3 - cubic kilometer
30. kWh/m^2 - kilowatt hours per square meter
31. kWh - kilowatts per hour
32. l - liter
33. l/sec - liter per second
34. LAC - Local Area Coverage
35. LLC - Limited Liability Company
36. LTD - Limited
37. m - meter
38. m/sec - meter per second
39. m^3 - cubic meter
40. m^3/sec - cubic meter per second
41. m^3/ year - cubic meter per year
42. MAC - Maximum Allowable Concentration
43. Mln - million

44. Mn - Manganese
45. MODIS - Moderate Resolution Imaging Spectroradiometer
46. MPC - Maximum Permissible Concentration (same as MAC)
47. MW - megawatt
48. NALA - National Association of Local Authorities
49. NDVI - Normalization of Differences between Vegetation Indices
50. NGO - non-governmental organization
51. NH_4 - Ammonia
52. NO_3 - nitrate
53. NO_2 - nitrite
54. NPK - Nitrogen, Phosphorous and Potassium
55. PA - Protected Areas
56. PAH - Polycyclic aromatic hydrocarbons
57. PEA - Programmatic Environmental Assessment
58. PCB - Polychlorinated Biphenyls
59. PO_4 - Phosphate
60. PRECIS - regional climate model (Hadley Centre)
61. PVC - Polyvinyl chloride
62. ROFIU-GE – Representative Office of Florida International University in Georgia
63. Sida - Swedish International Development Cooperation Agency
64. SME - small and medium-sized enterprises
65. SPSS - Statistical Package for the Social Sciences, (statistical analysis software)
66. t - ton
67. t/ha - tons per hectare
68. UNDP - United Nations Development Program
69. UNESCO-IHE - UNESCO Institute for Water Education
70. USAID - United States Agency for International Development
71. W/m^2 - watts per square meter
72. W/m - watts per minute
73. WB – World Bank
74. WEAP – Water Evaluation and Planning System, hydrological model
75. WINROCK - Winrock International
76. WSP – Water Safety Planning
77. WWTP - wastewater treatment plant
78. % - percentage
79. $\%_0$ - slope gradient

SUMMARY

Georgia is a country rich in natural resources abounding with picturesque and pristine ecosystems, but in the presence of ambiguous environmental legislation and fragile law enforcement, the country's environment has suffered for years. Many surface and groundwaters are severely polluted due to waste dumping and untreated wastewater discharge, large areas of forests are cleared owing to illegal logging, many unique biodiversity species are reduced because of poaching, and numerous grasslands are overgrazed. Inappropriate irrigation and agricultural practices have degraded large areas of arable land through soil erosion and salinization. The combined effects of these widespread practices in a synergy with the adverse impacts of natural disasters and climate change undermine the natural resource base and ecosystem services that Georgia depends upon for sustainable development.

For the purpose of addressing the above issues, in September, 2010, USAID-Caucasus launched a multi-year project "Integrated Natural Resources Management in Watersheds of Georgia" (hereafter INRMW). The project is implemented within the framework of an umbrella program "Global Water for Sustainability" (GLOWS) by a consortium of international and national organizations under the leadership of Florida International University (FIU) in a partnership with Care International, Winrock International, UNESCO-IHE and Caucasus Environmental NGO Network (CENN).

The primary goal of the INRMW Program is to improve current and future lives of people in Georgia by managing the sustainable use of natural resources. The project aims to introduce innovative approaches and practical models of participatory integrated natural resources management in a watershed context in targeted pilot areas, by facilitating reforms to and harmonization of national policies in the field of natural resources management and related areas, as well as by increasing the capacity of national and regional institutions to replicate these approaches and models throughout the country. These models will be introduced in four pilot watersheds/areas of Rioni and Alazani-Iori river basins, and efforts will be made to upscale and disseminate them across the country.

This goal is to be achieved through a number of sequential activities, several of which have been already accomplished: i) *baseline assessments of existing laws, policies, institutions* as well as practices in the area of natural resource management and other related sectors; ii) rapid assessments of the existing socioeconomic and environmental situation in targeted river basins; iii) selection of pilot watershed areas based on the rapid assessments and taking into consideration the geographic, environmental, socioeconomic, local governance capacities as well as other criteria, four pilot areas have been selected on the upstream and downstream areas of the Alazani-Iori and Rioni river watersheds.

The detailed assessment of the pilot watershed areas of the Alazani-Iori and Rioni river basins includes:

- Collection of detailed data on the current patterns of the use of natural resources;
- Synthesis and analysis of information to identify the links between utilizing natural resources and the ecosystem services encompassing them;

- Identification of priority community, and watershed-level issues;
- Identification of the potential for sustainable use and integrated management of natural resources that will reflect positively on the human health and economic situation, as well as the on the watersheds' environmental sustainability;
- Elaboration of recommendations on the proper utilization of natural resources to mitigate the existing negative impacts on the environment, and to demonstrate integrated management of natural resources to achieve desirable and realistic objectives.

Integrated Natural Resource Management Plans will be elaborated based on detailed watershed assessments, in close participation with local communities and authorities of the pilot watershed areas. Later, priority actions of the watershed plans will be implemented through a small grant program that will demonstrate the advantages of integrated natural resource management by local stakeholders, and support scaling up these models across the country.

The detailed studies cover the following fields: 1. Water resources; 2. Land resources; 3. Geology and hydrogeology; 4.Forest resources; 5.Biodiversity; 6.Waste management; 7.Socioeconomic conditions.

This report is a detailed assessment of the Lower Rioni Pilot Watershed Area. . Based on the general scope of work developed for detailed watershed studies, national experts hired under the INRMW program conducted field studies and obtained information from relevant institutions, following which, the data was compiled and analyzed. Community concerns and local knowledge were incorporated into the detailed assessments. Thematic maps of geo-informative systems, which provide information on natural resources from the environmental protection point of view and utilization of natural resources, were developed for lower courses of the RIoni river.

A hydrological model (WEAP) has been tested for pilot territories based on global and regional climate models to analyze surface water flow for the Rioni River and its main tributaries and include forecasted climate change in the ensuing 50 years.

During all of the studies, priority issues were identified, assessed and validated, and recommendations for interventions were developed.

Identification of priority watershed issues was carried out in three phases: The initial phase was identification and prioritization of issues by representatives of targeted communities and local authorities; the second phase was study and identification of priority issues by a group of Georgian experts hired under the INRMW program; the final phase merged the issues identified by both groups into one list which was validated by local stakeholders.

Identification and Prioritization of Watershed Issues by Targeted Communities and Local Authorities

To identify community and municipal level priority issues, a working meeting with local communities and government trustees was organized. Participants filled out evaluation score cards listing potential watershed issues with maximum attainable scores assigned to them as per specially elaborated environmental and social-economic criteria: 1. Negative impact on the health condition of villagers; 2. Negative impacts on the environment of the targeted villages and its surroundings; 3. Negative social-economic situation of the local population.

Evaluation results of the score cards revealed that the first priority is given to the issue of unavailability of the safe drinking water caused by absence of centralized rural drinking water supply systems, or presence of obsolete and dilapidated systems. Representatives of several villages indicated towards the dwindling of fresh water in their individual wells in areas without centralized systems. High risk of natural disasters, including floods and flash flood were also mentioned among top priority environmental issues, attributed to climate change, as well as the absence of proper agricultural and storm water drainage systems, existence of deteriorated flood control structures or non-existence of these structures. Furthermore, reduction of forest cover, wind and water erosion and secondary bogging of agricultural lands, water and soil pollution by solid household wastes as well as untreated wastewaters were considered as priority environmental issues by local communities and government trustees of these communities.

A list of priority issues and their causes identified by targeted communities and authorities is given in Annex 10.

Identification and Prioritization of Issues by Experts

Experts hired under the INRMW program have conducted comprehensive studies of watershed resources and have identified issues in each field of environmental and natural resource management. To prioritize these issues, experts discussed the topics and their interlinkages, following which, issues were evaluated on the following criteria: 1) negative health impacts; 2) negative environmental impacts on watershed; 3) negative social-economic impacts (e.g. housing, infrastructure, agriculture and etc.).

Full version of experts' evaluations of watershed issues is given in annex 11.

According to experts assessments, flooding of large areas resulting from floods and flash floods is a critical issue for the Lower Rioni pilot watershed area. This is caused by the deterioration of existing drainage systems or absence of such facilities as well as by degradation/absence of river bank embankments. Floods and flash floods damage household properties, including their houses, orchards and farm lands, local infrastructure and occasionally result in human casualties. Furthermore, as a result of inundation, flooded areas are bogged that leads to the spread of insects and algae, increase in ground water table and evaporation rates, which ultimately results in the degradation of natural landscapes and agricultural lands.

Deterioration of the overall quality of forest ecosystems is a major problem in the area of the forest management. This is directly caused by unsustainable utilization of timber resources that bring about forest degradation, soil erosion, deterioration of water, and climate regulation functions of the forests. Other areas of concern include, absence of common forest management policy, legal and regulatory framework, forest monitoring and inventory systems and function zoning of forests.

Poor waste management, including collection and disposal of solid household and industrial wastes was also identified as priority issues. More specifically, unsanitary municipal landfills compounded with illegal dump sites have negative impacts on the local environment, polluting water, soil and air with harmful substances. Environmental pollution and unsanitary conditions hinder tourism development in the PAs and other recreational zones.

Water and soil pollution from untreated sewage discharged from Senaki sanitation system that serves around 15% of the city's population, as well as from dry pit latrines of rural households and public buildings, was also listed among priority issues.

Poor access to safe drinking water due to deterioration of existing centralized water supply systems or absence of such systems was named as one of the major issues in the area of water management. It should be noted that almost every village of Senaki and Khobi municipalities do not have centralized water supply system and abstract drinking water from individual or common wells. This is an unsustainable and an inefficient drinking water use practice in terms of water quantity and quality.

Land degradation and loss of the fertile topsoil is cited among priority issues. This problem is caused by wind and water induced soil erosion, deforestation, destruction of windbreaks and overgrazing. The last mentioned occurs in the Kolkheti National Park and its buffer zones leading to the degradation of valuable floodplain and swampy forests of the Kolkheti Wetlands.

In the area of biodiversity and agrobiodiversity, habitat/ecosystem degradation, disintegration and loss, species loss, depletion of natural resource base, transformation of natural ecosystems due to the introduction of invasive species as well as the widespread use of GMO seeds and products resulting from the absence of control mechanisms, and loss of traditional agrobiodiversity (lentils, chickpeas, etc.) caused by extensive distribution of species used for mass production agriculture (e.g. kidney beans, corn) were ranked high among priority issues.

Synthesis, Validation and Final Evaluation of the Priority Issues

Based on priorities identified by local communities and experts, a common list of priority issues was developed by the INRMW Program Team. Priority issues were categorized by environmental/natural resource management field, and underlying causes for each issue were identified.

- ***Water quantity***: 1. Poor access to drinking water and reduction of water sources; 2. Increase in the frequency and intensity of floods and flash floods.

  Immediate/underlying causes - problem 1: existence of inefficient and outdated centralized water supply systems in urban areas and few villages; absence of centralized rural water systems in the absolute majority of villages; extraction of drinking water from individual/common wells;

  Root causes – problem 1: lack of financial, technical and human resources for rehabilitating existing systems and/or building new efficient systems; absence of effective water use tariffs and implementation systems (appropriate institutions, billing and bill collection systems and penalties).

Immediate/underlying causes – problem 2: deterioration of existing drainage systems and flood control structures and/or absence of such systems; river bank and bed erosion, riverbed sedimentation/silting, coastline erosion and loss, naturally occurring tectonic and geodynamic process including, eustasy, intensification of sea surges and storms, etc.

Root causes – problem 2: lack of technical, human and financial resources to properly design, construct, operate and maintain drainage systems and flood control structures; climate change and change in seasonal river runoff due to: a) forest degradation/decline as a result of unsustainable timber harvesting and absence of proper legal-regulatory, policy and institutional frameworks; b) extensive extraction of sand and gravel from riverbanks and beds without any environmental consideration, river bed diversion, construction and operations HPPs in the upstream areas of the river basin, etc.

- ***Water quality***: 1. Pollution of surface and ground waters; 2. Contamination of tap water.

  Immediate/underlying causes – problem 1: discharge of untreated wastewaters from point sources of pollution (sewerage systems, upstream and local industries, etc.) into surface waters; agriculture and urban runoff; drainage of storm waters and seepage of leachates from controlled and uncontrolled waste disposal sites, open pit mines, dry pit latrines;

  Root causes – problem 1: deteriorated or absent sewerage systems; absence of wastewater treatment facilities; absence of standard-based sanitary landfills and poor condition of existing landfills; non-proper agricultural practice; lack of state finances to rehabilitate/build centralized sewerage systems and construct WWTPs and standard-based landfills; poor ambient water quality and soil monitoring; absence of effective regulations, including standard for wastewater discharges; absence of a common effective policy on waste and water management; weak law enforcement; low environmental consciousness of local communities.

  Immediate/underlying causes - problem 2: deteriorated drinking water supply infrastructure or absent infrastructure in the majority of the villages; absence of sanitary zones/lack of protection of zones around existing water sources; absence of tap water treatment in virtually all communities with centralized water supply systems;

  Root causes – problem 2: shortage of funds to rehabilitate existing centralized systems or to build new systems; absence of effective regulations, weak law enforcement and monitoring mechanisms; low local capacity for tap water quality and environmental pollution control; low environmental consciousness of local communities

- ***Waste management:*** 1. Poor sanitary-hygienic conditions in urban and rural settlements; 2. Pollution of streams, rivers, groundwater and soil from waste dumped in dry ravines, drainage canals and riverbeds, as well as from seepage of pollutants from controlled and uncontrolled waste disposal sites.
  Immediate/underlying causes - problem 1: substandard waste collection, transportation and disposal systems in the urban areas and nonexistence of these systems in the vast majority of villages; existence of illegal and uncontrolled dumpsites

Root causes – problem 1: lack of financial, technical and human resources/capacity to organize effective waste collection, transportation and disposal systems; absence of effective waste collection and disposal tariffs; poor enforcement of tariff collections.

Immediate/underlying causes - problem 2: unsanitary and poor ecological conditions of existing legal landfills, proximity of waste disposal sites to streams and settlements; improper operation and maintenance of existing waste disposal sites.

Root causes problem 2: lack of financial, technical and human resources to build standard-based sanitary landfills and/or properly operate and maintain existing facilities; absence of waste recycling and processing practices and amenities; absence of common standard-based legal-regulatory, policy and institutional frameworks in the area of waste management; weak environmental monitoring and law enforcement; low environmental consciousness of local communities.

- ***Land resources:*** 1. Soil bogging, wind and water induced soil erosion, river bank and coastal erosion; 2. Loss of productive agricultural lands and high conservation value natural ecosystems, including floodplain forests, wetlands, etc.; 3. Soil contamination.

  Immediate/underlying causes - problem 1: poor land reclamation caused by improper drainage of agricultural lands or absence of such mechanisms; lack of flood control structures on river banks, river bed diversion or other changes in river hydromorphology as a result of various instream manipulations; eustasy and tectonic subduction of land; uncontrolled and excessive grazing, uncontrolled land cultivation, unrestrained forest cutting;

  Root causes – problem 1: lack of financial, technical and human resources to rehabilitate existing drainage and flood control systems, design and build new and more efficient systems as well as to implement erosion control/land reclamation measures; absence of policy/plan for sustainable land management; absence of effective land use tariffs and implementation mechanisms; low awareness of local farmers on sustainable water and land use and good agriculture practices; lack of the scientific knowledge on human and climate change impacts on coastal erosion, etc.

  Immediate/underlying causes - problem 2: application of unsustainable agricultural practices; destruction/elimination of windbreaks; overgrazing and uncontrolled timber harvesting; infrastructure development activities without considering and mitigating expected environmental impacts; uncontrolled peat extraction;

  Root causes – problem 2: absence of effective agricultural land management policy, including land use planning and its implementation mechanisms (e.g., land use zoning, land inventory and monitoring, land use fees, land allocation, etc.); absence of proper zoning or other regulatory or economic mechanisms for sustainable pasture management; absence of sustainable forest management laws, policies and effective mechanisms for law enforcement; lack of local knowledge on good agriculture practices;

absence of common effective policy and its implementation mechanisms for forest management.

Immediate/underlying causes - problem 3: leaching of pollutants from waste dumps or waste burial sites, open-pit mines and pit latrines; pollution from urban and agriculture runoff; discharge of untreated wastewaters into the earth's surface.

Root causes – problem 3: improper use of agrochemicals; poor knowledge on the optimum agrochemical inputs; absence of regulatory and law enforcement mechanisms for soil quality; absence of effective environmental pollution control regulatory and/or economic mechanisms; absence of financial and technical resources for implementing effective environmental control policies, including policies for waste and wastewater management.

- ***Forest resources:*** 1. Deterioration in the overall quality of high conservation value forests; 2. Reduction of timber resources.

  Immediate/underlying causes – problem 1 and 2: unsustainable use of timber resources, including uncontrolled cutting of trees for firewood; overgrazing in forest ecosystems; cutting of forests for implementation of land development projects; absence of forest maintenance and/or restoration measures.

  Root causes – problem 1 and 2: application of unsustainable silviculture methods, e.g. clearcutting; lack of financial, technical and financial resources to carry out afforestation/reforestation measures; underutilization of alternative energy sources; poor economic sense of local population that limits access to secure energy sources (gas, electricity, etc.); local population's lack of awareness on energy saving and efficiency measures; absence of a common forest management policy, effective legislation and regulations; absence of forest inventory and monitoring systems; absence of effective law-enforcement system.

- ***Biodiversity:*** 1. Degradation (destruction, modification/transformation) of natural ecosystems and biomes (e.g., wetlands, floodplain forests, sand dunes, etc.); 2. Species loss and decrease in wildlife populations; 3. Loss of traditional and endemic species (e.g. lentil, chickpea, flax, wheat etc.); 4. Widespread use of GMOs

  Immediate/underlying causes - problem 1: overgrazing; intensive forest cutting; introduction of invasive species; poaching and unsustainable tourism; uncontrolled peat extraction; instream operations, including extraction of sand and gravels from river beds and terraces; artificial fires; land clearing for infrastructure and other economic development activities in protected wetlands and its buffer zones.

  Immediate/underlying causes - problem 2: poaching; overfishing; distribution of invasive species; implementation of infrastructural projects in areas rich in biodiversity without conducting environmental impact assessment and mitigation measures; unsustainable tourism.

Root causes – problem 1 and 2: inadequate legal-regulatory, policy and institutional frameworks for biodiversity conservation and sustainable utilization; poor biodiversity monitoring and law enforcement capacities, including the lack of technical and financial resources and qualified staff; high local poverty level and low environmental awareness of the local population.

Immediate/underlying causes – problem 3: widespread use of mass-production crops.

Root causes – problem 3: absence of state policy and its implementation mechanisms on Georgian agrobiodiversity, and the decline of local knowledge on traditional agriculture.

Underlying cause – problem 4: wide availability and low cost of GMO seeds and products compared to ecological seeds and products.

Root causes – problem 4: low public awareness and absence of legal, policy and institutional frameworks for regulating the use of GMO raw materials and products.

The final list of issues was presented to local stakeholders to reach a consensus and an agreement of interested parties on priority issues. The stakeholders confirmed the validity of presented issues.

Final priorities were set based on maintaining the key ecosystem functions of the Lowe Rioni pilot watershed area: (1) preserve human health; (2) supply drinking water; (3) maintain ecosystem integrity and health; (4) reduce risk from natural disasters; 5. Provide hydropower generation[1]; (6) provide fuel wood; (7) support agricultural productivity; (8) provide mineral resources; (9) provide cultural resources; (10) provide tourism resources; and (11) provide recreational and spa resources.

For methodology and outcomes of evaluation refer Annex 12.

Recommended Measures

Experts hired under the INRMW Program have developed recommendations for watershed interventions to address major issues identified during the detailed watershed studies. These include both structural and non-structural measures. This list of suggested measures may serve as a basis for a watershed planning exercise that will follow detailed watershed assessments[2].

Water Resources

- Conduct flood control measures in high flood risk sections;
- Clean river beds on a regular basis;
- Rehabilitate/upgrade existing drainage systems or build new effective ones;
- Rehabilitate existing water supply systems in villages with centralized water supply systems;
- Construct new systems in villages without centralized water supply systems;
- Rehabilitate existing urban water supply system (Senaki) in the pilot watershed area;

[1] This function is only attributed to the surface waters of the Tekhuri River Basin
[2] Integrated Natural Resources Management Plan for the Lower Rioni Pilot Watershed Area will be developed based on this assessment and consultations with local stakeholders

- Fence sanitary zones at the intakes;
- Install drinking water treatment facilities/devices;
- Set GIS database on existing water supply infrastructure;
- Strengthen drinking water quality monitoring and state control capacities;
- Rehabilitate and expand Senaki sewerage system;
- Construct urban biological wastewater treatment plant;
- Construct on-site wastewater treatment facilities for small villages, industries or public buildings;
- Install aerobic bio-toilets in public buildings and/or structures holding small businesses;
- Study current patterns of the use of pesticides and fertilizers, develop and implement integrated pesticide and fertilizer management program and apply other good agriculture practices to reduce effluent discharges from agriculture lands;
- Establish drainage systems and wastewater treatment facilities on existing landfills, construct dams/levies near waste disposal sites located near riverbanks to protect them from flooding;
- Improve existing legislations in the areas of water resources protection and sustainable utilization;
- Expand existing ambient water quality monitoring system (reopen water quality monitoring site on the Tekhuri River and add new sites), as well as hydrological monitoring system ;
- Establish groundwater monitoring system;
- Improve state statistical accounting system for water uses, upgrade existing databases and link them with GIS systems.

Land Resources

- Develop national, regional and local sustainable land management policies;
- Develop general strategies for land use and spatial planning which will become a basis for developing detailed local spatial plans;
- Set-up and/or strengthen interagency coordination mechanism;
- Develop/update the KNP management plan and develop management plans for its buffer zones;
- Plan and implement forest restoration measures;
- Develop guidelines for preventing/reducing land erosion during implementation of infrastructural projects;
- Set grazing norms for pastures and implement sustainable pasture management measures;
- Study soil quality, and based on this information, implement relevant land cultivation practices;
- Conduct an inventory of eroded and degraded agriculture lands and implement land reclamation measures;
- Support establishment of livestock farms to reduce grazing pressures on forest ecosystems as well as to generate alternative incomes;
- Promote revival traditional herding practices;
- During designing of infrastructure or economic development projects, take into consideration the principles of integrated coastal zone management;

- Strengthen legislation and law enforcement capacities, as well as raise public awareness.

Forest Resources

- Develop forest policies, laws, and sub-laws, including regulations on forest use;
- Create forest inventory and monitoring system and establish comprehensive forest database;
- Implement functional zoning of forests and establish geographic information systems;
- Enhance law enforcement mechanisms and develop institutional and staff-level capacities for law enforcement;
- Develop integrated land, water and forest management plans for entire watersheds/municipalities including measures for using, maintaining, protecting and restoring forests;
- Set optimal quota for timber use that does not exceed the annual increase of timber;
- Restore degraded forest ecosystems;
- Determine the annual fuel wood demand at municipality level and develop alternative energy sources in case of shortage;
- Promote conventional fuels (e.g., gas, coal) or alternative energy sources, including hydropower, wind and solar energy, for heat generation;
- Promote efficient use of fuel wood using wood chips, pellets, briquettes, energy-efficient stoves, better thermo-insulation, etc.;
- Control livestock grazing in the forests bordering pastures and settlements;
- Lease large areas of forests (sub-catchments) for long-term commercial use;
- Conduct inventory of forest lands to be leased;
- Build roads leading to locations allocated for fuel wood extraction;
- Establish special crews for cutting fuel wood;
- Distribute fuel and non-fuel wood from central locations.

Biodiversity

- Improve law enforcement mechanisms and enhance the capacities of law enforcement agencies to protect biodiversity (this particularly refers to law enforcement against poachers and illegal forest loggers);
- Improve existing biodiversity monitoring system;
- Raise public awareness on the importance of local biodiversity and sustainable practices for its utilization;
- Promote extracurricular environmental educational activities and introduce biodiversity conservation in school curricula;
- Implement non-structural and structural measures to reduce/avoid forest and land degradation;
- Strengthen management effectiveness of the Kolkheti National Park through developing/updating and implementing PA management plans;
- Promote sustainable tourism within the Kolkheti National Park;
- Promote alternative livelihood programs for rural population living within the territory of the Kolkheti National Park or within its buffer zones to reduce pressures on local natural resources.

Waste Management

- Develop waste management strategies and plans for Senaki and Khobi municipalities;
- Improve the fee system for waste management;
- Construct new EU-standard based landfill(s) in Samegrelo Region for disposal of household solid wastes generated and collected in Senaki and Khobi municipalities;
- Build transit point in Senaki Municipality, where wastes from different locations will be stored temporarily and subsequently transported and disposed in the municipal/regional landfill;
- Decommission and conserve old waste disposal sites;
- Eliminate illegal dumpsites;
- Procure 4-5 closed waste transportation trucks each for Khobi and Senaki municipalities;
- Procure 250-300 waste collection containers, 1.1 m^3 in volume, each for Khobi and Senaki municipalities;
- Establish waste separation system, for waste recycling ;
- Raise awareness and build capacity of municipal authorities.

1.0 INTRODUCTION

1.1 Background Information

Georgia is a country rich in natural resources abounding with picturesque and pristine ecosystems, but in the presence of ambiguous environmental legislation and fragile law enforcement, the country's environment has suffered for years. Many surface and groundwaters are severely polluted due to waste dumping and untreated wastewater discharge, large areas of forests are cleared owing to illegal logging, many unique biodiversity species are reduced because of poaching and numerous grasslands are overgrazed. Inappropriate irrigation and agricultural practices have degraded large areas of arable land through soil erosion and salinization. The combined effects of these widespread practices in a synergy with the adverse impacts of natural disasters and climate change undermine the natural resource base and ecosystem services that Georgia depends upon for sustainable development.

For the purpose of addressing the above issues, in September, 2010, USAID-Caucasus launched a multi-year project "Integrated Natural Resources Management in Watersheds of Georgia" (hereafter INRMW). The project is implemented within the framework of an umbrella program "Global Water for Sustainability" (GLOWS) by a consortium of international and national organizations under the leadership of Florida International University (FIU) in a partnership with Care International, Winrock International, UNESCO-IHE and Caucasus Environmental NGO Network (CENN).

1.2 Goals and Objectives

The primary goal of the INRMW Program is to improve the current and the future lives of people in Georgia by utilizing and managing natural resources, including water, soil, vegetation, and the ecosystems that encompasses them, more sustainably. The key objective of the project is to introduce a practical and a scalable model of integrated natural resources management in a watershed context in the pilot territories, and subsequently to upscale the model across the country by facilitating reforms as well as harmonization of national policies, and strengthening the capacity of national and regional governance institutions. Following the implementation of these models in the pilot territories, efforts will be made to replicate them throughout the country. This goal will be achieved through a number of sequential activities, some of which are already completed: i) rapid assessment of the legal framework of natural resources management and related fields, including national policy and institutional settings; ii) preliminary assessment of environmental and socio-economic conditions in the targeted river basins.

Based on the rapid assessment as well as geographic, environmental, socioeconomic, local governance, capacity and other criteria, four pilot watershed areas were selected in upstream and downstream areas of the Rioni-Iori and Rioni river basins, where the INRMW program pilot interventions will be carried out.

The Detailed Assessment of the Lower Rioni Pilot Watershed Area is included the INRMW Technical Report with the following general objectives:

1) Obtaining detailed information and conducting studies on the pilot watersheds, particularly on the environmental situation and the use of natural resources in the upper and downstream areas of the Rioni River;
2) Synthesizing and analyzing the information to identify links between ecosystem services and natural resource utilization;
3) Identifying the potential of integrated natural resources management and sustainable utilization for positive impact on human health and economic conditions as well as on the ecological condition of the watershed territories;
4) Elaborating expert recommendations to mitigate pressure on watershed basins by proper utilization of natural resources, and for demonstrating integrated management;
5) Achieving promising tangible results that will enable the spread of these management models across the country.

The next phase of the project stipulates elaboration of integrated natural resource management plans for the pilot watershed areas based on the detailed assessment of pilot watershed areas with active participation of the local communities. A number of priority interventions of the watershed plan will be implemented to demonstrate participatory integrated management of natural resources.

1.3 Methodology and Limitations

This report has been developed for the Lower Rioni pilot watershed area that covers Khobi and Senaki municipalities. The study has specifically focused on the 15 communities targeted by the program (refer Annex 1)[3].

Information and conclusions presented in the report are based on analysis and amalgamation of information received through close consultation with local communities and studies conducted by environmental experts hired under the INRMW program on: 1) water resources; 2) land resources; 3) geology and hydro-geology; 4) forest resources; 5) biodiversity; 6) waste management; 7) socio-economic conditions.

The experts compiled and analyzed data obtained through field visits made to the pilot watershed area for studying the current situation and by collecting existing information from the Ministry of Environmental Protection, the Ministry of Energy and Natural Resources, the "United Water Supply Company of Georgia," LLC, and municipal authorities in Khobi and Senaki. Additional information was obtained by surveying the local population in cooperation with consortium member, CARE International. The rapid basin assessment and the Programmatic Environmental Assessment (PEA), DCN: 2012-GEO-064[4] was also used as sources for data.

The studies were accompanied by the development of GIS thematic maps that display information on the condition of the environment as well as the condition and use of natural resources (refer Annex 2).

River run-off was also assessed for the pilot territory based on the WEAP (Water Evaluation and Planning System) hydrological model, which evaluated the vulnerability of surface water runoff

[3]The detailed information on Community Selection Process is presented in the technical report "Selection of Target Communities in Pilot Watershed Areas"
[4] Source: http://www.globalwaters.net/projects/current-projects/inrmw/

of the Rioni River and its main tributaries in the forecasted climate change for the ensuing 50 years (refer Annex 3). A hydrology and water resources management specialist prepared conclusions and recommendations based on these data.

The local population was surveyed to evaluate the existing socioeconomic situation. The survey included the target villages and several control villages outside the scope of INRMW Program. Representatives of all surveyed communities were briefed in advance on the procedures of filling up the questionnaires. Households participating were randomly selected in both targeted and control communities, and the most informed member of the household was interviewed using a structured questionnaire (refer Annex 14). Overall, 255 households were interviewed in Senaki Municipality and 124 households in Khobi Municipality. In addition, several relatively better informed communities were interviewed using the in-depth structured interview method. The information was processed employing SPSS statistical program, and the data was weighed using the ratio of the number of households residing in the respective communities. The results of the survey obtained after statistical processing and analysis of the information are presented in the current report.

This report on detailed assessment of natural resources contains information on the condition of natural resources and their utilization in the Lower Rioni pilot watershed area. Future trends are also forecast and the pressure on the environment is analyzed through main factors. This report also includes experts' conclusions and recommendations for further action, annexes, and a bibliography. The opinions expressed herein are solely those of the authors and do not necessarily reflect the views of the Government of Georgia or the United States Agency for International Development (USAID).

The lack of current hydro-meteorological and environmental quality data due to extremely limited monitoring capacities as well as limited time and resources can be considered as the limitation of this study.

2. ENVIRONMENTAL CONTEXT

2.1 Location and Climate

Lower Rioni pilot watershed area embraces Khobi and Senaki municipalities located in the lower course of the Rioni River, and it covers an area of 419.8 km². Khobi and Senaki municipalities belong to the Samegrelo and Zemo Svaneti regions (please refer map 1 in Annex 2).

Khobi Municipality is located in the western part of West Georgia (centrally located in the Kolkheti lowland). From the north it is bordered by Zugdidi Municipality, from the north-east by Tchkhorotsku Municipality, from the east by Senaki Municipality, from the south by Lanchkhuti Municipality, from the south-west by Poti, and from the west by the Black Sea. The total are of the municipality is 676 km^2 (please refer map 1 in Annex 2), of which 27.0 km^2 falls under the area of Rioni Basin. The municipality is situated from 2-470 m above sea level, and belongs to the category of humid sub-tropic climate zone of Kolkheti lowland, with moderate winter, hot and humid summer and enduring warm autumn. Annual average temperature measures +14 °C. In general, windy conditions over land and water through all seasons is a characteristic of the municipal territory, however, the west wind is severe during winter. The municipality is rich in a variety of water resources, including surface and ground waters, wetlands, small sized lakes and thermal (sulfide) waters.

Senaki Municipality is situated to the south of Samegrelo - Zemo Svaneti regions, in the central part of Kolkheti lowland. The municipality is bordered by Khobi Municipality from the west, by Abasha Municipality from the east, Martvili Municipality from the north-east and Lanchkhuti Municipality from south. It stretches on both sides of Unagira Mountain Ridges. The total area of the municipality is 520.7 km^2, of which 392.9 km^2 comes within the boundaries of lower Rioni watershed area (please refer map 1 in Annex 2). The municipality is located in the sub-tropic zone and its climate is influence by the Black Sea. The average annual sea surface temperature does not dip below 9° C, in summer it hovers around 24-26° C, while on hilly plains it does not exceed 14° C and in mountains not beyond 10-12 °C. The coldest month is January and in rare occasions February. In the plains, the temperature does not go below 6-7° C, while in mountains it drops below 0° C. The warmest months are July and August with an average temperature of 22°C in plains, and 15-16°C in mountainous regions.

2.2 Surface Water Resources

General. The Rioni River is the largest water body in Western Georgia. The river runoff increases in the month of April and reaches its maximum in June and the minimum volume of water runoff is witnessed in end of August. In September, the runoff volume increases due to heavy rains and reaches it maximum in October-November. The minimum volume of runoff is observed during the months of December – February. Overall, 38.8% of the total runoff occurs in spring, 28.5% in summer, 18.4% in fall and 14.3% in winter. 34.7% of the runoff is created by groundwater, 32.5% by rain water, 28.2% by snowmelt and 4.6% by glaciers. The annual water flow of the Rioni River into the Black Sea touches 12.9 km³ and sedimentation flow of 6.9 million tons. Solid sediment loads vary from 96,000 tons to 6.9 million tons.

Both flash floods and floods are specific to the river. Floods happen in spring-summer seasons caused by snow and glacier melting as well as by rainfall. Flood in downstream areas takes place in the second half of February and continuous till the end of August. The flood reaches its maximum in the month of May and September due to rains resulting in severe floods. Flashfloods can also be caused by rainfall during the low runoff period of December to February.

Tekhura (near Abasha) and Tsivi rivers merge with the Rioni River in the territory of Senaki Municipality, while in the territory of Khobi Municipality, the Rioni River has no tributary and the riverbanks are barraged. The hydrological data map of the pilot territory is available in Annex 2, map 3.

Hydrography of the Rioni River. The Rioni River originates from Mount Pasi at an altitude of 2,620 m above sea level and merges with the Black Sea in the City of Poti. The length of the river is 327 km with average inclination 7.2‰. The total catchment area of the Rioni Basin is 13,400 km^2, and average altitude of 1,084 m.

The majority of the largest tributaries join the river on the Kolkheti lowland. The main tributary rivers and their respective length are: Jojora (50 km); Kvirila (140 km); Khanistskali (57 km); Tskhenistkali (176 km); Noghela (59 km); Tekhuri (101 km) and Tsivi (60 km). The length of eight tributaries are between 25 – 50 km, 14 tributaries between 10-25 km, and the remaining 355 tributaries are relatively short with none having a length of more than 10 km, which makes the total length of the river network 720 km.

Watershed of the Rioni River occupies half of Western Georgia. The largest chunk of the watershed (68%) is situated on the southern slope of main dividing range of the Caucasus, 13% on the Adjara-Imereti north tableland and the remaining 19% on Kolkheti lowland.

In the downstream areas below Kutaisi, the riverbed grows as wide as 250 m; depth varies between 0.8-5 m and the flow velocity of 0.7-1.5 m/s. The width of the river downstream Kutaisi varies from 100 to 150 m, depth of 1-5 m and flow speed at 0.6-1.2 m/s. The river mouth (delta) has a near shore with a floor slope exceeding 1‰, classifying this delta as very deep and therefore waves have relatively strong impact on the shoreline. In the downstream area, river runoff is relatively same in every season. The course of the river is conditioned by regimes of numerous tributaries. Floods and flashfloods occur all year round. After it passes the mountains, the Rioni River receives huge volumes water through the period of March-July, which is conditioned by the similar course of Tskhenistskali and Kviriula rivers. The minimum annual discharge rate of the downstream stretch of the Rioni River is in the beginning of autumn, which is slightly less than the rate in winter.

The Rioni River gorge within the pilot area is not shaped clearly with meandered riverbed and branchless body. The height of eroded riverbanks varies between 2.5 m and 3.5 m. There are no floodplains in this area and 4-5 m high terraces follow both sides of the riverbank, starting from the Tskhenistskali River confluence up to the Rioni River mouth. The natural width of both riverbank sides is shortened by embankments/earth levies to protect areas from floods that follow the path of the riverbank from the Tskhenistkali River confluence up to Poti. The height of the flood control structures is 4-4.5 m and at a distance of 350-650 m from each other.

The river is fed by melting of glaciers and snow, rains and groundwaters. The annual runoff regime is characterized by spring floods and flashfloods.

*Hydrography of the Tekhuri River***.** The Tekhuri River originates from the south slope of the Samegrelo ridge at an altitude of 2,360 m above sea level and joins the Rioni River from the right side at 57 km from its source. Length of the river is 101 km with total fall of 2,352 m having an average inclination of 23%°. The catchment area covers 1,040 km^2 and an average altitude of 730 m.

Around 503 tributaries of various sizes join the river with total length 1,045 km, of which the main tributaries and their respective lengths are: Tchkhorotsku (11 km); Chachkhura (12 km); Gurdzemi (20 km); Nakhuri (11 km); Abasha (66 km).

Upstream areas of the Rioni River Basin are located on the south slope of the Samegrelo ridge and the downstream area on the Kolkheti lowland. The geological structure of the upstream basin is composed of tuff breccia, limestones, sands and conglomerates. Geology of lower zone, Kolkheti lowland, is represented by old alluvial deposits. Carbonaceous raw humus soil is spread across the mountainous and mountain meadow lands, and the alluvial marshy soils are spread in Kolkheti lowland. Deciduous and coniferous forests are distributed across the mountainous region, and the major part of the lowland is used for agricultural purposes. Close to 35-40% of the watershed area is covered with forest.

The gorge is V-shaped from the beginning up to the city of Senaki and trapezoidal but not vividly shaped on the Kolkheti lowland. The width at the base of gorge varies from 100-200 m to 4-4.5 km. Terraces are interlaced throughout its length on both sides of the river. The terraces are 0.6-1 km in length, 0.5 km in width and 6-12 m in height. The floodplain is well developed in the middle and the downstream areas with the width that varies from 45-70 m up to 100-200 m.

The river body is moderately meandered and branched at some places. The width of the flow varies between 20-40 m and 60-65 m, depth from 0.4-0.6 m up to 1.5-2.0 m, and the flow velocity from 0.6-0.8 m/s up to 2.0-3.2 m/s, both sides of the riverbank are protected by 3-4 m high embankments.

The river is fed by snowmelt, rain and groundwaters. The annual runoff pattern in the downstream areas is characterized by less significant spring floods and all year round flash floods. The annual runoff breakdown is as follows: 34% in spring, 27% in summer, 27% in autumn and 21% in winter. Snow is not a feature in this area.

Both sides of the Tekhuri River banks are protected by 4-4.5 m high embankments from Abasha-Senaki Railway Bridge up to the mouth of the Rioni River.

Hydrography of the Abasha River.[5] The Tekhuri River originates from the south-east slope of the Tsekedela ridge at an altitude of 1500 m above sea level and joins the Tekhuri River from left side at 6.5 km from its confluence. The length of the river is 66 km, with total fall of 1,489 m and an average inclination of 22.5%°. The catchment area covers 350 km^2 with an average altitude of 320 m above sea level. Approximately 126 various tributaries join the river with total length 353 km, among which, the main is the Tarcheni River (16 km long), and its basin is located on the

[5] Abasha river joins Rioni at the border of Senaki Municipality, therefore the Abasha River is considered within the pilot watershed territory.

water dividing range between the river basins of Tekhuri and Noghela rivers. The length of the major part of the basin is 41 km and it is on the Kolkheti lowland. The upstream area of the basin, from river source up to the village of Bobota, is characterized by mountainous relief. The geological structure of the zone is predominantly limestones, where karst water springs with strong self-draining capacity are present in overwhelming numbers. Among them, the springs of the villages of Balda, Inchkhuri and Lebache are significant. It is to be underlined that one of the springs of the Balada Village is used for the City of Poti water supply system.

Argilliferous soil with imbedded limestones is spread across in the mountainous regions. The mountainous part of the basin is represented by dense–deciduous forest.

Downstream areas of the watershed that are located on the Kolkheti lowland are structured by old alluvial sediments, alluvial-marshy soils and the flora is characterized by agricultural crops.

River gorge is not shaped clearly on the Kolkheti lowland. The floodplains are found only on middle and downstream areas before the confluence. The widths of terraces are around 0.3-1 km and the heights are 5-6 m, and they are covered by agriculture crops. On the downstream areas, the river body is moderately meandered and is mainly branchless. The width of the flow varies between 30-40 m, with a depth of 0.6 -1.5 m and flow velocity ranging from 0.3 m/s to 0.8 m/s.

The river is predominantly fed by rain waters, and to a much lesser degree by snow melting and ground waters. Flash floods all year round are the characteristics of the runoff regime. The river is effluent mainly in spring, when the runoff represents 30-45% of annual flow, 16-18% in summer, 20-30% in autumn and 20-25% in winter.

Both sides of riverbank near the village of Sagvazavo are protected by 1.5-4.0 m high embankments.

The Abasha River is used for hydropower generation. Near the city of Martvili, there is a 7.5 high concrete dam and headworks that provides 1,120 kilowatt of electricity to Abasha Power Station. The river is also used for water mills. The river is transparent during the low water period and it can be used for drinking purposes.

Hydrography of the Tsivi River. The Tsivi River originates from the foothills of Samegrelo ridge at an altitude of 363 m above sea level and joins the Rioni River from the right side at 46 km from of its source and 1 km to the south-east of the village of Mukhuri. The length of the river is 60 km, with total fall of 357 m and an average inclination of 5.9%°. Total area of the watershed basin is 199 sq. km and it is located at the average altitude of 140 m. 138 tributaries join the river with total length 256 km, among which, the main tributaries and their respective lengths are: Otskare (12km); Shebe (16 km).

The upstream zone of the basin is located on the foothills of the Samegrelo ridge and between the basins of the Khobi and Tekhuri rivers. The downstream zone is located on the Kolkheti lowland. The relief of the basin on the foothills is smoothly shaped hills, and the relief of the lowland is tableland/plain. The geological structure of the upstream zone is clay shales, marlstones, sandstones and conglomerates. The downstream area is composed of strong alluvial depositions. Clayey soil used for agricultural crops is widespread in this area.

The river gorge is trapezoidal in the hill shaped relief and the width of the base varies from 150 m to 800 m. Kolkheti lowland is not shaped clearly in areas where terraces stretch along both sides of the river, the width of these orographic structures/features vary from 30-80 m up to 400-700 m and from 1 m to 9 m in height. The river has no floodplains. River body is meandered, branchless as well as twisted, and the flow width varies from 2 m to 12 m, depth from 0.5-2 m and flow velocity from 0.2 m/sec to 1m/sec. The riverbed on the Kolkheti lowland is sandy and loamy.

The river is fed by snowmelt, rain and groundwaters. The flow regime is characterized by year-round flashfloods. Embankments at distances of 300-500 m are constructed along the river from Poti-Senaki road up to the river mouth.

Hydrological Characteristics of Rivers. Hydrological observations were conducted in the lower course of the Rioni River at Skochakidze gauging site in 1928-1988, and on north and south branches of the river near Poti City in 1971-1980. Empirical data on river hydrologic is available for the gauging site located near hydropower plant, Nokalakevi. It covers the following two time periods: 1937-1942 and 1984-1991. Data on Abasha and Tsivi are very limited and inconsistent that makes them as good as useless for trend analysis. Even though observations and studies were conducted till 1991, the latest official published data are of 1986.

Multiyear average monthly and annual river discharge and flow volume data indicate an average annual discharge rate of 399 m^3/sec and an annual flow volume of 12582.9 million m^3 at Sakochakidze gauging site. For the Tekhuri River, results for the same parameters are 32.4 m^3/sec and 1,021.8 million m^3 respectively. For further details on hydrological data, please refer to Annex 4 and Annex 2 for the hydrology maps.

Regardless of the fact that river discharge rates have not been measured since 1992, one can assume that seasonal runoff patterns of the above rivers has been changed due to pressures and impacts from anthropogenic (deforestation, improper drainage, etc.) and natural (climate change). Increased frequency and intensity of floods and flashfloods can be considered as indirect evidence for river flow regime change. Intensification of flashfloods is also confirmed by locals.

If we extrapolate existing empirical data on river discharges, we can say that peak discharges on the Rioni River are specific to April and May, while minimum discharge in August, September and January. The Tekhuri River has similar maximum discharge pattern, though its minimum discharge regime is different from that of the Rioni River and the lowest values are observed in November-February. Location of hydrometeorological observation sites is given on Map 5, Annex 2.

Surface Water Quality. Assessment and study on surface water quality of the Rioni River and its tributaries due to effluent discharges is extremely difficult because of the poor ambient water quality monitoring and absence of effluent monitoring system. Available data on the surface water quality are inadequate and sporadic. Monitoring of chemical substances such as PAH, PCB and pesticides are not covered in the scope of the national water quality program. Groundwater quality and biological monitoring of surface water quality has never been conducted, hence there is no ecological baseline data to define the ecological condition of the water systems. Groundwater testing monitoring data is of utmost importance to the Lower Rioni pilot watershed area, since water supply is implemented mainly through underground water sources (wells).

Currently, surface water quality is measured at points located on north and south to Poti City. Additionally, monitoring data for the Tekhuri river downstream area of Senaki City is available until 2004.

Water quality data for the lower course of the Rioni River are included in Annex 4.b[6]. More specifically, 2002-2012 data on BOD_5 NH_4, NO_3, NO_2, PO_4, Cu, Fe, Mn, DO and mineralization are given for two measurement points – upstream and downstream Poti. At the downstream monitoring site (South), **BOD_5** concentrations varied in the range of 1.35-2.85 mg/l (MPC 3 mg/l); ***NH_4^+*** concentrations in the range of 0.59-1.38 mg/l (MPC 0.39 mg/l) and in many cases exceeded the maximum permissible concentration. ***NO_3, NO_2, PO_4*** concentrations generally did not exceed the MPC and therefore varied in the following ranges: ***NO_3*** - 0.16-1.54 mg/l (MPC 10 mg/l); ***NO_2*** - 0.029-0.127 mg/l (MPC1.0 mg/l); ***PO_4*** - 0.043-0.086 mg/l (MPC 3.5 mg/l). Moreover, concentrations of heavy metals (***Cu, Fe and Mn***) generally did not exceed the corresponding MPC values in the years 2002-2012, and were as following: ***Fe -*** 0.29-0.59 mg/l (MPC 0,3 mg/l) within the MPC with the exception of some cases; **Mn** – 0.035-0.089 mg/l (MPC 0,1 mg/l); **Cu** - 0.012-0.060 mg/l (MPC 1.0 mg /l). Values of dissolved oxygen were satisfactory throughout the year and ranged from 7.84 to 9.92 mg/l (MPC 4-6 mg/l). Rioni is a moderately mineralized river and its values vary from 241.0 to 315.9 mg/l.

Water quality measurements for 2002-2012 at upstream (north) monitoring site revealed the following trends: **BOD_5** concentrations - 1.65-2.83 mg/l (MPC 3 mg/l); ***NH_4*** concentrations varied in the range of 0.35-1.41 mg/l (MPC 0.39 mg/l) and in many cases exceeded the MPC; ***NO_3, NO_2*** and ***PO_4*** concentrations generally did not exceed the MPC and therefore varied in the following ranges: ***NO_3*** 0.127-1.380 mg/l (MPC 10 mg/l), ***NO_2*** - 0.011-0.123 mg/l (MPC1.0 mg/l) and ***PO_4*** - 0.025-0,083 mg/l (MPC 3,5 mg/l); the concentration of heavy metals ***(Cu, Mn)*** generally did not exceed the corresponding values of MPC as well, in the years 2002-2012 and were as following: **Mn** – 0.023-0.084 mg/l (MPC 0.1 mg/l) and **Cu** – 0.008-0.041 mg/l (MPC1.0 mg /l) and ***Fe*** - 0.27-0.51 mg/l (MPC is 0.3 mg/l). Values of dissolved oxygen of were satisfactory throughout the year and ranged from 7.76 to 9.79 mg/l (MPC 4-6 mg/l). The Rioni River is moderately mineralized and its values vary from 179.8 to 290.2 mg/l.

On the basis of the above, we may conclude that in the past 11 years, no major changes in water quality have been observed.

Stemming from the above water quality trend analysis, we can conclude the Concentrations of dissolved oxygen near the river mouth were within MPC range and we can characterize the condition of the Rioni River as “good “;In general, contamination by nitrogen and nitrogen containing substances (biogenic substances) is caused by untreated wastewater discharges, drained waters from agriculture lands or surface runoffs due to precipitation;

[6] Source: NEA, MOE

2.3 Land Resources

2.3.1 Soil Characteristics

Lower Rioni pilot watershed area is distinguished by its diverse soils (map 1, Annex 5) and belongs to the Western Georgia soil zone, delineated by sub-areas, zones and regions.

<u>Sub-areas of Intermountain lowlands.</u> This sub-area consists of the West Georgia podzolized and marshy soils' zones and is represented by: i) marshy soil regions of the south lower part of the Kolkheti lowland; ii) podzolized and alluvial soil regions of Abkhazia-Samegrelo.

<u>Caucasus Sub-area.</u> This zone is represented by the region of red coarse-grained, yellow coarse-grained and carbonates (calcerous) raw-humus soils of Abkhazia-Samegrelo foothills.

In Khobi Municipality, sub-tropic podzolized soils of small, medium and large thicknesses are spread between the areas of Khobi and Rioni rivers, alluvial carbonate and alluvial non-carbonate marsh-ridden soils are also found in some places. More detailed information on soil types of the Rioni watershed section of the Khobi Municipality is available on map 1, Annex 5.

In Senaki Municipality, silt and silty-podzol soils are found on the Rioni River bank, while alluvial and marshy soils are found on the floodplains and low lying terraces. Sub-tropic podzolized soils are spread on the uphill areas of the north part of the lowland, red coarse-grained soils on the steep hills and yellow coarse-grained soils on the eastern section the lowland.

Kolkheti lowland represents the west part of the pilot territory and its lowest point is located on left and right sides of the Rioni downstream areas. This area of the lowland is demarcated from the Kolkheti lowland's system as a sub-zone of marshland. The second sub-zone of the lowland is an uphill area (north and north-east part of the pilot territory) that is more aged and represents the upper terraces of Khobi and Rioni and its tributaries Tsivi and Tekhuri. Kolkheti's relief is shaped as a result of physical activity of these rivers. With regard to the geological structure of this area, it is an outcome of accumulative effects of the above rivers, and it is represented by upper and lower strata of alluvial deposits. In most areas, these strata are composed of sandy and sandy-clay texture and found along rivers. Gravel stony deposits are found on the watershed divide, and at some places, the riverbank is covered with clay sediments of various thicknesses.

High humidity is a typical feature of top and sub soils of the west part of the pilot watershed area. This factor, along with high precipitation, supports the spread of marsh-ridden soils of various structures and thicknesses. Alluvial soils are spread along the riverbanks, which is dominated by marsh-ridden soil types.

In the podzolized and marshy soil zones, two distinct soils are found: i) marsh-ridden soils in the west parts of the lowland ii) podzolized and alluvial soils on the steep hills.

Marshy soils. On the western areas of the pilot territory, peat bogs and silty-marsh soils are spread. Peat soils are found in large areas of the Kolkheti lowland, towards the direction of west, close to the sea. These are mainly represented by grassy peat bogs in the central part. Peats of various thicknesses are mostly around 1 meter in depth. This part of the land is practically useless for agriculture. Silt boggy soils are spread across on large areas of the western Kolkheti lowland in the vicinity of peat bog areas. Often, thin layers of peat, around 5-10 cm deep, is characteristic to this part of the land, together with heavy clay content and strong gleization.

Peat-bog soils (Histic gleysols). Histic gleysols are mainly spread on the coastline of the Kolkheti lowland. The area covered with peat bog soils constitutes 106.2 km^2 (9% of total pilot watershed area). The profile of this soil is of the following composition: Ap-A(g)–Bg-BCp. Main soil specification is existence of a peat horizon and gleization of the entire profile, and its other major features are: acidic; neutral or alkaline reactions; low or medium humus content; low to medium hydraulic conductivity; strong mechanical texture. The soil is poorly or moderately enriched with total nitrogen, moderately enriched with hydrolysable nitrogen, poorly or moderately enriched with absorbed phosphorus and is poor in exchangeable potassium. The soil is polluted by radionuclides.

Silty-bogs soils (Haplic gleysols). Silty-bog soils are common to the Kolkheti lowland. Total area of such regions constitutes about 100.8 km^2 (8.6% of total land of pilot watershed area). The profile of this soil is of the following composition: A(g)–Bg-BCg. The main soil characteristics are heavy mechanical composition and gleization of entire profile. Other main features include: acidic; neutral or alkaline reaction; low or medium humus content; low hydraulic capacity; heavy mechanical structure. The soil is well or poorly provisioned with total nitrogen, moderately or well-provisioned with hydrolysable nitrogen, poorly or well provisioned with total and absorbed phosphorus, and poor in exchangeable potassium. The soil is polluted by radionuclides.

Podzolized soils. This type of soil is mainly found on the elevated areas of the Kolkheti lowland, where the soil is less humid. It is predominantly specific to the upper terraces of the Rioni River. It has weak, medium or strong level of podsolization. On the hills and foothills, both soil bogging and podsolization take place, and therefore, on this territory gley-podzolic soils are widely spread. The gley-podzolic soil is a transitional soil between podzolized and silt-bog (silt-marsh) soils. Often, this soil has clay content, especially in the middle and lower layers, and high level of marshification attributed to the impacts of surface waters. Podzolized soils of the pilot area were historically used for tea plantations and to a lesser extent for citrus, corn, vegetable and other crop growing. Gley-podzolic soils of the pilot area are also intensively used for agricultural purposes. Prior to their cultivation, they needed intensive drainage that used to happen in the past by draining large areas of the Kolkheti lowland.

Sub-tropic podzol soils (Haphic acrisols). Total coverage area of podzol soils constitutes 56.1 km^2 (4.8% of the pilot watershed area). This soil is widely spread in the humid sub-tropic zone located 200-300 m above sea level, and is mainly found at slightly elevated areas of old lacustrine terraces. Soils have clearly differentiated profiles with the following composition: A-A_1-A_2 - A_2(g)-B_1-B_2-BC-C. The main characteristics of these soils is vividly shaped eluvial horizon, weakly developed sediment fraction, scarce oxides and existence of yellow-brown forest illuvial horizon. These soils are characterized by acidic reaction, low or medium humus content, low hydraulic conductivity, presence of fine particles, poor content of eluvial horizon, eluvial-illuvial distribution of major oxides, clay and argillic mechanical composition and medium content of hygroscopic water. The soil is poor in total nitrogen, poor or rich in hydrolysable nitrogen, poor in total and absorbed phosphorus, rich in total potassium and poor in exchangeable potassium. The soil is polluted by radionuclides.

Subtropical gley podzol (Gleic acrisols). Yellow coarsegrained gley podzol soils are characterized by vividly differentiated profile of the following composition: Ag-A_1g-A_2g-B_1g-B_2g-BCg-CDg-Gg or A_1gA_2g-A_2g -A_2Bg-BCg. In terms of genesis, yellow coarsegrained gley-podzol soils are close to yellow coarsegrained podzol soils, but different by ground and surface waters runoff and higher humidity. The total coverage area of these soils amounts to 351 km^2 that represents 29.9% of the total area of the pilot watershed. The yellow coarse-grained gley-podzol soils are characterized by acidic, neutral or weak alkaline reaction, moderate humus content, deep organification (humus development), clay and argillic texture, medium content of hygroscopic water, volumetric weight within the range 1.24-1.41 and saturation or unsaturation (swelling or shrinking). Soils are well (0-10) or poorly (10-20) provisioned with hydrolysable nitrogen, rich in absorbed phosphorus and poor in exchangeable potassium. They are polluted by radionuclides.

Subtropical orstein podzol soils. Total coverage area of yellow ground podzol soils is 32.3 km^2. These soils are widely spread in the humid sub-tropic zones at 30 – 200 m above sea level, and in most cases in slightly elevated areas of the old lacustrine terraces. These soils are characterized by vividly differentiated profile of the following composition: A-A_1A_2-A_2g-B_1-B_2-BC-C. Main characteristics are: well shaped eluvial horizon; lack of sediment fraction and oxides; presence of yellow-brown forest illuvial; various thicknesses Orstein horizons. Other major qualities include acidic reaction, medium or low humus content, low conductivity, lack of eluvial horizon, presence of fine fractions, eluvial-alluvial distribution of major oxides, clay and argillic composition, medium content of hygroscopic water and volumetric weight of 1.22-1.23. The soil is poor in hydrolysable nitrogen, rich in absorbed phosphorus and is well (0-10) or poorly (10-20) provisioned with exchangeable potassium. Soil is contaminated by radionuclides.

Alluvial soils. In the extreme low reaches of the pilot watershed area, alluvial soils of different qualities are found widely, mostly on the lower/old terraces of the Rioni River. Predominantly, the soil is medium to high thickness non-carbonated alluvial soil with medium to weak mechanical texture. Sandy and sandy-alluvial soils of low thickness and coarseness are found less frequently. Alluvial carbonated soils are also come across as discrete lines on the lower terraces of the Rioni River. Part of the alluvial soils is bogged, but the unbogged part is used for corn and vegetable growing. In addition, tea, citrus, various fruits and geraniums are grown on these soils.

Alluvial calcareous soils (Calcaric fluvisols). The total coverage area of alluvial calcareous soils constitutes 95.7 km^2 or 8.1% of the total area of the pilot watershed. Soil zonality gets more vivid as you go further from the riverbed. Soils in these areas have various regimes, properties and textures. Alluvial calcareous soils have stratal structure with the following profile: A-BC-C-CD. They are characterized by neutral or alkaline reaction, low humus content, high hydraulic conductivity, clay and/or argillic mechanical composition and high hygroscopic water content. They are poorly, moderately or well provisioned with hydrolysable nitrogen, poorly or moderately provisioned with total phosphorus, poorly provisioned with absorbed phosphorus, poorly or well provisioned with total potassium and poorly or moderately provisioned with exchangeable potassium.

Red coarse-grained and yellow coarse-grained soils. Red and yellow soils are found on small areas of the steep hills and foothills. They are the most common group of soils in the steep hills and foothills located at 500 m above sea level surrounding the Kolkheti lowland. From geological point of view, these parts of the pilot area are represented by various sediments of tertiary period and predominately by marls and marl-clay, sandstones, conglomerates and clay shales. In most cases, these sediments are covered with sandstones and sand-clay layers of older periods. Under sub-tropic humid climate condition of the steep-hill zone of West Georgia, mentioned sediments have been significantly changed due to leaching and weathering processes. Therefore, these sediments are covered with thick layers of red-ground and yellow-ground soils. The main type of soil is red-ground that is found on the steep hilly parts of the pilot watershed area. On relatively low inclined slopes (<8-6°) and hilltops, red coarse-grained soils podzolized soils is predominant among red coarse-grained soils. Yellow - coarse-grained soils are spread on the north and north–east parts of the pilot territory that is largely conditioned by presence of conglomerates and clay shales. The leaching and weathering of these soils create weak denudation core with low content of sesquioxides (namely the iron oxides). Similarly, yellow-ground podzolized soils are the most common among other types of yellow-ground soils.

Red soils. The total coverage area of red soils constitutes 23.2 km^2 representing 2% of the pilot territory. This soil type is spread in the south-west of the humid sub-tropic zone. The main identifying characteristics of this soil are red color, argilization and existence of strong profile with following composition: A-AB-B-BC-C. Red soils are characterized by acidic reaction, medium humus content and deep humusification, moderate content of hygroscopic water, volumetric weight ranging within 1.19-1.34, clay and clayey texture, medium to high conductivity, no saturation. Soils are moderately (0-10) or poorly (10-20) provisioned with hydrolysable nitrogen, well (0-10) or moderately (10-20) provisioned with absorbed phosphorus and poorly (10-20) provisioned with exchangeable potassium. The lack of vegetation cover heightens the threat of erosion. The soil is contaminated by radionuclides.

Yellow soils (Haphic alisols). The total distribution area of yellow soils constitutes 48.8 km^2 or 4.1% of the pilot territory. These soils are widespread on the steep hills of the humid sub-tropic zone. Their main characteristics are: yellow color, argillization and strong profile with following composition: Ao-A-AB-B-BC. Yellow soils are characterized by acidic reaction, medium humus content, medium hygroscopic water content, volumetric weight within the range of 1.16-1.26, clay and clayey texture. Soils are moderately (0-10) or poorly (10-20) provisioned with hydrolysable nitrogen, well (0-10) or moderately (10-20) provisioned with absorbed phosphorus and moderately (0-10) or poorly (10-20) provisioned with exchangeable potassium. In the event of destruction/reduction of the vegetation cover, the threat of erosion will increase. Yellow soils in the pilot watershed area are polluted by radionuclides.

Strongly manifested zones of red coarsegrained and yellow coarse-grained soils are found in the foothills of Western Georgia, which is often partitioned by the spread of limestone, calcareous conglomerates, marls and other lime sediments. These sediments are specific to the northeastern and eastern sections of the pilot watershed in the form of mountain lines surrounding the foothills. As a result of such deposition of mentioned sediments, raw-humus calcareous soils are spread on this territory. Soils developed on marls and limestone are remarkable, and they vary from one another in thickness, denudability/erodibility and coarseness. Calcareous raw-humus soils are specific to the limestone line on the border of sub-tropic zone and on the elevated areas of the mountain-forest zone.

Raw-humus calcareous soils (Calcaric-rendzinas). The total coverage area of raw-humus calcareous soils constitutes 134.4 km^2 or 11.4% of the total land of the pilot territory. The distribution area of this soil coincides with the area of sediments rich in calcium carbonates (limestone, marls, dolomites and marl slate among others). Its profile has the following composition: Ao-A-AB-B-BC, and major features of this soil are vividly formed humus horizon, weak alkaline reaction, medium composition of humus, low content of hygroscopic water, volumetric weight ranging 1.16-1.34, clay or clayey mechanical composition, medium to high conductivity and high level of saturation. Soil is moderately (0-10) or poorly (10-20) provisioned with hydrolysable nitrogen, poorly provisioned with absorbed phosphorus and moderately (0-10) or poorly (10-20) provisioned with exchangeable potassium. In of the event of decline in vegetation cover, threats of erosion will be increased.

Anthropogenic soils (urbic antrosols). The total distribution area of these types of soils constitutes 47.4 km^2 or 4% of the total land of the pilot territory. These soils have loose natural structure and very small sized profile due to undergoing anthropogenic pressures. They are characterized by neutral or alkaline reaction, low or medium humus content, low or medium hydraulic conductivity and varied mechanical composition. The soil is poorly or moderately provisioned with nitrogen, well or moderately provisioned with hydrolysable nitrogen, poorly or moderately provisioned with total or absorbed phosphorus, poorly provisioned with exchangeable potassium, and it is polluted by radionuclides.

Soil Productivity. Generally, soils found in Khobi Municipality area are of high productivity, (Annex 5) though low productive soils are also present in the northwest part of the municipality. The west coastline consists of highly humid territories that are in the list of protected wetlands under the Ramsar Convention.

Senaki Municipality consists of low, medium and high productivity soils (Annex 5). The major part of the municipality is occupied by medium and low productivity soils, but it should be noted that areas between Tsivi and Tekhuri basins have high productivity soils. Kolkheti National Park is located on the south-west part of the municipality. Maps N3a and N3b of Annex 5 depict the bonitet of agriculture lands of Khobi and Senaki municipalities.

2.4 Geography, Geo-morphology, Geology

2.4.1 Geography

Khobi Municipality is located in the western part of the West Georgia, in the middle of the Kolkheti lowland. It is bordered from north by Zugdidi Municipality, from northeast by Tchkhortsku Municipality, from east by Senaki Municipality, from south by Lanchkhuti Municipality, from the southwest by the city of Poti and from the west by the Black Sea

Total area of the municipality is 676 km^2 and an average altitude of 2- 470 m above sea level. The administrative center of the municipality is Khobi City located at 25 m above sea level and 285 km from Tbilisi. Senaki Airport is located 15 km from Khobi and Poti marine port is 35 km from Khobi.

Senaki Municipality is located in the southern part of Samegrelo-Zemo Svaneti region, in the middle of the Kolkheti lowland. The municipality is bordered from west by Khobi Municipality, from east by Abasha Municipality, from north – by Tchkhorotsku Municipality, from north-east by Martvili Municipality and from south by Lanchkhuti Municipality. Municipal territory is divided into two sections due to relief specifications: northern and southern sections. The northern section is occupied by uphill and steep hills. The average altitude of Tablelands is up to 270 m above sea level. Distance from Tbilisi is 270 km, from Zugdidi 45 km, from Poti 35 km and 41 km from the nearest airport – Kopitnari. Spatial and Altitude model is available on map 4 of Annex 2.

2.4.2 Geo-morphology

Lower Rioni pilot watershed area is located in the central part of the Kolkheti lowland, which is a large geomorphological unit. Kolkheti lowland, from the Bziphi River mouth up to the northern slope of Adjara-Imereti ridge, is separated from the foothills by medium-heighted but vividly curved geomorphological stair case. The altitude of the Kolkheti plain varies from 3 m to 80-100 m and covers a total area of 1,000 km^2. The relief of the plain (tableland) is slightly elevated towards north and northeast direction. Elevated area of the lowland is composed of alluvial and marine deposits. Tectonic subduction of the Kolkheti lowland started in the Quaternary period and still ongoing at a rate reaching 13 cm, in some places, in every 100 years. The lowland near the coastline, between the mouths of the Bzipi and Supsa rivers, is significantly bogged. Behind the dunes, the land is below sea level, which is one of the reasons for the frequent flooding of the given area.

The mouth of the Rioni River has the typical morphology of that of a delta. Here, the river creates numerous meanders (please refer to picture 1, Annex 6).

The riverbed is wide varying from 0.5 and 10 km and is filled with fine particles of loam (silt) and clay (please refer to picture 2, Annex 6).

At meandering points, the riverbed creates sandy shallow islands with asymmetric slopes. On some sections, particularly on the right bank, 2-3 m high grooves/folds composed of clay and clayey sediments are found (Please refer to pics. 3 and 4 in Annex 6). Similar formations can be observed on the left bank, the difference being, the formations on the right bank seem sandy and sloping (pic. 5, Annex 6). There are numerous dry cracks developed in the clay sediments.

Initial terraces of the upper riverbed are wide on both banks of the river and covered with Acacia and Alder thin grooves.

2.4.3 Geology

Kolkheti lowland, including coastline, is structured with quaternary deposits of various origins and lithology. They are mainly marine, marshy, alluvial and eluvial sediments. Geological profile in the area of the village of Sabajo is as follows (Map 8, Annex 2):

i) Deposits of Apt-Alb stage of the Lower (early) Cretaceous (K_1a+al) period are represented by thin marine sediments and lithologically structured with marls, limestones, carbonated clays, glauconitic sandstone, lavas and volcanic (igneous) rock lithoclast (alkali basalts, andesite and tuff) from place to place.

***ii) Deposits of Upper Cretaceous (K_2)* period**, identical to that of Alpian-Albian stage, are composed of thin marine sediments and structured with glauconitic sands, stratum limestones, (lithographic, crystal breccia), marl limestones and marls.

iii) *Deposits of the Miocene stage (N_1m)* are composed of marine and continental varieties of molasses and lithologically structured with conglomerates, clays, sandstones and sands.

iv) Deposits of Pontian Stage (N_2p), similar to Miocene sediments, are represented by marine and continental varieties of molasses, including clays, sandstones, sandy clays, conglomerates and sands.

The entire territory under review is covered with strong quaternary sediments and consequently, natural outcrops are practically not witnessed in this area (we have used data taken from various boreholes).

Lower Rioni pilot watershed area is located between two regional faults. The south fault is an anticline that has outcrops of middle Eocene (P_2^2) volcanogenic-sedimentary rocks on the right bank of the Supsa River. The northern wing of the north fault, composed of Paleocene–Upper Cretaceous sediments, is also outcropped in the arch of the Urta anticline. Therefore, the pilot area represents tectonic Graben, which is located between two different shear fractures and filled with recent sediments.

2.4.4 Hydro-geology

According to the design of Georgia's hydro-geological zoning,[7] lower Rioni pilot watershed area is located on the border of two hydrogeological regions: on the north – fracture and fracture-karst groundwater of the Samegrelo artesian basin (III_3); on the south – porous, fracture-karst groundwater of the Kolkheti artesian basin (III_5). The map of groundwater aquifers is provided in map 9, Annex 2.

More specifically, ground water aquifers and water bearing complexes are distributed in the following sequence:

Aquifers of recent alluvial sediments (alQ_4) is lithologically structured with pebbles and sands and are mostly found in riverbeds, floodplains and their terraces. During high water (seasonal floods) these areas are flooded. Granulometric variation of alluvial sediments is very visible in river gorges. For instance, in the downstream areas of the Rioni gorge along Poti-Samtredia, alluvial sediments are composed of sands and sandstones, while in the upstream area, in Kutaisi section, coarse sediments are found with predominantly pebbles. Aquifers of recent alluvial sediments have calcium-hydrocarbonate composition, with total mineralization not exceeding 0.5 g/l. These waters are widely used by the inhabitants for drinking purposes through abstraction from individual wells. The flow rate of the groundwater is 30-40 m^3/sec.

Aquifer of Quaternary Marshy Sediments (hQ) is widespread on the Kolkheti lowland on both sides of the Rioni River. It is structured with peat, sapropelic (lamalginite) silts and clays, which in some places are covered with layers of fine sands of alluvial and marine origin. The thickness of marshy sediments vary from 5 m to 30 m and at some places it reaches 50 m. Groundwaters of this aquifer are not deep and water table is only 1 m, which is very close to the earth's surface.

[7] I. Buachidze 1965.

Often, land plots are marshy-ridden due to high ground water table. The capacity of groundwaters contained in sandy-silt layers of the marshy deposits varies from 1 l/sec to 10 l/sec. At some places where the aquifer thickness reaches 30 m, there are water containing several layers (strata) and lenses with pressured waters. Chemical composition of groundwaters of marshy sediments is hydro-carbonate and calcium-sodium, and rarely hydro-carbonate chloride sodium or hydro-carbonate sodium, with general mineralization of 0.3-0.8 g/l. Aquifers of marshy deposits have poor potable qualities due to specific smell of rotting matter and are not used for drinking or bathing purposes.

Aquifer of Early Quaternary Alluvial Sediments (alQ_{3-1}***)*** is widely spread within the Bleak Sea coastline and the Kolkheti lowland. The aquifers in the coastline territory belong to the old marine and riverine terraces that go down below the recent alluvium in the river delta. The lithological composition of the horizon is diverse and represented by sandy, clayey and mainly sandy-pebble sediments. The upper layer of the aquifer has an overall capacity in the range of 0.1-1.0 l/sec, while the lower layer, where pressured waters are spread, bore well capacity reaches 3.0 l/sec. Large areas of the pilot watershed have aquifers with a depth/thickness of 3 m. Along the coastal line, water table gets closer to the surface and in many areas creates marsh-ridden spots. The chemical composition of the waters of this horizon is a calcium-hydrocarbonate, chloride–hydrocarbonate and calcium-sodium, with general mineralization 0.8 g/l. Within the Kolkheti lowland, the maximum thickness (capacity) of the aquifer reaches 500 m and diminishes gradually from the coastline in easterly direction. Water content of sediments increases near large rivers since these rivers (Enguri, Tskenistskali and Rioni among others) are the main sources for the revival of the given aquifer. Circulation of groundwaters of the aquifer of early Quaternary sediments is directed from the northeast to the southwest (map 1, Annex 6). The chemical composition of these waters is hydrocarbon calcium-sodium or sodium–calcium with 0.2-0.5 g/l mineralization level. At some areas hydro-chemical inversions are prominent, which are manifested through the decline of salt content with increase in the depth.

Water-bearing complex of the Lagoon-Marine Pontean-meiotic sediments ($N_2^1pn\text{-}m$**)** is represented by sediments of various lithology and thickness (capacity). They are mostly structured with sandstones, sands, clays and conglomerates. Strong water containing horizons have been discovered in pontian and meiotic sediments during oil boring operations in Western Georgia. The lithogenic composition as aforementioned is sands and rarely sand-gravel. Most wells are of self-drained capacity with several liters per second that creates possibility to use these sources in centralized water supply systems. The aquifer is fed by precipitation, as well as by ground and artesian waters of the quaternary deposits and sometimes by surface runoff seepages. Discharge of the groundwater occurs on the bottom of the Black Sea, and in tectonic fractions in small amounts. Deep water bearing horizons of the pontean-meotic sediments are released on the Kolkheti lowland by oil–drilling wells. They have high mineralization of up to 80 g/l. Groundwaters of this area are associated with oil deposits.

Aquifer of sporadically distributed ***Upper and Middle Miocene Marine Sediments (*** $N_1^3 + N_1^2$ ***)*** is most widely found in Samegrelo artesian basin, the most subducted section of Georgia. These sediments are composed of clays, sandstones and conglomerates, limestones, marl and lenses. Total thickness of the layer varies in the range of 550-900 m. Groundwater associated with Miocene sediments circulates in sandstones, limestones, conglomerates. The major part of this groundwater aquifer is formed within an active circulation zone and under favorable geomorphological conditions groundwater is discharged as low capacity springs. The remaining part is confined and forms pressured layers and lenses partially in Samegrelo syncline. High hypsometric values of the wings of the Samegrelo Syncline represent the sources for pressured (artesian) waters. Flow rate of pressured groundwaters varies from 0.1 to 1 l/sec and that of karst origin springs ranges from 5 to 20 l/sec.

Mineralization of the groundwater in the free - flowing zone is low varying within 0.3-1.0 g/l range, and exceeding 1 g/l from place to place. Water mainly belongs to hydrocarbonate and hydrocarbonate-sulphate, calcium-sodium or magnesium-calcium class. Water temperature is 10-15^{0}C and its potable qualities are good enough to be used for drinking purposes. Therefore, this type of water is widely utilized by drinking water systems. Various intake structures are constructed at the springs to extract drinking water for many settlements.

Groundwaters with limited circulation features are spread in middle Sarmatian (sarmatic) sediments, namely on Supsa-Opareti territory and Guria artesian basin. The groundwaters linked with miocene and especially sarmatian sediments represent oil-associated waters.

Water-bearing Horizon the Paleocene – Upper Cretaceous *(P_1 +K_2*) Carbonated Sediments is contained in limestones and marl-milestones, with strong embedded layers of marl and carbonated clay. The thickness of the layer exceeds 1000 m. The aquifer is widely spread in Western Georgia and its outcropped line is directed from north-west to south-east. The horizon is subducted towards south and south-east direction and is a part of the structure of Kolkheti lowland. Basic geological composition of the sediments is Apt-Alb, volcanogenic, terrigenic and carbonate rocks, which are practically impermeable and have a region-wide distribution. The horizon is composed of several water bearing layers which contain groundwaters of karst, fracture-karst and fracture types.

Groundwaters have low salt content (0.5 g/l.) and belong to calcium-hydrocarbonate category, groundwaters of sodium-calcium type are rarely found. Water temperature varies from 9 to 16°C. Within Bzipi, Kodori, Kolkhida and Tskaltubo artesian basins, the subducted horizon gradually increases from 200 m (village of Sanapiro) up to 1800 m (village of Chaldidi) in the of north-east to south-west. The temperature also increases in same direction. By chemical composition, these groundwaters are of chloride and rarely sodium-hydrocarbonate type with total mineralization varying from 1.5 up to 56 g/l. Within this horizon, the famous healing waters of sodium-chloride type are formed known as Sokhumi and Menji groundwater deposit.

***Aquifer of the Cenomanian-Apt-Alb Marl Clay Impermeable Deposits (K_2cm-K_1al –ap)* is widely found in Western Georgian as almost continuous stratum/line between Upper Cretaceous and Neocene aquifers.** The major peculiarity of these impermeable deposits is high variability of facies, with marl facies of Apt-Alb stage dominating among all others. Total thickness of the waterproof sediments varies from 10 m to 200 m, but on Chaladidi territory, the thickness reaches 750 m. Water content of the aquifer is low and under the dominant distribution of marl facies, karst processes do not take place at all. In the fraction zones, general mineralization of groundwaters is 0.2-0.6 g/l. Chemical composition is calcium-hydrocarbonate (refer table 1, scheme 2, Annex 6).

2.5 Forest Resources

A part of the lower Rioni pilot watershed area is located on the Kolkheti lowland, while the other part is situated on steep hills at 500 m above sea level. Based on the regional division scheme of Georgian forests and vegetations developed by Academician V. Gulisashvili, the pilot watershed belongs to the Colchis (modern name - Kolketi) Forest Region.

Colchis region is located in Western Georgia. The Black Sea borders the region from the west, Main Caucasus Range from the north, Surami (Likhi) Range from the east, Adjara Region and Imereti Range from the south. The climate is warm and humid differing by vertical zonality, and the average annual amount of precipitation varies from 1200 to 4000 mm. Due to favorable climatic conditions, the oldest relict flora of Tertiary period are well preserved and were named after the forest as Colchic flora. The forests of the region have high yield class and characterized by evergreen forest stands (Prunus laurocerasus, Rhododendrum Ponticum, and Llex). Colchis region can be segregated into five vertical zones, of which the pilot territory only occupies the subtropical zone.

In the past, the part of the Kolkheti lowland characterized by excessive humidity was fully covered with Alnus barbata, Fraxinus excelsoir, Fagus orientalis, Pterocaria pterocarpa, Quercus hartvissiana, Carpinus caucasia and other species. It was also characterized by deep groves of lianas and Buxsus colchica underwood. Later, the above forests were logged and subtropical cultures were cultivated. Colkhian type of forests with extreme dampness are still maintained on some territories, and based on them, the Kolkheti National Park has been established.

Castanea sativa, Quercus iberica, Quercus imeretina, Quercus hartvissiana, Fagus orientalis, Carpinus caucasia, Alnus barbata, Fraxinus excelsior, Acer campestre, Diospiros lotus are considered to be characteristic species of the forests situated on the hills. *Buxus colchia, Liaurocerasus officinalis, Ilex colchica, staphilea colchica* and others can be observed out of underwood types.

The total area of the forest fund of the lower Rioni pilot watershed area is 10,406 ha, of which only 129 ha (former collective forests that presently are under ownership and management of local self-government) are on the territory of Khobi Municipality. The map of forest distribution on the pilot territory can be found in Annex 2, map 10. The remaining 10,277 ha of the forest fund is grown on the territory of Senaki Municipality. The territory falls under the Senaki Forestry Unit of Kolkheti Forest Section of Samegrelo-Zemo Svaneti Regional Unit of the Forestry Agency (legal entity of the public law) of the Ministry of Environmental and Natural Resources Protection. The forests (the territory covered by forest) out of the total forest fund measures 1, 029 ha. Senaki Municipality woodland constitutes 31.1% of the total territory. Relatively low level woodland is conditioned by densely populated areas and extensive use of the territory as agricultural lands. Detailed information on the division of the forest fund land into various categories can be found in table 1 of Annex 7.

Out of 1,706 ha of the total forest fund area, 16.6% is attributed to the green zone, while the remaining (83.6%) to the soil protection and the water regulatory forest categories.

Forests of the former Soviet collective farms constitute 9,910 ha of the total forest fund, 9635 ha represents mountain forests, and 771 ha plain forests. Mountain forests are spread on the slopes of Eki and Abedati mountains (their height does not exceed 500 m), while plain forests on the Kolkheti Lowland (most part of the forests is represented by artificially grown forest shelter belts).

The main woody types of trees in forests on the low course of the Rioni River Basin are: Alnus (49.0%), Carpinus (34.6); Fagus (5.5%); Acacia (5.2%); Carpinus orientalis (2.6%). Forest area distribution by tree types can be found in table 2 of Annex 7.

The average density of the basin forest stands is 0.59, and 77.6% of the forests are represented by forest stands having 0.6 or lower density. Forest territories by respective density can be found in table 3 of Annex 7.

Average age of forest stands equals to 34 years. Based on a special scale, the average yield class of the forests is attributed to II class, which is not a low indicator. Generally, the conditions in the region for forest vegetations are favorable, and the region is characterized by high level of biodiversity. Around 100 species of trees, bushes and lianes are represented in the region.

Total timber stock amounts to 839.5 thousand m^3, and average size of forest stands per ha is 81.6 m^3. The territory of mature and oldest forest stands accounts for 17.1% of the total forests, while wood stock for 19.9%. Average annual increase of forest stands' timber equals to 30.2 thousand m^3, while average increment per ha is 2.9 m^3. The latter is a very important indicator, given that annual use of timber per territorial forest unit should not exceed the average increment indicator. Average forest indicators can be found in table 4 of Annex 7.

A major part of the forest stands (89.5%) is located at an altitude of 250 m above sea level, while the rest of the forest at up to 500 m above sea level. Distribution of the forest fund by sea level can be found in table 5 of Annex 7.

Also, a major part of the forest stands (about 80%) is grown on the slopes with an inclination of less than 20^0. Distribution of woodland by slope steepness can be found in table 6 of Annex 7.

The forests grown on Kolkheti plain (same as Kolkheti lowland) on the territories of Senaki and Khobi municipalities are a part of watershed basins of Khobi and Pichori rivers and fall under Kolkheti National Park and Strict National Reserve. A section of it (Senaki and Colkhian areas located on the right bank of the Rioni River) is situated near the Rioni River (on the outer side of the dikes).

There are forest fragments in the line of dikes and on the river islands that are not recorded as a part of the forest fund. Total territories of such forests do not exceed 100 ha. The population of the adjacent villages uses such forests for harvesting of firewood and construction materials. Periodically, on some sections, the dikes are breached and water flows to the other side of the dike, as a result agricultural land and forests get flooded and the territory swamped.

2.6 Biodiversity

2.6.1 Bio-geographic division

Physical and geographic peculiarities of the lower Rioni pilot watershed area are plain and flat (uncurvy and smooth) surface, rich hydrographic network, soils with excessive dampness and hydrophilic vegetations. The above characteristics are the result of geographic location and geological past of Colchis bio-gepgraphic region.

By bio-geographic division, the present Colchis is located in the biome of evergreen and sclerophillous forests in the area of subtropical region and bio-geographic area of Colchis. It includes the forest zone of the Kolkheti lowland (0-50-60m above sea level) and the zone of Colchis subtropical forests (50-60-500-600m above sea level). The vegetation cover map can be found in Annex 2 (map 11).

The territories with excessive dampness having characteristics similar to the north part of Kolkheti plain, Gagidi and Zorgati peat bogs between the Enguri and Okumi rivers, were not included into the National Park due to the current political situation.

The territories along Khobistskali and Rioni rivers are not included in the National Park as they are too urbanized and agro-reclamation activities are well-developed. This is the reason behind the National Park being divided into three parts (Anaklia-Churia, Nabada and Imnati areas). In addition, the north-east and south-east territories of Kolkheti plain were not included in the National park due to the same reasons.

The territory of the National Park represents a critical minimum that makes it possible to maintain the balance of viability and natural environment of wetland ecosystems, rare vegetations of littoral sand dunes and landscapes of sea littoral water area.

A part of the Kolkheti National Park[8] is located on the pilot territory and a rather urbanized territory outside the National Park that includes the middle reaches of the lower Rioni pilot watershed area. Based on the above, it would be reasonable to focus on Kolkheti National Park and biodiversity of the rivers when evaluating the biodiversity of the territory under study. The map of the Kolkheti National Park can be found on map 7 of Annex 2.

2.6.2. Biodiversity

Colchis as well as Talish represents a refugium for a variety of relict flora and fauna preserved in these areas, which are living chronicles of geological developments of the Cainozoic era. This uniqueness is the outcome of its geographical location, orographic construction and geological past.

[8] The Project pilot territory includes a very small portion of the Colkhis protected area, but the infrastructure and different economic activities on the territory have some influence on it due to which the report presents the Colkhis National Park as a whole.

In the Cretaceous period of the Mesozoic era, the Caucasus Range emerged as an island in the paleokinetic system, and In Miocene, the Sarmat Sea was formed. The island of the Caucasus significantly increased in size over time. In geological literature it is referred to as Lapetida. The flora during this period was mainly subtropical, dominated by evergreen species mixed with deciduous types. The northern part of Iran mainland drew closer to the central part of the Lapetida and joined the territory like a wedge. It is through this process that the two refugia of the Caucasus-Colchic and Talish were formed. Colkhis flora was protected from cold climate of the North by the Main Caucasus Range. The ranges formed to the South of Colkhis during middle Pliocene era, isolated the region even further. Intensive glaciations took place in the northern semi-sphere during the Quaternary era, Pleistocene. However, Colkhis became the shelter as it was less affected by the above glaciations, and despite the fact that a large number of boreal elements forced their way into its territory, the ancient flora here have almost been left untouched in its primitive form.

Bio-geographic location, geographic past and natural conditions define flora and fauna diversity. The flora in this area is distinguished by its high level of endemism, tertiary relicts and endemics.

Vast amounts of boreal vegetations *(Sphagnum imbricatum and Drosera rotundifolia)* can be found in the floristic system of peat bogs. Along Churia bogs, together with ephemeral species, other rare species such as *Pancratium maritimum* and *Glaucum corniculatum* can also be observed.

Many endemic and relict animals can be found in the fauna of the region. This is especially true for invertebrates, and among them, *Brahmaea ledereri* is worth mentioning, which is a species of the moth family. It inhabits in Colkhis type, damp and relict forests, and is one of the archaic representatives (Miocene and Pliocene). Its existence once again proves the presence of tropical-subtropical climate here. Unfortunately, nobody has been collecting the species for the last decade. Supposedly, it has gone extinct due to forest logging and drying out bogs.

Different types of landscapes, individual ecosystems and cenosis can be observed on the territory of Kolkheti National Park, namely, the systems of seawater areas, rare species of vegetations of dunes, littoral peat bogs with relict and endemic vegetations, marshy and damp alder thickets, and ecosystems of the rivers, lakes and bogs.

Humid and warm subtropical climate, intensive hydrological network and soil with excessive dampness have facilitated the containment of high level of biodiversity. In addition, biodiversity of the National Park was also conditioned by inaccessibility of many sites located in the park (impenetrable swamps and marshy forests).

The territory of the National Park, along with the adjacent seawater area, represents the most important region of the migration route of African and Asian water and swamp birds. 194 types of birds inhibit, spend winter and repose in the swamps, marshy and damp forests of the Park. Some of them such as Pelicanus crispus, Grus grus, Ciconia nigra, Egretta garzetta, etc. are protected species based on CMS (Convention on Migratory Species) and AEWA (Agreement on the Conservation of African-Eurasian Migratory Waterbirds).

The rivers on the territory of Kolkheti plain represent significant habitats for fish spawning roe. They are very important for the purpose of maintaining the population *of Acipenseridae* , in particular, for rare species such as *Acipenser sturio* that is on the “Red List” of IUCN - the category facing the critical risk of extinction (CR). It has only been seen in the Rioni River for the past several decades.

The territories of the Kolkheti National Park are unique in some ways due to the presence of boreal *Sphagnum imbricatum, S. papilosum, S. acutifolium, S. palustre*, *Drosera rotindfolia*, *Rhynhospora alba*, *Carex lasiocarpa*, *Menianthes trifoliata*, *Rhododendron luteum*, and *R. ponticum* as well as the tertiary relicts such as *Pterocarya pterocarpa*, *Q. hartwissiana*, etc. Existence of individual forest stands of Buxus colchica in marshy and damp Alder thickets are also noteworthy.

Groupings of dunes vegetations in their natural form are retained between the mouths of Churia and Khobistskali rivers. Natural form of the dunes vegetations on the territory between the mouth of Khobistskali and Rioni rivers have been altered to some extent due to creation of artificial forests.

Natural or close to natural marshy ecosystems are present in the south part of Anaklia, Churia and Pichora swamps, in the central and north-east parts of Nabada swamp and central part of Imnati swamp.

Marshy Alder thickets are maintained in their primitive forms in the peripheral of littoral swamps, and they have been less altered due to its location.

Uniqueness of the National Park landscape is conditioned by the fact that it is the preserved remains of the landscape belt, which was rich in subtropical and tropical biocenosis spread on the Eurasian continent tens of millions years ago.

Apart from Colkhis, the biocenosis of the above landscape belt can be observed in south-east of the Black Sea coast, Kakheti Region, Talish and Eastern China. Colkhis flora still retains a number of vegetations that went extinct long ago on the Eurasian continent. In addition, some of the Colkhian modern types of flora represent weakly spread endemics and they can only be fund in Colkhis, and therefore can be termed as rare.

Peat bogs on the territory of the National Park represent unique bio-geographic phenomenon in terms of swamping process as well as geobotanic content of modern vegetations. The above bogs are represented by relatively diversified phytocenosis that are developed on 4-12mm peat layers. The Colkhian peat bog, by its construction and floral composition, is to some extent, similar to tundra and taiga bogs, a very unusual phenomenon for subtropical latitude.

Natural or close to natural massif of marshy forests are preserved in a number of areas, where the forest stands of some relict species are represented compactly (“olipone” a place for Pterocarya, and “ozakle” a place for Buxus), should also be noted. Relict or rare species such as *Quercus imeretina*, *Quercus hartwissiana*, *Pterocarya pterocarya*, *Fraxinus excelsor* and *Fagus orientalis* among others are represented in individual or grouping form.

Among rare wild fauna, the following species are noteworthy: Acipenser sturio - a species on the “Red List” of Georgia; Elaphe longisima - reptiles; Ciconia nigra, Gris grus, Egretta alba and Haliaeetus albicilla among others - birds; Lutra lutra and Sorex raddei among others - mammals.

From among the IUCN list of species, Pelecanus crispus, Crex crex , Tursiops truncatus and Phocoena phocoena are worth mentioning.

2.6.2.1 Biomes

Forest biomes of the pilot territory are represented by following formations:

Colchic forests. On Colchis marshy plain in Western Georgia, Alnus barbata and Petocarya pterocarpa thickets can be observed starting from the sea level. In less damp areas, one can find *Quercus iberica, Q.hartwissiana*, *Carpinus caucasica*, and *Castanea sativa* thickets. The above forests are rich in lianes (*Hedera colchica, Smilax excels and Vitis sylvestris*).

In the lower lying segment of the forest belt (up to 500-600m), the slopes developed by human beings are covered with Quercus thickets that are formed by Quercus iberica and Q.hartwissiana. At a higher altitude, we can observe Fagus orientalis thickets, whereas at 1000m above sea level and beyond, Picea orientalis and Abies nordmanniana are found.

Forests. Relict shrubbery understories as well as forest stands of evergreen plants (Jauroceraus officinalis, Rhododendron ponticum R.ungerni, Ulex colchica, Ruscus ponticus, etc.) are characteristics of forests in Western Georgia.

In some regions, especially in Apkhazeti and limestone mountains of Samegrelo, we can still observe Buxus colchica and Quercus Imeretina, which along with Zelcova carpiniflia, forms the thickets of Zelcova carpiniflia and Quercus that dominate in the eastern part of Western Georgia (Imereti).

Castaneta thickets are spread across in Western and Eastern Georgia. These are located from 100 m up to 900-1000 m above sea level in Western Georgia, and the highest altitude these thickets can be found is 1400-1450 m. If we evaluate the pilot territory in terms of biodiversity, we cans say that it includes a part of the National Park and a fairly urbanized territory outside the reserved territories that include the middle reaches of watersheds creating separate sections of the KNP.

Wetlands (marshes and swamps). One of the peculiarities of Khobi and Senaki municipalities is the presence of wetlands. Such lands can be seen in Khobi as well in Senaki municipalities, and are represented in the form of individual massifs. In 1996, based on the resolution of Georgian Parliament, Kolkheti wetlands were declared as Ramsar area (territory with excessive dampness of international importance). Refer map 7, Annex 2.

All big swamps on the territory of Khobi Municipality are located between the Rioni River and the Samtredia-Batumi railway roads, it is known as Pichori-Paliastomi swamp and it is bordered by Black Sea dune and Paliastomi Lake from the west. Pichori-Paliastomi swamp, which is the biggest wetlands, is located on the section with the lowest altitude in the Kolkheti plain that fluctuates within 0.3-2.0 m above sea level. The surface territory of the marshy areas covers 490 km^2 with depth exceeding 8 m. The Imnati Lake is the deepest on the marshy territory and the height of peat bog reaches 12 m. The volume of water accumulated in the swamp is around 1328 million m^3.

Another large swamp, Tikori-Churia, can be found on the territory of Khobi Municipality, it spans from the Enguri River up to the Khobi River, and it is not within the borders of the pilot territory. The altitude of this area fluctuates from 0 to 5m above sea level.

The territory covered by wetlands totals to 90.0 km^2 with a depth of 1.5 m. A big chunk (66 m^2) of the marshy territory is covered with Alder forest, but there is no forest on 25 m^2 that which is covered with vegetations characteristic to marshy areas. There is an intensive hydrological network on the marshy territory that consists of small rivers and streams flowing from higher places of the swamp. The volume of water accumulated in the swamp is around 64.8 million m^3.

There is also a big swamp, Chaladidi-Poti, on the territory of Khobi Municipality, which is located between the mouth of Rioni and Khobi rivers, and bordered by Black Sea dune from the West. The altitude of this segment is 0.3-0.5 m above sea level. A large portion of the marshy territory (50 km^2) is covered with impassable peat bogs. Marshy area covers 144 km^2 with a depth of 1.5-1.7m. The volume of water accumulated in the swamp is around 190 million m^3.

Peat bogs. Peat bog is the most important component of the hydrological network. Swamping process is the most intensive on the territory of the Kolkheti protected areas and ideally where the flat surfaces of the earth are not tilted in any direction. Consequently, drainage of surface waters is very complicated that leads to increased dampness and swamping under the conditions of strong precipitation.

Anaklia, Churia, Nabada, and Imnati sections of Kolkheti wetlands are located on the territory of Khobi and Senaki municipalities within the borders of the National Park. It is noteworthy that large sections of the swamps are not included within the pilot territory of the project i.e. the Rioni River watershed basin.

Juncus-Carex swamps (in the form of individual segments in littoral swamps and marshes is represented on a bigger territory of Churia and Nabada swamps), soddy-sphagnum marshes (central part of Imnati swamp and north-east area of Churia swamp that is characterized by dome peaty surface), Phragmites communis and Typha latifolia swamps are spread across locally in littoral swamps of the pilot territory mainly along lakes and bogged rivers. Shrubbery-grassy swamps can mostly be found on the territory where the massifs of peat bogs and swampy Alder thickets become closer. In most cases, the landscape of shrubbery-grassy swamps is of secondary (anthropogenic) origin. However, we can also come across primary shrubbery-grassy swamps on small sections of impassable and inaccessible peripheral swamps. Starting from the 1930s, tens of water drainage and discharge channels were constructed while performing irrigation works that resulted in the violation of their hydrological regime to some extent (lowering the level of surface waters, etc.).

Currently, the above swamps (sections of the Kolkheti wetlands) are protected under the regulations of Kolkheti National Park and by Ramsar International Convention that Georgia joined in 1996.

In addition to the abovementioned wetlands, there are 18 more on the territory of the Kolkheti plain that are not located in Khobi and Senaki municipalities. However, the main channels of most of their dehumidification networks cross the pilot territory.

2.6.2.2 Protected Areas

Kolkheti National Park.[9] The remnants of landscape belt, rich in subtropical and tropical biocenosis, spread across the Eurasian continent tens of millions of years ago are preserved in the Kolkheti National Park. The National Park is distinguished by its damp and marshy forests rich in flora, peat bogs, interesting vegetations of water and littoral dunes, and a number of rare, endemic and relict vegetations. The territory of the National Park, along with the adjacent seawater area, represents the place for local and migratory birds to inhabit, spend winter and repose.

Location and land distribution. Kolkheti National Park is a part of protected territories of Georgia. It includes the lowest segment of the western part (the Black Sea coast) of Kolkheti plain. Kolkheti National Park is situated to the south of the Caucasus Range, in the Black Sea littoral area of Georgia, on the Kolkheti downland, in the latitude of 41º 48 and 49 degrees N. and in the longitude of 42 º 12 degrees E.

In accordance with the Law on Formation and Management of Kolkheti Protected Areas, the National Park is divided into Anaklia-Churia (between the littoral sections of the gorges of the Churia and Khobistskali rivers), Nabada (between the western sections of the gorges of the Khobistskali and Rioni rivers), and Imnati (between the western sections of the gorges of the Rioni and Supsa rivers) natural-geographic regions. The above regions are separated from one another by the littoral sections of the beds of the Khobistskali and Rioni rivers. In addition, the water area located between the mouths of the Rioni and Churia rivers is also included into the National Park. In total, the land area of the National Park is 28 571 hectares, and the sea water area – 15 742 hectares. Below is a list of Kolkheti wetlands sections with respective total area:

- Anaklia-Churia section (located between the littoral sections of the gorges of the Churia and Khobistskali rivers) - 13 713 ha;
- Nabada section (located between the western sections of the gorges of the Khobistskali and Rioni rivers) – 10 697 ha;
- Imnati section (between the western sections of the gorges of the Rioni and Supsa rivers)-19 903ha.

The sections of the National Park located on the territories of five administrative units, Zugdidi, Khobi, Senaki, Abasha and Lanchkhuti, are a part of Guria and Samegrelo that are historical regions of Georgia. Lower Rioni pilot watershed area includes Nabada and Imnati regions.

Poti, the most important port of Georgia, and the most urbanized center of the region is located to the west of the National Park. There are more than 30 villages and towns such as Khobi, Senaki, Abasha and Lanchkhuti near the borders of the National Park. The above settlements, on their respective territories, affect the National Park and its adjacent territories.

[11] Data on Kolkheti National Park is received from the management plan of the National Park, approved by the Decree N50 of the Minister of Environment Protection and Natural Resources of February 1, 2006

The territory of Kolkheti National Park is shared by Zugdidi (802 ha), Khobi (13963 ha), Lanchkhuti (9800 ha), Abasha (197 ha) and Senaki municipalities (3789 ha). INRMW pilot area covers only Khobi and Senaki municipalities.

Khobi municipality. Based on the National Park management plan, in Khobi administrative unit the Kolkheti National Park comprises 13,963 ha, among them:

State forest fund totals 10,153 ha (72.7% of the total National Park territory is located in Khobi Municipality), of which 337 ha is in Churia, 1,454 ha in Kheta, 2,581 ha in Khobi, 1,081 ha in Chaladidi, 4,200 ha in Patara Poti, and 500 ha in Kolkheti State Strict Reserve. State land fund totals 2,712 ha, of which winter pasture land adds up to 2,632 ha and dunes are 80 ha (0.6%). State water fund comprises 1,098 ha, of which the Partotskali Lake makes up 18 ha (0.1%) and the Paliastomi Lake embraces 1,080 ha (7.8%). A large section of the Kolkheti National Park located in Khobi Municipality (total area adds up to 3,455 ha) is under temporary disposition of the Defense Ministry. 2,266 ha is state land fund, 1,175 is state forest fund and 14 ha is state water fund.

The territory of the National Park within the borders of Khobi administrative unit is arranged in three plots of land:

The first plot is located in Anaklia-Churia regions, between the Churia and Khobi rivers, and includes the forestry lands of Churia, Khobi and Kheta municipalities. The length of the plot's border line is around 26.5km. The border starts at the mouth of the Churia River and it stretches along the Churia River and Zugdidi administrative border up to the crossing of Zugdidi administrative border and Kheta forestry area. Starting from this point, the border stretches to the east and then to the south. The borders of Khobi and Kheta forestry areas reach the Black sea coast and then it goes to the north along the Black Sea coast as far as Zugdidi Municipality administrative border.

The second plot is located in Nabada Region, between the Khobi and Rioni rivers (in accordance with the Resolution #79/10 of November 2, 1997 of the State Commission of Land Use and Protection of Georgia, 9.35 ha of the total territory of the former Khobi forestry unit located on the territory of the National Park was illegally transferred to "Terminal 2000" for the construction of Kulevi terminal). The length of the border is around 31.5km. In the north, the border starts from the Black Sea coast and stretches along the left embankment of the Tsiva River. The border goes past Khobi forestry unit, Kulevi local council, the dividing line of Chaladidi forestry unit and Kariati Village local council. In the east and south-west, the border passes along the dividing line of Chaladidi forestry segments up to Poti customs railroad and from this point It stretches along the right embankment of the Rioni River and its tributary up to Kulevi Village earthen road (passing sandy dunes). The western border starts here and stretches along Poti-Kulevi connecting road up to the mouth of the Khobistskali River.

The third plot is in Imnati Region between the Rioni and Khobi rivers. Its length is around 27 km. In the north, the border stretches along the northern embankment of the Paliastomi Lake and then along the left embankment of the Rioni River. In the east and south, it stretches along the administrative border of Khobi Municipality. The south-west borders of the third plot overlap with the administrative borders of Khobi and Lanchkhuti administrative frontiers up to the Paliastomi Lake.

Senaki Municipality. The territory of Imnati section of the Kolkheti National Park in Senaki administrative unit covers 3,789 ha that includes the lands of the state forest fund of Senaki forestry unit. The length of the border stretches 11.5 km. It extends along the dividing line separating the Senaki forestry unit and the territory of the Chaladidi Village council up to borders of Abasha Municipality and then to the border dividing Lanchkhuti and Senaki administrative units.

Development of natural resources of Kolkheti lowland (land, forest, peat, etc.) in the Soviet period was unsystematic and mainly involved agriculture, forestry and fishery. Industry was only developed in the area of forest logging and wood processing as well as extraction of peat (Maltakva and Anaklia among other areas). Peat extraction was considered to be a prospective commercial activity in the recent past. After being processed, peat was used as fertilizer. Logging in the forest was permitted.

Relief. The territory of National Park is located at 0-5 m above sea level and distinguished by its ideally flat, weakly dismembered and slightly inclined surface. The main form of the relief is flat, littoral plain with a few riverbeds having a depth of 1-3 m. In some places, due to excessive accumulation, the riverbeds are 1-2 meters higher than the adjacent plains.

Along the littoral line, we can observe a narrow line (100-300 m) of sandy dunes that is located 1.5-2 meters higher than the adjacent plain. The dune line is the relict form of the relief, which based on radiocarbon and archeological data, was formed 5000-6000 years ago as a result of sea wave aberrations (the sea level was 1-2 meters higher compared to modern level). The energy of wave aberration gets suppressed on the surface of sandy dunes and adjacent sea shores. Based on the above, sandy dunes and sea shores protect littoral land from erosive action of waves.

Geology. The territory of the National Park is located on the western part of the Kolkheti plain. The plain represents tectonic depression. The downland had suffered from tectonic sinking for a long period of geological time.

The above sinking was compensated at the expense of accumulation of sediments. The territory of the National Park, together with the total territory of the Kolkheti lowland, even in the present day is an area of intensive sedimentation where sea, bog, river and lake sediments get accumulated. Based on the data of geological drilling, the territory of the National Park, starting from the surface down to 10-14 m below, is formed from alluvial (sand, clay, and loam), marshy (peat and bog clay) and littoral-marine (sand and loam) genesis sediments. Near the shore, plain is under the process of intensive swamping, for this reason peat bogs are well-spread in this area. The bog surface is at sea level and the peat layers create a single intact horizon. Peat horizon thickness is around 12m. In almost all littoral bogs, the middle and lower layers of peat are formed below the sea level. Application of radiocarbon and lithologic methods enabled to conclude that the accumulation of peat in Colkhian littoral bogs began around 6000 years ago and it is permanently ongoing.

Climate. The climate on the territory of the National Park is typical of subtropical, marine, humid and warm. The radiation balance of the sun is moderately high (the total radiation balance in Poti equals to 69.2 kcal/cm^2) that stipulates high thermal regime. Annual radiation duration is above 2000 hours, while the number of days without sun equals to 60.

This area does not witness snow in winter, and the number of freezing days may sometimes exceed 20 per year. Absolute minimum level of temperature rarely goes below -15^{0}C, and summer is moderately warm. Maximum temperature sometimes reaches 40-41^{0}C, and annual level of precipitation fluctuates between 1650-1980 mm.

Hydrology. As a result of the climate characterized with high level of precipitation, the deep-water rivers on the territory of the National Park are fed by snow, rain and groundwaters. Some of them are transit rivers (Supsa, Rioni, Khobistskali, Tsivi, Tekhuri and Enguri), while the sources of some are local swamps (Maltakva, Dedabera, Tsia, Tsiva, Churia, etc.). Meandering riverbeds of some rivers were artificially straightened as a result of land reclamation works performed there in the past. Generally, the rivers flowing on the territory of the National Park are characterized by hydrological seasonality of river runoff, rivers virtually never get shallow and floods are expected in every season. Sometimes catastrophic floods are witnessed, especially those on the Rioni River. Based on existing literature sources, the most severe floods on the National Park and adjacent territories were observed in 1842, 1895, 1922, 1938 and 1987. On January 31, 1987, during the flood on the Rioni River, roughly 300 km^2 of the National Park and adjacent territory were covered with mudflow reaching 1-3 m high. The flood destroyed over 1600 buildings serving different purposes, roads and hydrotechnical constructions. Close to 6000 heads of cattle drowned, wild fauna suffered immensely, namely mammals such as dear, wild hogs and reptiles.

In the event of heavy floods, the dams located on the left bank of the Rioni River gets washed away, torrents gush to the National Park territory flooding the marshy forest massifs as well as Pichora peat bog located between Rioni and Pichora riverbeds. Earth dams and natural near-bed bars along both banks of the Rioni River, and the villages of Siriachkoni, Zemo Chaladidi (Mukhuri), Sagvichio, Sagvamichao, Sachochuo, Sakorkio as well as settlements populated by migrants from Adjara get inundated even when the floods are not heavy.

There are several lakes on the territory of the National Park, and among them, the most important is the Paliastomi Lake, which is of lagoon origin. The lake is in the western section of the National Park (its territory covers 18.2 km^2 with maximum depth of 3.2m).

The process of distorting environmental balance that has been developing for thousands of years on wetlands areas of the Paliastomi Lake and its basin started as a result of strong anthropogenic influence.

The fresh water lake has gradually transformed into a salty one (during storms the level of salt in the Paliastomi water increases up to 12-14 ppm). Likewise, species composition of the lake ichthyofauna has changed too. Currently, bog rivers add water into the lake that is saturated with the biogenic elements originated as a result of peat decomposition. The above has resulted in significant reduction of the lake water transparency. Respectively, we observe sharp deterioration of photosynthesis and related processes of formation and cyclicity of nutritional elements. The lake water is becoming increasingly salty and polluted resulting in the degradation of its natural ecosystem. Compared to previous periods, the lake plankton biomass has reduced by 15 times, while that of benthos by 6 times.

Peat bog is the most important component of a hydrographic network. Swamping process is most intensive within the frames of the preserved territories where the ideally flat surface of the earth is not inclined in any direction. For this reason, the drainage of surface waters is very complicated under the conditions of high level of precipitation that results in heavy damping of the earth leading to swamping/marshification. There are Anaklia, Churia, Nabada, Maltakva, Pichora, Imnati, Grigoleti, Kvedauri, Zedauri and transitional types of swamps and marshes in this area. Starting from 1930s, tens of storm water and agricultural drainage channels have been constructed that upset the balance of the existing natural hydrological regime (change of groundwater table, etc).

Soil. Excessive humidity of the climate as well as dampness of the flat land with insignificant inclination within the borders of the National Park contributes to the formation of hydromorphic and alluvial soil.

One can find peat-boggy, alluvial-swampy and silty-boggy soils in this area. The process of development of podzolic-soddy, alluvial-sandy and clay-sandy soil is ongoing in relatively elevated territories where the conditions are suitable for surface water drainage.

Flora. On the first place, the Kolkheti National Park is significant for its botanical value. The environment on the territory of the Park is characterized by excessive dampness, which is conditioned by its flat surface with insignificant inclination as well as by warm and humid climate. However, on the basis of the peculiarities of the relief and hydrographical network, we can also witness the existence of different edaphic conditions. The above ensures the existence of different ecosystems that are radically different from one another on the territory of the National Park. The ecosystems are represented in the forms of littoral sandy dunes, peat bogs, marshy and damp forests and driftweeds groupings. Several types of driftweeds groupings represents the relict of the oldest, the tertiary period flora. For this reason, the vegetation cover on the territory of the National Park represents an extremely important natural heritage.

Vegetations of sandy dunes are still preserved in their original form in the North-western littoral line between the mouth of the Churia and Khobistskali rivers. Very specific and diverse vegetation groupings of lithoral, bulbous, ephemeric, and perennial xerophytes and xerophyte shrubbery grow on the substrate of littoral dunes that periodically get salty and sandy due to sea water. Among lithoral species, one can find Euphorbia paralias, Eryngyium ratium, etc.; among perennial xerophytes, one can come across Anthemis euxina, Silene euxina and Stachis maritime; among xerophytes shrubbery, one can observe Paliurus spina-christi, Hippoplae rhamnoides, etc. On small patches of local territories, one can find rare groupings of Mediterranean species such as Glaucium flavum and Pancratium maritimum.

Similar to boreal bogs, Colkhis (Kolkheti) bogs are also characterized by dome-shaped and hummocky surface created by sphagnum moss. It is also characterized by the boreal (taiga and tundra) swamp vegetations such as *Sphagnum imbricatum, S.* papilosum, S. acutifolium, S. palustre, Drosera rotundifolia, Rhynhospora alba, Carex lasiocarpa, and Menianthes trifoliata. The reason behind the existence of elements of boreal flora is still unknown. A part of botanists explain the fact by quaternary glaciations, and consider the above elements of Colkhian flora as the relicts of glaciations period.

Carex acutifolium, C. vesicaria, Juncus effusus, J. infexus, J. acutus, Typha latifolia, T. angustifolia, Phragmites australis, Iris pseudacorus, Sparganium poliedrum, Molinia litoralis, Osmunda regalis, Solidago turfosa, Hibiscus pontica, Kosteletzkya pentacarpos, etc, grow in Colchic swamps. Colchic peat bogs acquire a degree of uniqueness for its mountainous Colkhian flora such as Rhododendron luteum R. ponticum.

Marshy forests formed and developed in the peripheral line peat bogs and along the bogs and rivers hold immense ecological value.

Alnus barbata, a Colchic-Hirkan relict is most dominant among the above forests. Alder thickets formed in the National Park represent one of the primary formations of Colkhic flora. As a rule, Alder thickets are forests with low yield class and the average height of trees equals to 10m. Along with Alnus barbata, one can also find Pterocarya pterocarya, Quercus imeretina, Acer campectre, etc. in the forests. Due to anthropogenic factors, the aforementioned trees are on the verge of extinction.

Rhododendron luteum, R. ponticum, Ruscus ponticus, R. hypophillum and Ilex colchica can be seen in the marshy Alder underwoods. From among lianas, we can observe Hedera colchica, H. helix, Smilax excelsa, etc.

Damp Alder thickets are well-formed under better drainage conditions of surface waters on elevated areas. Alnus barbata plays the dominant role in the damp Alder thickets. Pterocarya pterocarya, Quercus imeretina, Quercus hartwissiana, Vitis silvestris, Diopyros lotus, Staphyiea pinnata, and Buxus colchicaare are also preserved in some areas of the forests. One can rarely come across species that were well-developed in the past such as Fagus orientalis, Carpinus caucasica, Acer campectre, Fraxinus excelsor and ulmus carpinifolia. Damp Alder underwood is represented by Ilex colxica, Ruscus hypophillum, Rhododendron ponticum, Laurocerasus officinalis, etc. In addition, concerning the lianas, Hedera colchica and Smilax excelsa among others are worth mentioning.

Moreover, the following rare algae species are noteworthy among the ones existing on the territory along the swamps, rivers, lakes and damp areas: Nymphaea colchica; Numphar luteum; Trapa cochica. In addition, one can also come across Lemna minor, Salvinia natans, etc.

In the water area of the Kolkheti National Park, 350 species of algae can be found.

Based on ecological aquatic-floral analysis of algae biotypes observed on the adjacent territories of the Paliatomi Lake, running water is considered to be mainly formed from cenosis developed from benthos organisms which is dominated by rheophils, epiphytes and epiliths such as Merismopedia tenuissima, Microcystis aeruginosa, Gomphosphaeria lacustris, Cerotium hirundinella, Gloeococcus schroeteri, Pediastrum tetras and Scenedesmus arcuatus.

Plankton bionts create significant environment of stagnant water.

The Paliastomi Lake can be attributed to eutrophic reservoir.

Majority of algae found in the swamps of the Kolkheti plain belong to the family of Desmidiales.

Invasive species that are characterized by high rate of reproduction and competitiveness pose serious threats to autochthonic flora and vegetations grown on the Kolkheti plain. Quite often, their monodominant groupings grow on large territories. The key adventive types found on Colkhis plain are East-Asian Polygonum thunbergii, Paspalum paspalodes and Oplismenus undulatifolius, and North-American Ambrosia artemisiifolia, Robinia pseudoacaia, etc. Based on the existing data, invasive types such as *Gomphocarpus fruticosus*, *Hypericum mutilum*, etc. are spread more locally. Presumably, the above taxsons will widen their area of inhabitation on the territory of Colkhis plain where the process of fragmentation-destruction of co-habitants of primary vegetation is relatively intensive that contributes to widening the area of the spread of adventive elements.

Fauna. The Kolkheti National Park represents the most significant habitat not only for rare species of flora, but for a number of types of wild fauna as well. However, it should also be mentioned that the realm of wild animals of the National Park and its adjacent territories is less studied and researched. The habitats of different types of fauna, the number of specific types, the ecological conditions of their populations, etc. have not been defined yet.

Mammals. From among the Insectivora family, one can find Talpa caucasica, Crocidura russula and Sorex daddei on the territory of the National Park. *Rhynolophus mehelyi, Myotis bechsteini*, *Miniopterus schreibersi* and *Nyctalus leisleri* among those of *Chiroptera* family recorded on the territory belong to rare species.

Eight (8) types of Carnivore family are recorded on the National Park and its adjacent territories. Among them, the single type that abounds on the territory is Canis aureus. We should also point out Lutra lutra from the same family that turned out to be on the verge of extinction due to anthropogenic factors. The species is listed in the “Red List” of Georgia. Monitoring of the National Park is necessary to define the exact place of its population, its number and ecological conditions of this animal.

Capreolus capreolus and *Sus scrofa* of Artiodactyla family inhabit the territory of the National Park. Due to sharp deterioration of environment during the past decade, the condition of the family is getting closer to the ones that are already critical.

Birds. 194 types of birds are recorded in the National Park and on its adjacent territories. Among them, 62 types are the habitants, 76 types are migratory and 56 types spend winter in this area. The above types of aves in the National Park and on the adjacent territories belong to the classes of Gruiformes, Ciconiiformes, Chradriiformes, Falconiformes, Galiformes, Passeriformes, Anseriformes, Pelecaniformes, etc.

Anserfabialis, Anseralbifrons, Anasplathyrynhos, Aythyafuligula, Pelecanus crispus, etc use the lakes on the territory of the National Park and the adjacent sea water area to repose and spend winter.

The lakes of Paliastomi, Imnati and the Churia, Tsia, Pichori, Gurinka and Kukan rivers among others hold special importance for migrating aves. Bogs along lakes, swamp rivers, marshy forests and shrubberies represent the places where species such as Crex crex, Boptaurusstellaris, Ixobryehus minitus, Egretta alba, Egretta garzeta, Ardea cinerea, Grus grus, Anthropoides virgo, Galinago media and Ciconia nigra among others inhabit, repose and spend winter.

Among the above types, Ciconia nigra and Gris grus are listed in the “Red List” of Georgia, while Crex crex and Galinago media in the IUCN “Red List”.

Swamps, reservoirs, marshy forests and forest-shrubberies are used for hunting purposes by the following birds of prey that are significant from their conservation point of view: Circus melanoleus; Pandion haliaetus; Haliaetus albicilla; Aquila heliaca; Falco naumanni, etc.

Reptilia. In literature sources, the following reptilia have been observed and described in the National Park and on the adjacent territory with excessive dampness: Emys orbicularis; Angius fragilis; Natrix natrix; Natrix tesselata; Elaphe longisima, etc.

Amphibians. Among amphibian, the following is recorded on the territory of the National Park: Tritorus vulgaris; Tritorus vitatus; Hyla arborea; Rana ridibunda, etc.

Fish. The National Park is distinguished by variety of ichthyophauna. Seven types of Crondrihtes and 81 types of *Osteichtyes* classes are recorded on its territory. Refer Chapter 1.3.3. Annex 1 (The List of Fauna Types). Among them 44 types are inhabitants of the Black Sea, 21 types live in fresh water, and 23 types are migratory. Out of Osteichtyes class, we should mention *Salmo fario (truta) morpha labrax, Alosa caspia paleostomi, Mugil cephalus, Mugil auratus, Stizostedion lucioperca, etc*, while among Crondrihtes, we should point out Acipenser sturio, which belongs to rare species and listed in the "Red List" of Georgia. Based on various reliable sources, this is the last of its natural population worldwide that is still preserved.

The crab-likes and mollusks are represented by several tens of types.

Landscape. The following types of landscapes can be observed in the National Park:

Littoral sandy dunes landscape. This type of landscape is preserved in its natural form between the mouths of the Khobistskali and Churia rivers on a slightly elevated relief of dunes located along the sea shore. The surface is rather warm and salty because of sea water with sandy-soddy soil where one can find lithoral psammophytes such as Euphorbia paralias, Eryngyium ratium, etc. as well as perennial xerophytes such as *Anthemis euxina, Silene euxina,* Stachis maritime, and ephemeral vegetations like Aira elegans, Vulpia myurus and Lolium loliaceum, etc., and xerophytes shrubbery in the likes of Paliurus spina-christi and Hippoplae rhamnoides among other groupings. Rare Mediterranean species such as Gglaucium flavum and Pancratium maritimum and other adventives plants like Paspalum digitaria and Erigeron canadensis can also be observed here. The level of degradation of the natural form of littoral sandy dune landscape varies on a large territory along the sea shore of the Kolkheti plain. In some areas it is fully destroyed as a result of anthropogenic pressure.

Landscape of Carex-acutiformis-Jumcus affusus swamps. This type of landscape can be found as separate areas in all littoral swamps of The Kolkheti plain. The territory it occupies is especially big in Anaklia, Churia and Nabada swamps. The landscape is distinguished by its relief with ideally flat peaty surface; small and crooked-bed swamp rivers where Carex acutiformis, C. vesicaria and others as well as Juncus effusus, J. inflexus are predominant. The structure of the landscape of Carex-acutiformis-Jumcus affusus swamps in the southern part of Anaklia swamp, on the central areas of Churia and Nabada swamps, is natural or very close to natural. On the remaining areas of the swamps, the Carex-acutiformis-Jumcus affusus landscape is damaged at varying degrees, while in the areas of peat exploration, it is almost completely damaged.

Landscape of grassy-sphagnum swamps. This type of landscape is developed in the central part of Imnati swamp and on a small territory in the north-east of Churia swamp. Grassy-sphagnum swamp differs from other types of swamps in the Kolkheti plain in floristic composition and structurally.

Grassy-sphagnum swamp is characterized by dome-shaped, peat surface, which is noticeable elevated above the surface of neighboring swamps (for example, in central areas of Imnati swamps, the breadth of the dome, formed by sphagnum, at the bottom equals to 3km, while the height reaches 5m.). In addition, we have to note that at the surface of peat dome the sphagnum creates the relief with different sizes and forms of hummocks. The key edificator of vegetation cover of the landscape of grassy-sphagnum swamp is Spahgnum imbricatum, S. papilosum, S. acutifolium and S. palustre along with Molinia litoralis which is also predominant in the area. You can also find Rhynhospora alba, Menianthes trifoliata, etc.

Landscape of Phragmites communis-Typha latifolia swamps. This type of landscape is spread locally in Colchic littoral swamps and marshes and can be mainly observed along the lakes, swamp river embankments and some areas of peripheral line of swamps. Phragmites communis Typha latifolia and T. angustifolia dominant on the peat soil of the above landscape. We rarely come across Bolboschoenus maritimus. Iris pseudacorus and others can also be observed in scattered areas. This type of swamp landscape is preserved relatively well compared to other types of landscapes of Colchic littoral swamps.

Marshy landscape of Alnus barbata thickets. This type of landscape can mainly be found on the peripheral areas of littoral swamps and along the riverbeds. It is well-developed on flat and well-damped relief as well as on peaty or silty soil of swamps. In this area, Alnus barbata thicket plays the dominant role in creating forests with low yield class (the height of plants and trees does not exceed 10 m). Ecological conditions of the above landscape in the National Park are not homogeneous. The marshy landscape of Alnus barbata thickets along the embankments of the Churia, Tsiva, Tsia and Pichori rivers have especially suffered due to logging activities in the recent years.

Landscape of shrubbery-grassy swamp. The above landscape is mainly formed in areas of peat bogs and marshy Alnus barbata thickets. This type of landscape is formed by the unison of Carex acutiformis, C. vesicaria, Juncus effusus, I. inflexus and other groupings of grassy plants found is the bogs and Alnus barbata thickets. In most cases, the landscape of shrubbery-grassy swamps is of secondary (anthropogenic) origin. However, primary shrubbery-grassy swamps can also be observed in small areas of peripheral lines of impassable swamps and inaccessible places. In this case, the reason behind the degradation of Alnus barbata into shrubbery is the substratum of deep-bedded peat that has negative influence on the growth of plants.

Damp landscape of Alnus barbata. This type of landscape is mostly formed in the north-east, east and partially in the south-east areas of the National Park. It is formed under better drainage conditions of surface water, in the elevated area of flat surface with alluvial and podzolic, and partially on silty soil of bogs. Alnus barbata represents the dominant vegetation cover of this landscape. We can also find *Quercus imeretina, Q. hartwissiana*, *Pterocarya pterocarpa*, *Carpinus caucasica*, *Frangula alnus*, etc. Compared to the marshy landscape of Alnus barbata, the damp landscape of Alnus barbata is more damaged ecologically due to the influence of anthropogenic factors (firewood production, grazing, etc).

Landscape of secondary meadow-shrubbery. This type of landscape was formed as result of logging and one can find it everywhere as individual fragments on the territory of National Park covered with forests. On this landscape, we can mainly observe *Alnus barbata*, and though rarely, the shrubs of secondary origin of *Quercus imeretina*, *Carpinus caucasica* and *Pterocarya pterocarpa* can be found mixed with grassy groups.

Landscape of secondary meadow. This type of landscape, in the form of small or big fragments, is represented in almost all areas of the National Park. It is formed in areas of logged forests or dried swamps as well as on flat reliefs with silty-podzolic or alluvial soils. Secondary meadows of swamps can be observed in the places saturated with moisture, and damp secondary meadows can be found under better drainage conditions of surface water. *Paspalum digitaria* and *P.dilatatum* are dominant among the vegetation cover of both types of meadows. On the marshy meadows, one can often come across *Juncus effusus, J. acytus*, *Trifolium repens*,*Carex acutiformis*, etc. On the secondary damp meadows, along with *Paspalum digitaria and P.dilatatum, one can also observe* Agrostis *alba*, *Poygonum hydropiper, P. minus*, *Sorghum halepense*, etc.

Anthropogenic-aqua landscape. The above landscape was primarily formed as a result of melioration works performed on the territory of the National Park. In the 1930s, with the purpose to drain out the swamp, tens of channels were built on the lands with excessive dampness, pools of different forms were formed as a result of peat extraction from peat bogs, and crook beds of bog rivers were straightened out. Presently, a number of shallow channels have been constructed on the territory of the National Park with excessive dampness, in the basin of the Pichora River and the Paliastomi Lake as well as on the surface of Nabada swamp.

2.7 Renewable Energy Resources

Overall, the Rioni River Basin is rich in hydro resources as well as in biomass, and especially, in wood resource. Geothermal and wind energy resources are also very significant, and as for solar energy, it is far less than that of the Alazani River Basin. However, significant hydro potential exists in the upper and the middle reaches. Hydro potential of the rivers of the Rioni River Basin within the Samegrelo Region amounts to 64.9 MW, while annual installed capacity equals to 363.7 million kWh.

As for the pilot territory, only the Tekhuri River has the above potential. Construction of 3 power-stations are planned on this river, and among them, the Tekhuri hydropower plant will be built in Senaki Municipality.

As regards wind energy potential, it amounts to 100-250 w/m^2. However, in Poti and its neighboring areas, it fluctuates from 800-1,200 w/m^2 in the coastal line. Construction of wind power station with 90 MW of installed capacity and 210 MW production capacity is possible near Poti.

Concerning solar energy, its daily potential on the territory of the region equals to 3.8 kW/m^2.

Samegrelo Region is rich in wood resources, though the same cannot be said about its Rioni downstream section. Timber is harvested extensively for the production of firewood. Agricultural waste in the form of nuts shells is very significant biomass resource with 10,000 tons of nut core being produced annually, and taking into consideration the ratio of 40:60 between the core and waste, the region produces 15,000 tons of nut shells annually. In addition, in the nearest future Ferrero SPA and its associated companies plan to expand nut production in the region.

There are 4 geothermal springs in the Zana Village of the Senaki Municipality. The total thermal potential of the above geothermal water is assessed at 4.1 MW.

2.8 Mineral resources

General: Samegrelo-Upper Svaneti region is rich in thermal water that can mainly be found in the lower course of the Rioni River. The total supply of this resource is 35 000 m^3/d. In addition, there are a number of sand and gravel as well as limestone deposits in the Senaki Municipality. Black-clay deposits can be found in Khobi and Senaki municipalities. In addition, deposits of healing waters, minerals and precious stones can be found in the region.

Khobi Municipality. The municipality is rich in thermal water, but they mainly belong to the Enguri River Basin.

Senaki Municipality. The main mineral resource is thermal water, which is located in the villages of Sakharbedio, Ledzadzame, Zana, Nokalakevi, Potskho, Akhasopeli, etc. One can also find inert materials, limestone and brick clay in this area.

Refer map 12, Annex 2 for more information and map of mineral resources.

3. INSTITUTIONAL SETTING

3.1 Regional Government

Lower Rioni pilot watershed area falls entirely under the Samegrelo-Zemo Svaneti regional administration, with the region's center located in the city of Zugdidi. The regional administration is led by the Governor and two Deputies. The administration also includes various sectoral departments. The region does not have a short or a long-term development strategy. However, it should be noted that the key strategic direction, similar to other regions, includes the infrastructure development of roads, drinking water, sewage system, irrigation and drainage, etc.

3.2 Local Government

The pilot territory includes Khobi and Senaki municipalities.

Khobi Municipality administration is located in Khobi City. The municipality Sakrebulo (representative body) is headed by the Sakrebulo Chair and Deputy Chair. The Sakrebulo comprises the following commissions: 1) The Commission on Mandates, Voting and Procedures; 2) The Commission of Legal Issues and Human Rights; 3) Finance and Budget Commission; 4) The Commission of Social Affairs and Economic Development. The Sakrebulo has its Secretariat/Administration. The municipality Gamgeoba (executive body) is headed by Gamgebeli and Deputy Gamgebeli. The Gamgeoba consists of the following structural units: Administration; Economic and Infrastructure Development; Finance and Budget; Education, Sports, Cultural Heritage and Youth; Healthcare, Labor and Social Security; Drafting and Fire/Rescue units. In addition, Regional office of Georgian Civil Registry is located in Khobi Municipality.

Senaki Municipality administration is located in Senaki City. The municipality Sakrebulo (representative body) is headed by the Sakrebulo Chair and Deputy Chair. The Sakrebulo comprises the following commissions: 1) The Commission of Mandates and Procedures; 2) Finance Commission; 3) The Commission of Social Affairs; 4) The Commission of Infrastructure; 5) The Commission of Agriculture and land Issues. The Sakrebulo has its Secretariat/Administration. The municipality Gamgeoba (executive body) is headed by Gamgebeli and Deputy Gamgebeli. The Gamgeoba consists of the following structural units: Administration; Economic and Infrastructure Development; Finance and Budget; Education, Sports, Cultural Heritage and Youth; Healthcare, Labor and Social Security; Drafting and Fire/Rescue units. In addition, Regional office of Georgian Civil Registry is located in Khobi Municipality.

3.3 Local NGO Sector

The NGO sector on the pilot territory, Khobi and Senaki municipalities, is developed at an average level compared to the overall scenario of NGO activities in the regions of the country. In August 2011, EWMI G-PAC conducted a survey, and according to which, the gap between the low level of engagement of Georgian society in civic sector and the high level of engagement in civic activity through informal methods is rather sharp. Georgian civic society is relatively weak with only 1% of the country's population is engaged in NGO sector. With this in mind, the situation in Samegrelo Region should be considered worse than average. As of date, only 5 active NGOs are registered in Khobi Municipality, of which 3 are community unions and one is farmers association. Merely 3 NGOs are operational in Senaki Municipality: "Senaki Community Education Center", focused on the problems in the sphere of education; "Archeopolis" Union, active in the sphere of education; "The Union of Economic Development of Old Senaki", operational in the sphere of economy. The above organizations are working to study the problems existing in the relevant fields and find ways for its improvement.

None of the above organizations specify the interest on environment protection and sustainable use of natural resources as one of its sphere of concerns. However, clean drinking water supply and the problems related to sanitary system are acknowledged as being one of the priorities of the above NGOs. The network of drinking water distribution is fairly underdeveloped in the region, which, despite rich water resources, creates problems in water supply and availability. The problem is especially acute in the villages where local population often uses well (ground) water, and sanitation system does not actually exist.

There is not a single NGO on the pilot territory specifically focused on environment protection or eco-tourism.

4. SOCIO-ECONOMIC CONDITIONS

4.1 Socio-Economic Features

4.1.1 Demography

There are 15 administrative units in Senaki Municipality, 1 town and 14 communities, composed of either single village or a number of villages. The number of local population (including IDPs) totals 48,900, of which 27,217 is town population, and the population density is 100.1 persons/km^2.

There are 20 administrative units, comprising 1 town and 19 communities, in Khobi Municipality. The number of population (including IDPs) totals to 41,700, of which 17% is town population, and the population density is 62.6 persons/km^2.

There are 25,956 people (8,614 households) residing in the INRMW target villages of Senaki and Khobi municipalities (Annex 1). On an average, each family consists of 5 members (min.1; max.11), and 51.9% of the local population are women. There are 3,895 children (up to 18 years old) representing 1.9% of the total local population, and 3,972 pensioners (17.8% of the local population).

There are no precise statistical data available on migration in the region.

4.1.2 Vulnerable Groups of Population

The following categories may fall under the vulnerable population: people below the poverty line; invalids; pensioners; IDPs.

There are 1,210 (4.9% of the total local population) people under the poverty line residing in the target villages. The rate of such people is especially high in Zana (15.5%) as well as in the villages of Chaladidi and Upper Chaladidi communities (11.8%).

As aforementioned, the pensioners account for 17.8% of the total local population. This proportion is especially high in the Mesame Ubani Village (69.0%) of Patara Poti community.

Overall, there are 1,316 IDPs residing in the target villages, of which 275 reside in the villages of Dzveli Senaki Municipality, 207 in the villages of Teklati Municipality, 167 in the villages of Nokalakevi Municipality, and 158 in the villages of Potskho Municipality.

4.1.3 Education

4.1.3.1 Day Care Centers

The majority of the target villages do not have day care centers. They function only in some villages. However, the buildings housing day care centers need repair.

4.1.3.2 Schools

Public schools are operational only in a part of the target villages, and majority of the schools need material repair. However, the schools of Sabazho, Potskho, Ledzadzame, Bataria, Jikha, Shua Nosiri and Tekleti are exceptions in this regard, and their schools are in satisfactory conditions.

4.1.4 Healthcare

Primary healthcare facilities (outpatient clinics) function in almost all target villages of Khobi Municipality, with the exceptions of Shavgele, Sagvamichao and Sachochuo villages. Overall, the conditions of the outpatient clinics are satisfactory.

Most of the target villages of Senaki Municipality do not have outpatient clinics. Primary healthcare facilities (outpatient clinics) only exist in some villages (Sagvichio, Potskho, Zana, Ledzadxzame, Dzveli Senaki, Mukhuri/Siriachkoni and Akhalsopeli). It should also be noted that most of the above outpatient clinics need material repair.

4.1.5 Household Economy

4.1.5.1 Key Economic Trends in Pilot Communities

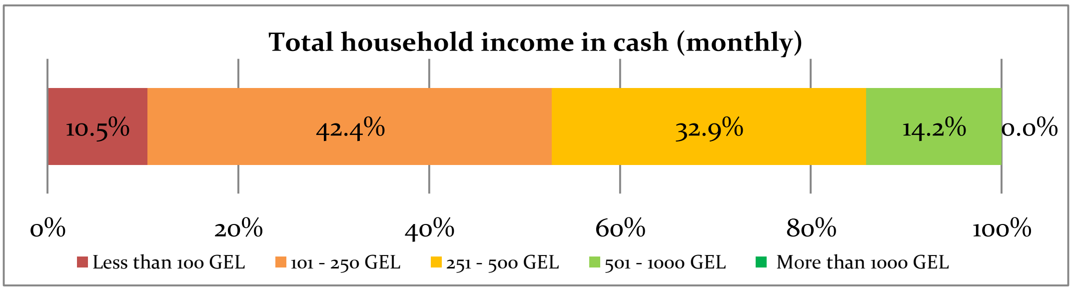
Based on socio-economic indicators, Senaki and Khobi municipalities hardly differ from one another. The key conclusions are common for the target communities of both municipalities.

- The number of people under the poverty line is relatively low (up to 5%). The rate of such people is especially high in Zana (15.5%) and in the villages of Chaladidi and Upper Chaladidi communities (11.8%).
- The number of IDPs in the target villages totals to 1 316, of which 275 reside in the villages of Dzveli Senaki, 207 in Teklati, 167 in Nokalakevi and 158 in Potskho municipalities.
- The economic conditions of the majority of households residing in the target villages are below average.
    - For the majority of the respondent households, the amount of income in cash for the last month did not exceed GEL 250;
    - Monthly current expenses for the majority of the local population are less than GEL 150;
    - Long-term expenses of the households do not exceed GEL 150 per month, and some of the respondent households stated not having long-term expenses at all;
    - Communal expenses do not exceed GEL 25 per month for most of the respondent households;
    - In terms of income, the majority of the respondent households attribute themselves to the category of middle income or the category of lower than middle income.

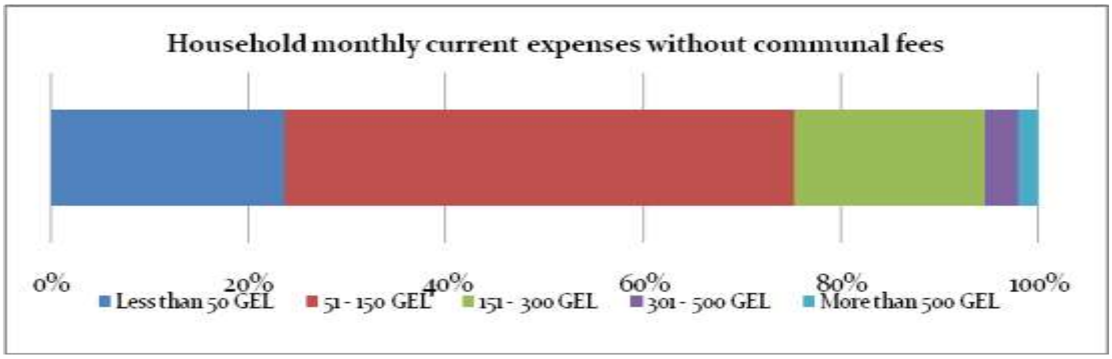
- Among the households residing in the target communities, 70% are involved in some kind of economic activities such as selling agricultural products or trade. For the majority of the households, the income generated from the above activities makes up 75% of their total income.
- On an average, the households residing in the target villages own around 1 ha of land. A household uses only 0.7 ha on an average for agricultural purposes.
- Almost all households grow corn, and many that grow haricot and vegetables. Almost every respondent household owns cattle/poultry that is used for food or generates income, and it mainly consists of poultry, cattle and pig. Cows are mostly used for producing milk, cheese and butter.
- The majority of the households residing in target villages collect firewood from forests. The number of households collecting mushrooms, grasses and berries for personal use or for selling is not big. Correspondingly, the majority of the respondent households do not generate income from selling natural resources (hay, fish, construction materials, healing and coloring plants, etc.).

4.1.5.2 Household Economy

During the final month of the survey, the total amount of the monetary income of the majority (52.9%) of the interviewed households did not exceed GEL 500, while for 58.3% of the respondents it amounted to less than GEL 250.

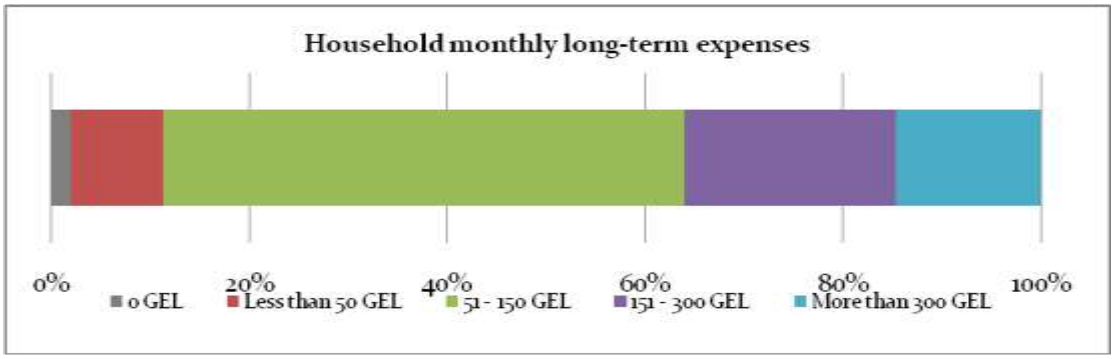


For the majority of the respondents (75.2%), monthly current expenses[10] are less than GEL 150 and fluctuate between GEL 51-150.

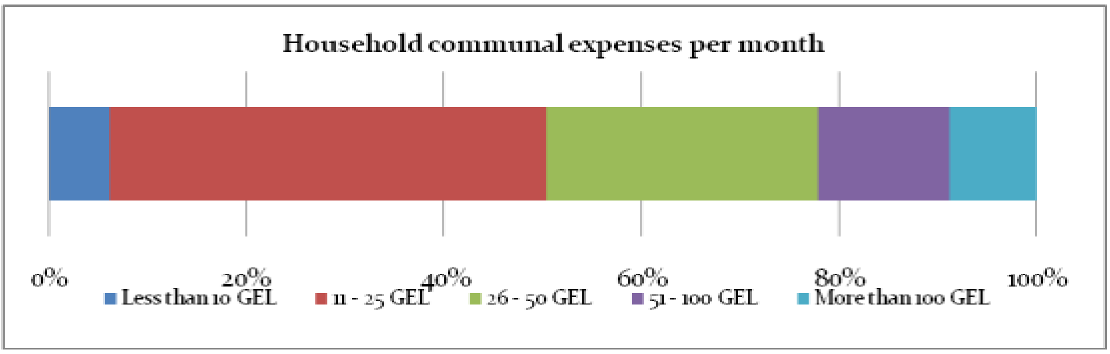


[10] Current expenses include daily expenses such as food, soup, detergents, toilet paper, shampoo, cigarettes, newspapers, matches, bulbs, transportation fees, etc.

Long-term expenses[11] of the majority of the households (64.0%) do not exceed GEL 150 per month. It should also be noted that 1.9% of the interviewed households stated not having long-term expenses at all.



Communal expenses[12] do not exceed GEL 25 for almost half (50.4%) of the interviewed households.

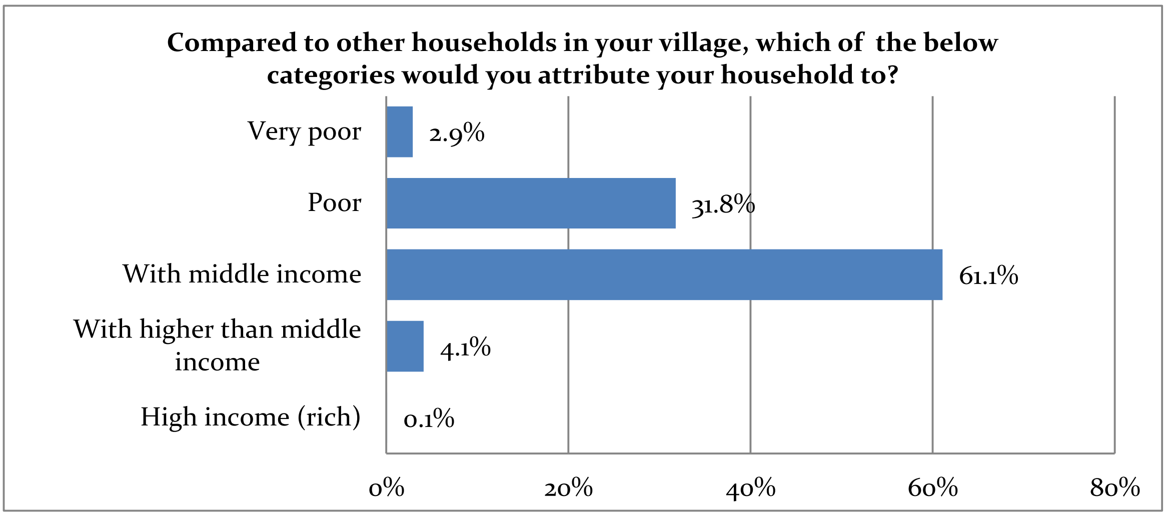


Based on self-evaluation of the households, welfare is considered to be another important indicator of their wellbeing.

In terms of income, the majority of the respondents attribute their households to the categories of average (61.1%) or low (31.8%) income.

[11]Long-term expenses include expenses such as clothes, shoes, sheets, quilts, towels, books, stationery, education expenses, transportation fees excluding fuel, marriage, dowry, funeral fees, renovation expenses, etc.

[12] Communal (utility service fees) expenses include monthly expenses such as electricity, gas, telephone, water, firewood, kerosene, etc.

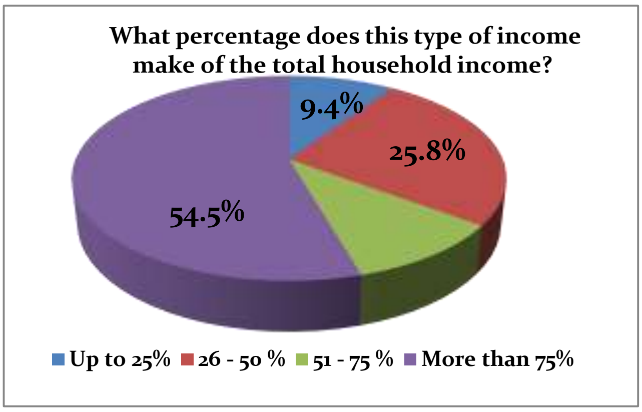


4.1.6 Employment Opportunities

The majority of the local population of the target villages is self-employed and engaged in agricultural activities.

Based on the data of the survey previously conducted within the frames of the Project, 2 169 (8.8%) people residing in the target villages consider themselves self-employed. The indicator is relatively high in village of Zemo Chaladidi (35.1%) and other villages of Nokalakevi community (23.4).

Among the households residing in the target villages, 66.4% mentioned that members of their families are involved in some kind of economic activities. 73.9% of them are in selling agricultural products, 30.2% in trade, while 0.5% in tourism-related activities. 54.5% of the interviewed households believe that the income generated from the above activities makes up for more than 75% of their total household income.



4.1.7 Land Uses and Agriculture

On an average, households residing in the target villages possess 1 hectare of land. A household averagely uses 0.7 hectares for agricultural activities.

The following crops that favor marshy soil are mainly spread on the pilot territory of Samegrelo Region: Foxtail millet (*Setaria italic (l.) P.B)*, rice, etc. Prior to corn becoming eventually widespread, millet was the main traditional crop, and it is considered to be of local origin. Later, it was replaced by corn. In addition, citrus, tea and other subtropical cultures were also actively introduced.

Viticulture/vine-growing is also traditionally well-developed sector of agriculture in Samegrelo Region. Wide variety of Georgian vine species is universally acknowledged. Ojaleshi, Cheshi, Shonuri, and the oldest species: Pumpula, Makhvateli, Kharistvala Colkhuri, Kachichi, Dudgushi, etc. are the ones that are widely spread.

Cattle-breeding was also well-developed in Samegrelo Region and local breeds such as Megruli cows, goats and horses can serve as a testament.

Presently, almost every family residing in the pilot villages grow corn/produce corn flour (92.0%). Many of the local households grow haricot (60.2%) and vegetables (59.9%).

Almost every family has cattle and poultry (94.1) that generate food and/or income. 64.1% of local households produced chicken meat and 76.5% - eggs. Beef was produced by 45.0% of local households, and pork by 37.4%. Local population use cows for producing milk (51.1%) and cheese/butter (63.2%).

Sheep-breeding is hardly developed (mutton was only produced by 0.6% of local population).

Table 1 of Annex 14 depicts the data on households residing in the target villages and the numbers (percentage) that grew or produced various kinds of products in their households in the preceding year.

4.1.8 Use of Natural Resources

Firewood from the forests is collected by 81.1% of the population of target villages, 25.4% collect mushrooms, grass and berries for their personal consumption, 6.9% for the purpose of selling, and 76.8% take their cattle/bees to forests to feed them.

Among respondent households, 65.4% do not generate any income from selling natural resources (hay, fish, firewood, construction materials, berries, mushroom, healing/coloring plants, etc.). For 28.6% of the respondents, this kind of income makes up less than 25% of the total household income.

4.2 Infrastructure

4.2.1. Agricultural Drainage Systems and Flood Control Structures

Starting from 1920s, the Rioni River and its tributaries have been barraged with the purpose of drying-out and developing the Kolkheti lowland. The above process excluded floods from being one of the key factors of marshing and flooding of the area. Simultaneously, construction of drainage systems was underway.

In the 1950s, water diversion structure was built in order to protect Poti City from flooding. It consists of two independent structures: i) left bank regulator weir with 20 sluice openings and designed capacity to discharge a total of 400 m^3/sec water, 20 m^3/sec through each sluice opening into the canal going through the Poti City; ii) main weir with 10 sluice openings and designed capacity to discharge a total of 4,000 m^3/sec water, 400 m^3/sec through each sluice opening. Sluice openings are regulated by vertical (in case of left bank regulator) and radial (in case of main regulator) lift gates.[13] The structure divides the Rioni River into two sleeves/branches, south and north. The south branch with the capacity of 400 m^3/sec flow on the territory of the city, and the main stream of the river flows in the north branch.

During the period of low waters when flow rate does not exceed 400 m^3/sec , all sluices are closed and water only flows to the south or the city branch. During the periods of floods and flash floods, the sluices of the north branch are opened and excess water flows in the north branch. Presently, the capacity of the south branch canal is significantly diminished. No protective dam is located along any bank of the north sleeve.

The marshy zone of the Kolkheti lowland characterized by excessive humidity and requiring intensitve draining covers a three-kilometer-line of the Black Sea coastal zone. The main drainage water collector on the Rioni-Khobi area is the M-2 main channel that starts from the Tsivi River dike, gets connected to the other M-1 main channel at the bridge of the Korati Village, discharges drained water into the Khobi River through Tsiva Canal and ultimately into the Black Sea through the said canal.

The length of the M-2 main channel from the Tsivi River dike up to the bridge of the Korati Village measures 15,650 m. The structure has the following designed specifications: trapezoid shape; bottom width – 10 m; wall inclination – m=1:2; capacity to convey water with 105 m^3/sec 10-year recurrence pick discharge and 190 m^3/sec 100-year recurrence pick discharge.

One of the largest drainage systems of the pilot watershed area serves to drain the territories of villages of Chaladidi and Patara Poti. The main canal of the above drainage system conveys excessive water into the Rioni River, below the diversion weirs. From the main channel, water flows through gravity flow during low waters. However, during the periods of floods and flash floods, when the level of water is high, the sluice gates are closed and excess water gets pumped into the Rioni River through the high capacity pump. Due to frequent rains and change in groundwater levels, the main canals are characterized by high water level fluctuations. In addition, the level of water in the canals falls more rapidly than that of the groundwater, resulting in delayed infiltration of ground waters in the canal and inserting pressure on canal sides. This, in turn, leads to the loss of the soil stability and canal siltation. The above causes the reduction in canals conductivity and inundation of secondary and tertiary canals in the event of floods and flash floods.

The main drainage water collector of the Rioni-Supsa area is the abovementioned large canal that receives runoff of rivers and streams from Nigoiti Ridge and ravines and discharges into the Kaparcha River.

[13] Emergency Underwater Rehabilitation of the Poti Main Diversion Weir, Georgia, LJILJANA SPASIC-GRIL, Jacobs, Reading, UK. http://www.britishdams.org/2006conf/papers/Paper%2020%20S%20Gril.PDF

The Pichori River flows in the extreme downstream of the Kolkheti plain and discharges into the Paliastomi Lake. In accordance with the general plan, in order to dry-out the marshy and excessively damp lands of the Kolkheti lowland, a 25 km long section of the riverbed was straightened and barraged. For the purpose of getting rid of excess water from the drainage systems constructed in the north area of the right bank of the Pichora River, 6 pump stations were constructed. The above facilities discharged agricultural drainage water into the Pichori River.

For many years since the disintegration of the Soviet Union, existing drainage systems, particularly village level main canals and drainage networks have not been maintained properly, which has resulted in siltation of canal bottoms and loss of their capacity. Moreover, pump stations were stolen, and without them, excess water is not pumped out, which results in flooding of drained areas and their secondary bogging.

4.2.2 Water Supply and Sanitation Systems

4.2.2.1. Drinking Water Supply Systems

Water supply system of Senaki town is comprehensively discussed in the technical report developed under the water safety planning (WSP) component of the INRMW Program. [14]Google map of the system is given in Annex 9.

Water to the settlements, including the target communities, under Senaki and Khobi municipalities, is supplied from the sources existing in the Rioni River Basin. The sources feeding the villages of pilot communities represent river filtrates, natural springs and groundwaters of artesian aquifers. Detailed information on the conditions of water supply systems of the pilot communities can be found in tables 1 and 2, Annex 9.

Pilot villages of the Khobi Municipality and three communities of the Senaki Municipality (Teklati, Zemo Chaladidi and Akhalsopeli) are supplied with water from Poti water supply system.

The villages of the Senaki Municipality receive water mainly from individual wells. Only the villages of Akhalsopeli) and Nosiri are supplied from Senaki water supply system. Community of Menji (Bataria) partially supplied from Senaki Drinking Water Supply System and partially from its own sources (LTD “Menji”).

Headworks. Source water at headworks mainly is abstracted through drilled wells.. However, in villages where there is no water supply system, local population abstracts ground water from individual or neighborhood/common wells.

Headworks are mostly outdated and damaged. The sanitary zones of the headworks are not fenced and protected. A number of water collector/catchment wells are not in satisfactory condition and unprotected, and often, there are no locks and lids to protect the wells.

Many water intake facilities do not have sufficient capacity, which is partially caused by the shortage of water resources, and rather often by poor technical condition of the intake constructions: pipes are old (often asbestos and cement pipes are used); from some of the intake

[14] Both electronic version and harc copy of the report are available at INRMW Program office and GLOWS web-site: http://www.globalwaters.net/publications/

chambers, water is directly supplied to water mains due to absence or bad conditions of collector reservoirs;

Main canals and distribution network. Water mains, internal network and valves/gears are old in the majority of villages. Some of the systems are in need of major rehabilitation/replacement. Time and again, some sections of the network are damaged significantly needing replacement, and there are also many point damages observed. There are villages where the conditions are satisfactory for the time being, these villages are located in areas where the networks were partially rehabilitated. Old networks are laid with steel and sometimes cast iron pipes. Newly replaced pipes are made from steel and PVC. The villages actually do not have storage and regulating tanks that could balance hydraulic regime. In some cases, partial regulation of water supply is performed through valves.

Water consumption. Some of the villages have round the clock water supply. However, most villages are supplied with water 12 hours a day or less, and fairly often, the village population collects water from natural sources and they transported in vessels.

4.2.2.2 Sanitation Systems

Sanitation systems do not exists in rural areas of Khobi and Senaki municipalities, and hence, untreated sewage is directly discharged into rivers and on agricultural plots. Village communities use pit latrines/toilets.

Sewerage system of Senaki City serves merely about 15% of local population. The length of the Senaki internal networks is 6 km and it is connected to the 8 km collector. There is no wastewater treatment facility to treat the sewerage collected by Senaki collector. As a result, this untreated water is discharged into the Techuri River in its downstream area.

4.2.2.3 Drinking Water Use and Sanitation Tariffs

In accordance with Resolution #17 (17 August, 2010) of the Georgian National Energy and Water Supply Regulation Commission on Water Supply Tariffs, consumers with water meters pay 0.423 GEL per m^3 (including the price for sanitation service). The tariff for consumers without water meters is set at 2.03 GEL per capita (including the price for water sanitation service). Organizations (legal entities) pay 3.65 GEL per 1 m^3 of water (for the time being, this rate includes the price for sanitation service).

Presently, tariff mechanisms do not function in the villages of the pilot territory. The change expected to be made in April 2012 to the regulations of the Regulatory Commission of Energy and Water Supply of Georgia envisaged the tariff of 30 tetri per household. However, the changes have not yet been introduced, and the above municipalities do not have any information on the time of its introduction in the near future.

4.2.3 Roads

All target villages under their respective areas are connected to the highway. However, most of the internal roads need repairs despite being either graveled or asphalted, and only a few among the target villages have roads in satisfactory conditions.

4.2.4 Energy

Power supply. Power supply system is built in all villages of target municipalities and function round the clock, with the exception of the Shavgele Village where the power supply grid is built only in some areas of the neighborhood.

Gas supply. Almost none of the target villages have centralized gas supply system, with the exceptions of Sagvamichao, Akhalsopeli, Isula and Mukhuri/Siriachkoni villages. Local population of most of the target communities uses liquid gas, firewood and electric energy as alternative means.

4.3 Waste Management

Bearing in mind that till date waste collection and disposal data of most municipalities were never recorded, the below information is based on experts' approximate assessments. Vast majority of municipalities only provide waste collection service to 30-40% of the local population. Presumably, around 20% of the generated waste gets collected and removed in Khobi and Senaki municipalities. Correspondingly, only the above amount of waste gets recorded. Experts' assessment calculates waste based on the amount generated per capita, and it includes the total size of the municipal population.

Existing legal municipal landfills in Khobi and Senaki municipalities do not meet minimum sanitary and environmental standards. Presently, construction of a new landfill for individual municipalities is not planned since a Solid Waste Management Company has been established under the Ministry of Regional Development and Infrastructure that plans to construct and operate regional landfills. The existing landfills will also be transferred to the company for managing their future operations. At the initial stage, the company plans to establish proper order in the existing (operational) landfills and shut down some of them.

Please refer the map of household waste landfills functioning in Khobi and Senaki municipalities in map 13, Annex 2.

4.3.1 Municipal Solid Waste Management

Khobi Municipality. Based on experts' assessment, approximately 25, 000 m^3/year of waste is generated in Khobi Municipality. However, the Waste Management Department collects and disposes wastes at the operational landfill only in the volume of 4, 500 m^3/year.

Khobi Municipality state company "Cleaning and Lighting of Khobi" Ltd., collects and disposes wastes (personnel includes 65 people). Waste collection, transportation and disposal service is funded from local budget and amounts to about 294,000 GEL, of which 84,000 GEL is spent on the landfill operations and maintenance. Based on the explanations offered by the company management, the service of waste removal is only partially rendered to Khobi town (amounts to 40%). Other communities and villages of the municipality are not provided with the waste collection and disposal service.

Local population of the above villages dump the generated waste onto the territory near populated sites, in the gorges, riverbeds, directly into the rivers or incinerate them in the yards that creates small and illegal piles of litter.

There are two types of solid waste collection system in Khobi Municipality: container and bell. Containers are placed in the streets, and near buildings. There are three types of containers: 150 pieces of 0.25 m^3 plastic containers; 20 pieces of 1.1 m^3 containers with metal covers (both types of containers have automated emptying systems); 80 pieces of 0.05 m^3 containers fixed to streetlight poles. Due to the lack of containers, in some of the city areas, waste is collected through bell system, with open body trucks.

Waste from the high volume containers is removed 3-4 times a week, while small capacity containers, attached to the streetlight poles, get emptied on a daily basis. Presently, the Waste Management Company has one refuse vehicle with the capacity of 22 m^3 and with automated emptying system, and it also has two motor scooters and one tractor with a trailer.

All the above waste transportation means (second-hand ones) were procured in 2007. Presently, they can operate, but are partially depreciated. There is no waste separation/recycling system in the municipality. The only exception is scrap metal that is collected in the scrap metal collecting stations.

Waste collection tariff per capita amounts to 0.5 GEL, the tariff is set different for private companies and other organizations, and defined based on the space, number of staff, number of places to be served, etc. The amount accumulated from waste collection payments totals to 21,600 GEL.

Khobi Municipality has one central landfill that is located 7 km to the south of Khobi. No landfill is located on the territory of the Rioni River Basin.

<u>Senaki Municipality.</u> Approximately 26,000-28,000 m^3/year of waste is generated on the territory of Senaki Municipality. However, the Waste Management Department collects and disposes wastes at the legal municipal landfill merely 5,000 m^3/year.

State company "Senaki Municipality Improvement, Cleaning and Greening Center" (with personnel of 64 people) collects and disposes waste in the municipality. Solid waste collection and removal is funded from local budget and amounts to 170,000 GEL. Based on the explanations offered by the company management, the service of waste removal is only partially rendered to Senaki town (around 30%). Other communities and villages of the municipality are not covered by waste collection and removal service.

Local population of the above villages dump waste in village surroundings, river banks and gorges, directly in the rivers or burn/bury them in their yards.

In Dzveli Senaki, Menji and Nosiri villages, the generated solid waste gets periodically removed to the operational landfill by the cleaning service on as needed basis.

The container system is used for waste collection in Senaki town. Containers are placed in the streets, and near buildings. There are two types of containers: 75 pieces of 0.25 m^3 plastic containers; 100 pieces of 1.1 m^3 containers with metal covers. Waste is removed two times a day. Presently, the Waste Management Company has two refuse vehicles (Mercedes brand) with the capacity of 21 m^3 and with automated emptying system. It also has one open body truck (GAZ 53) with 7 m^3 capacity. Currently, the transportation means are operational, though partially depreciated. There is no waste separation /recycling system in the municipality. The only exception is scrap metal that is collected in the scrap metal collecting stations, and plastic bottles that are collected by the local population in a disorganized manner.

Waste removal tariff per capita amounts to GEL 0.3, the tariff is set different for enterprises and other organizations and is defined based on the space, number of staff, number of places to be served, etc. The amount collected from cleaning service payments totals to GEL 20,000 per year.

Senaki Municipality has one central landfill that is located on the territory near Teklaki Village, 15 km from the city center, and it has been operating since 2008. The landfill does not meet the environmental and sanitary standards. The nearest populated site is 3 km from the landfill and the nearest water body is the Rioni River at a distance of 1.5 km from it. The territory of the landfill covers 13 ha, of which 4 ha is operational. The landfill is not fenced, and it has a water-diversion ditch. Access road is unpaved and covered with gravel. Based on the information provided by the cleaning company, 18,000- 20,000 m^3 waste was placed in the landfill. In order to get the waste compacted, a DT-type or Belarus tractor is used, which the company hires periodically based on demand. The landfill does not have drainage - storm water collection system.

4.3.2. Hazardous and Construction Waste

For the time being, no hazardous waste is registered on the territory of Khobi and Senaki municipalities. As for the construction waste, a small amount is observed, but not registered. The construction waste is re-used as inert materials (to level off the roads and construction sites), while a part of it is transported to the central landfill.

4.3.3. Medical Waste

Khobi Municipality has one hospital that can accommodate 25 patients, and there are outpatient clinics in every community. Based on the explanations provided by the company management, hazardous medical waste is generated in small amounts and it is transported to the central landfill.

There are two hospitals, one polyclinic, two maternity hospitals and outpatient clinics in every community. Based on the 2007 data of the Ministry of Environment on waste inventorization, the amount of medical waste equals to around 1900kg per year, among them 600 kg accounts for hazardous waste. According to the explanation offered by the company management, the hazardous medical waste is transported by a private company in special containers to Kutaisi for disinfection.

5.0 UTILIZATION OF NATURAL RESOURCES AND RELATED ISSUES

5.1 Water Resources

5.1.1 Use of Water Resources

5.1.1.1 Current Water Use Patterns per Economic Sector

Lower Rioni Pilot Watershed Area – Senaki and Khobi municipalities is rich in fresh groundwaters. In this region, these resources are abstracted through drilled wells for drinking, household and industrial uses.

Given that there are no irrigation systems in the pilot area, groundwater is not abstracted for irrigational use. Similarly, due to the absence of hydropower plants, water is not used for hydropower generation.

According to the 2011 data of the Ministry of Environment, there were no registered water abstractions in Khobi Municipality, while there were seven registered water users in Senaki Municipality that abstracted 2, 529, 000 m^3 groundwater in 2011. Out of which, only 1, 773, 700 m^3 was consumed, 1, 763, 500 m^3 by households and 10, 200 m^3 by industries. Water losses during water transmission added up to 754, 000 m^3. Predominantly, groundwater of Tekhuri aquifer was abstracted.

The largest water user was Senaki water supply system, which abstracted 2, 317, 000 m^3 of water. Out of this amount, 176, 200 m^3 was used by population for drinking and other domestic needs and 755, 900 m^3 is lost in the system due to its poor condition.

Based on the above data, we can conclude that there are data completeness and quality issues. Other information sources also suggest that in 2011 and during preceding periods, a number of industrial facilities were not able to submit their water accounting reports to the Ministry of Environment. More specifically, there are many facilities producing construction materials (gravel, brick clay, limestone, etc.) in the municipality together with the food processing industries that are not officially registered by the Ministry of Environment. Industrial facilities currently operational are shown on the map 14, Annex 2.

Unfortunately, there is no official data available on the use of geothermal hot water as well as on rural water supply.

5.1.1.2 Water Use Trends

As aforementioned, water use accounting data is incomplete and in many cases inaccurate. According to this data, water abstractions have tripled since 2002 in the Lower Rioni pilot watershed area. Regardless of the fact that only one water user was registered in 2002 and 7 in 2011, the rise in the water abstraction and consumption occurred as a result of increased water use by Senaki drinking water supply system. Detailed information on water use trends are given in tables 1 and 2, Annex 8.

Keeping in mind the absence of data/presence of very limited data on water uses, it is extremely difficult to estimate water supply-demand balance. However, based on economic development trends, we can still draw general conclusions on this parameter. Due to the further development of Poti free industrial zone, it is expected that the infrastructure will grow in the lower reaches of the Tekhuri and Tsivi rivers. This will result in increased water use for domestic and industrial needs. In addition, the region has high potential for tourism and recreation that may end up with increased water use by these sectors.

Development of rural water supply systems has also a high potential in the region. At the moment, a large majority of villages do not have centralized water supply systems and the population abstracts water from individual wells. This, by itself, is an unsustainable groundwater use practice. However, due to the high capacity of available resources, water shortage is not expected to occur. On the contrary, development of centralized water supply systems will enhance water use efficiency.

Regarding the use of surface waters (Rioni, Tekhuri and Tsiva rivers), it is not planned to develop hydropower and irrigation systems within the pilot watershed area. Therefore, significant increase in surface water abstractions is not expected. In line with this and in accordance with the hydrological modeling of the Lower Rioni courses, (the river runoff will increase by 6% during the period 2021-2050 that will make up 1, 462 million m^3 at the gauging site of Sakochakidze) Lower Pilot Territory will not face the risk of water deficit. Impacts on the climate change on water hydrology are described in more detail in chapter 5.3.1 as well as in Annex 3.

Regardless of all above, planned construction of large hydropower plants in upper and middle courses of the Rioni River Basin may have impacts on river hydrology and hydromorphology, and this should be taken into consideration while estimating water use supply-demand.

5.1.2. Major Problems Related to the Water Quantity and Quality

- *Increase in catastrophic floods and flashfloods that will have major impacts on the local population due to the absence/presence of poor drainage, water supply and river bank revetment structures;*
- *Change in maximum and minimum discharges. More specifically, peak discharge is expected to increase in during floods and minimum discharge to decrease during low waters and droughts. The reason for this is climate change together with deforestation and river bank erosion;*
- *Unsustainable use of groundwater resources due to the absence of centralized water supply systems or presence of poor water supply systems;*
- *Pollution of surface and ground waters from diffused sources of pollution, including agricultural and urban areas polluting water bodies with surface runoff, controlled waste disposal sites and pit toilets arranged in Senaki Municipality due to the absence of centralized sanitation systems, and polluting water bodies with leachates and drained water;*
- *Pollution of surface and ground waters from point sources of pollution, including centralized sewerage system of the city of Senaki that has no wastewater treatment facility, and small to medium-size industrial facilities having little impact on water resources;*
- *Presence of limited monitoring network for water quantity and quality within the Rioni River Basin and its tributaries;*

- *Presence of incomplete and unreliable water use accounting data.*

The aforementioned problems, including their causes, scale and impacts are discussed in detail below.

Water Quantity (hydrology). The pilot watershed area is highly susceptible to floods and flash floods induced by climate change and unequal distribution of atmospheric precipitation as well as by presence of obsolete and damaged drainage systems/absence of such systems, heavy damage of main pipes of water supply systems, pumping stations and levees and dikes. This itself imposes pressures and causes negative impacts on riverine biotopes. Secondary bogging of soils as a result of water losses and leakages in water infrastructure bring about increase in the evaporation of ground water table which has a negative impact on the climate and soils. Damaged levees could not withstand high waters resulting in flooding of villages, infrastructure and other amenities. In addition, riverbed erosion and unequal distribution of sediments are among other probable impacts.

Currently, many segments of river bank reinforcement structures built on the Rioni River are damaged or destroyed that increases the risk of inundation for neighboring territories. The largest unprotected area is located on the left bank of the Rioni River in the vicinity of Siriachkoni Village. In this area, around 600 m long section of the levee is destroyed as a result of gully erosion, and was over flooded several times that resulted in the inundation of the village. For this reason, the local population has abandoned the village. Water from the Rioni River flows into the Pichori River before it flows into the Paliastomi Lake. During the periods of maximum water level in the Black Sea, there is a high risk of flooding the city of Poti.

***Water Quality*.** The majority of pressures on the pilot watershed are of social-economic character. Rapid economic growth, disregarding ecological condition and population growth have contributed immensely to the degradation of natural resources and ecosystems of the Lower Rioni Pilot Watershed Area in the 20th century.

***Point Sources of Pollution*.** In the Lower Rioni Pilot Watershed Area, the main point source of pollution is the sewerage system of the city of Senaki. Wastewater discharges from small-size enterprises and municipal buildings such as hospitals and carwash facilities add to this pressure as well.

According to the 2011 data of the Ministry of Environmental Protection, there were no wastewater discharges into the water bodies of the Rioni River. A total of 1, 415, 380 m^3 untreated wastewater was discharged into the Tekhuri River, of which 99% (1, 410, 000 m^3) was accounted for the sewage discharged from the Senaki sewerage system. The remaining untreated wastewater was discharged by 8 registered entities and amounted to 5, 400 m^3. None of the pollution sources have wastewater treatment facility. Detailed data on wastewater discharges for the Lower Rioni Pilot Watershed Area are given in tables 3 and 4, Annex 8.

It should be noted that official data on wastewater discharges and incomplete and imprecise.

Non-point (diffused) Sources of Pollution. Significant pressure on the water resources of the Lower Rioni Pilot Watershed Area are imposed by diffused sources of pollution, including agricultural and urban surface runoff.

Legal controlled waste disposal (landfills) and illegal waste dumpsites also exert significant pressures on the water resources. In Senaki Municipality, local landfill is located near the village of Tkhiri in close proximity to the river, and it does not meet the minimum health and environmental requirements. The landfill is unfenced, there is no organized drainage system and waste utilization is not carried out. In Khobi Municipality, wastes dumped on the river banks impose major pressures on water resources.

In addition to landfills, pit toilets (latrines) arranged by individual households of the rural communities could be considered significant risk factors for ground and surface water quality.

5.1.3 Drinking Water Supply and Sanitation

Major problems of targeted rural communities of Khobi and Senaki municipalities are related to both water quality (access to safe drinking water) and quantity (water availability).

As described in chapter 4.2.1.1, centralized rural drinking water supply systems located in the areas of targeted communities receive water from urban water supply systems of the cities of Poti and Senaki. Apart from this, the Menji community is partially supplied with drinking water from the centralized drinking water supply system of the LTD “Menji Water Supply System” . People living in villages without centralized water supply systems abstract drinking water from individual wells.

Monitoring of drinking water quality in inadequate in areas where it is carried out. In addition to the absence of disinfection, the obsolescence of water pipes and the presence of pollution sources within the catchments, it can be assumed that water quality does not meet national drinking water quality standards, especially under unfavorable climate conditions.

Technical specifications and current condition of centralized water supply and sanitation systems of selected communities of Lower Rioni Pilot Watershed Area are given in tables 1 and 2 of Annex 9. Table 3 of the same Annex contains the list of villages and problems facing these villages where water availability and quality were named among major issues.

Regarding the sewerage systems, it is only connected to the city of Senaki with a very small coverage rate (15%). Other settlements do not have sanitation systems. The majority of the Senaki sewerage system is outdated and in poor technical condition, there is no wastewater treatment plant and untreated sewage flows directly into the Tekhuri River.

Summarized information on the situation related to drinking water supply, wastewater collection, treatment and discharge in the Lower Rioni Pilot Watershed Area is as follows:

- *Unprotected sanitation zones around drinking water sources pose threats to source water and create significant risk of its pollution;*
- *During heavy rains, headworks of the drinking water supply systems are flooded and pollutants reach the source water. This is caused by improper design of water collection wells and absence of flood protection structures around headworks;*
- *Source water is not treated technologically and chlorinated. Therefore, safety of drinking water is not assured, particularly during heavy rains;*

- *There is a high risk of water pollution at sources as well as within main pipes and internal networks due to obsolete and damaged existing systems;*
- *Majority of rural communities do not have centralized water supply systems;*
- *Due to the poor technical conditions of the infrastructure, water collectors do not operate at the designed capacity;*
- *Water losses in the system are high due to poor conditions of pipes, distribution networks and closing valves;*
- *Owing to the absence of storage or regulating capacities and in certain cases due to the improper design of above structures, optimum hydraulic pressure is not maintained in the system, which leads to inefficient allocation of drinking water among consumers;*
- *Sewerage system exists only in the city of Senaki and it covers only 15% of the population;*
- *The city of Senaki does not have wastewater treatment facility.*

5.1.4 Impacts of the Climate Change on Water Resources

Hydrological modeling of the Rioni River runoff in its lower course from the Gumati HPP to the gauging site of Sakochakidze has predicted an increase of 6% in the water flow by the year 2050. For climate modeling, regional model PRECIS and global model ECHAM4 were used based on A2 and B2 economic development and greenhouse gas emission scenarios. For modeling the change in runoff regime, WEAP was used. In accordance with the modeling results, significant increase in the winter runoff is expected. Runoff increase is also expected during the fall season.

River runoff will decrease during spring and summer seasons that will reduce the risk of floods and flash floods. However, flood risk will remain high, because there will be an increase in the rate of daily precipitation and during rainy periods that will heighten the probability of heavy rains and rain-related flash floods. Unfortunately, it is impossible to forecast floods and flashfloods through application of the WEAP together with glacier accumulation and melting. If we also consider the latter in the equation, the forecast of the river runoff will become more complete and precise.

According to the WEAP, the annual water flow will become 14,163 million m^3 at the Sakochakidze gauging site compared to current and historical high of 12,582 million m^3. Detailed existing information on river runoff, both annual and monthly is given in Annex 4.

Based on the current water use patterns and river runoff as well as river runoff forecasts for the future, water shortage is not expected to occur in the Lower Rioni Pilot Watershed Area until 2050.

River runoff modeling forecasts are described in detail in Annex 3.

5.2 Land Resources

5.2.1 Land Uses

In the Lower Rioni Pilot Watershed Area (Khobi and Senaki municipalities), agriculture is the most important economic sector in terms of contribution to the regional GDP and the number of people employed. The majority of local population is engaged in this sector and its income depends on the level of agriculture development. Regardless of the completion of privatization of agricultural lands, small area plots and subsistence economy are prevalent in the region. On an average, each household in rural areas holds up to 1 ha lot, which is insufficient for agriculture development. There is no agriculture development strategy in Georgia, where local agrobiodiversity could play a significant part. More specifically, 39% of the households in the pilot area own 0.5-1 ha land and 25% own 1-2 ha land. There are large agriculture farms in this area that occupy more than 100 ha each (please refer chart 1, Annex 5). However, their share of the total agricultural lands is insignificant.

Changes in land cover and land use result in changes in land productivity, fauna and flora diversity and biochemical and hydrological cycles. Land use change is the primary reason behind land cover change. Alteration of forest cover contributes significantly to climate change, while overgrazing and other unsustainable agricultural practices lead to land degradation. Therefore, it is of utmost importance to assess both land cover and land use.

5.2.1.1 Land Cover

In order to assess land cover, we have used global data sources such as MODIS (Moderate Resolution Imaging Spectroradiometer). Regardless of the low resolution of this scientific tool, MODIS data was used in assessing the land cover and its temporal changes for the Lower Rioni pilot watershed area.

MODIS 2001, 2007 and 2009 data reveal insignificant changes in the land cover, and the total area of settlements has not changed since 2001. Compared to 2001, the size of agricultural lands increased slightly (by 1679 ha) in 2007. This trend was maintained in 2009. There was an increase in the total area of agricultural lands (arable lands with the mozaics of natural vegetation) by 1,150 ha in comparison with 2007.

Traditionally, forests were cleared for agriculture land use in Lower Rioni pilot area. Total forest cover constituted 32,543 ha in 2009, which is 5,600 ha less than it was in 2001. This change can be also tracked while comparing 2001 and 2007 data. There is virtually no difference between 2007 and 2009 data. Thus, we can conclude that forests were intensively cut prior to 2007. Table 1 in Annex 5 describes MODIS retrieved land cover data in accordance with 17 categories of International Geosphere-biosphere program.

Meadows occupy limited area on the pilot territory. 2001 and 2009 data on the total area of shrubberies is approximately the same, while insignificant change can be observed between 2007 and 2001 data. In 2007, the total area of shrubberies was 22 ha less than it was in 2001.

Significant changes are observed in land cover with savanna high-grass and forest-high grass type vegetation. More specifically, between 2001 and 2007, these areas decreased by 9,467 ha.

Wetlands of Lower Rioni pilot watershed area have high ecological value. On the west of these landscapes, biogenic sediments, including peat, loam clays and clayey sediments of marshy origin are widely spread. In the recent past, peat was extracted for industrial uses in marshes of Imnati and Anaklia sections. This had a detrimental effect on the unique plant associations with high ecological and scientific value.

Land cover of Khobi and Senaki municipalities is given on map 4.a, Annex 5. The map 4.b of the same Annex shows land cover of the Rioni Delta in the Khobi Municipality.

5.2.1.2 Land Use

For the purpose of assessing land uses, we have used land cadastral data, 2006 and 2010 aerial photos, Soviet era topographic maps and data on forest inventory.

As demonstrated by graph 2, Annex 5, in the Lower Rioni pilot watershed area, the largest portions of agricultural lands are occupied by arable lands – 52%, followed by pasture and hay fields – 31% and perennial crop lands – 17%. Table 2 of the Annex 5 shows different categories of land uses, types of agricultural lands and their size, while table 3 illustrates the distribution of perennial crop lands in Senaki and Khobi municipalities. Stemming from the fact that only very small part of Khobi Municipality is located within the lower course of the Rioni River Basin, data of this area is given separately in table 3, Annex 5.

Senaki Municipality is predominantly an agriculture-based region, and Major branches of agriculture practiced in this area are crop production and livestock husbandry. The main crops are corn and soya, and orchardry is also a relatively developed sector. Among perennial crops, the major cultures are citrus, fruits, tea, grapes, subtropical persimmon and kiwi. There is a possibility to restore agriculture lands in abandoned tea plantations.

Khobi Municipality is also an agriculture-based rural region. The local population practices crop production and livestock husbandry. Corn is the major crop of this area. Among perennial crops, citrus, chestnut, laurel and tea are most widespread. In addition, aromatic plants are grown in this area. Arable lands and pastures are utilized to its maximum potential.

Agriculture lands. Around 43% of the total land of the Lower Rioni pilot watershed area is occupied by agricultural lands. Of these, arable lands make up 26.564 ha (around 52% of agricultural lands), perennial crop lands – 8,780 ha, and pastures and hay fields – 16,179 ha. Hazelnut plantations occupy largest areas among perennial crop lands – 3,063.8 ha, followed by tea plantations - 1,164.1 ha; Laurel - 880 ha; citrus – 6 31.7 ha; feijoa or pineapple guava **(***Feijoa sellowiana, synonym to Acca sellowiana***) –** 380.8 ha; apples – 319.3 ha; cherry plum *(Prunus cerasifera)* – 295.4 ha; pear - 271.1 ha; persimmon *(Diospyros)* - 215.4 ha; kiwi – 50.5 ha; bamboo – 50.5 ha; grapes – 15 ha.[15]

In this area, 71% of the total arable lands and 67% of the total perennial crop lands (75% in Khobi Municipality and 53% in Senaki Municipality) are under private ownership.

Arable lands. Major crops grown on arable lands are grains, fruits, vegetables, greens and forage. Large areas of arable lands are used for the cultivation of annual crops. Corn is the

[15] State Statistical Office, 1 January 2009

dominant crop among grains. In addition, animal husbandry is an important agricultural activity in the pilot area.

For the purpose of tracking land use changes, we have compared the data of 1985 and 2009 (refer table 2, Annex 5). Based on this comparison, we can conclude that there were no significant changes in the above parameters during the given period of time. Small variations (within the range of 2-4 thousand ha) can be attributed to the varying precision of different methods used for land use planning and calculating total areas.

Perennial crop lands. Total area of perennial crop lands increased from 1970 to 1990 and subsequently decreased until 2009. In particular, the size of tea plantations has decreased significantly. Likewise, the total area of vineyards fell from 1990 to 2009. Meanwhile, hazelnuts, kiwi and feijoa have been cultivated. At the present time, studying the prospects for tea growing and indentifying the optimum size of tea plantations holds significant importance.

Pastures and hayfields. As aforementioned, pastures occupy 16,179 ha of total land of the Lower Rioni pilot watershed area, which represents around 31% of agricultural lands and 13% of the total land fund of the pilot area.

Livestock husbandry is one of the leading agricultural activities for rural communities. Almost every household has several heads of livestock. Pastures as well as household plots and their surrounding areas are used for livestock grazing. Frequently, territories within the Kolkheti National Park are used for grazing. Livestock from other municipalities is also brought to Lower Rioni pilot watershed area. Mostly, the local population has cattle, buffaloes and pigs, and typically, each family owns 3-4 heads of livestock, which are mainly cattle and pigs.

There are two categories of pastures in the pilot area: i) village pastures, where villagers graze their livestock; ii) commercial pastures, where hired herders graze large-sized herds.

Local people rely heavily on raising livestock and their economic prosperity depends on the size of livestock they maintain. They consider hay production as the only alternative for livestock grazing, and they are used to following this agriculture practice since the old Soviet era, when hay was produced in an organized manner from spring to summer.

The maximum size of commercial herds is 50 heads of cattle. The majority of herders have up to 10 heads of cattle (80%), 10% of herders keep 10-50 heads of livestock and the remaining 10% maintain more than 50 heads of livestock[16].

The location and size of pastures have not changed significantly in the last 20 years. Grazing has been done more or less on same areas. It should be noted that following the disintegration of the Soviet Union, and as a result of the decrease in household incomes as well as various income sources, families have increased the size of their livestock. In some villages, the increase was two-fold.

After the establishment of the Kolkheti National Park (KNP), illegal grazing in this protected land became one of the key environmental issues. The law bans grazing within the boundaries of these protected areas. Currently, the population living in buffer zones of the KNP violates the

[16]Source: 2004 household survey data 2004

law and continues grazing on the park's territory. Even more serious, is the problem of grazing by commercial herders that graze large-sized herds in the rare habitats of the KNP.

Specific issues related to grazing are significant increase in the number of herders, change in livestock raising practices, and burning of peat lands which is a very frequent phenomenon in the pilot watershed area.

Forests. Forests occupy around 32,000 ha in the Khobi and Senaki Municipalities, which constitutes 24.7% of total land[17]. Broad-leafed forests are most widely spread in this region. Roughly 19% of all forests are located in the KNP. Large areas of KNP forests represent Colchic forests.

Energy shortage of the preceding years has resulted in the increased demand for fire wood. Therefore, local inhabitants have destroyed existing forests to meet their needs for heating and cooking. Forests surrounding the settlements are most damaged. Moreover, uncontrolled logging was a common practice in the KNP.

Wetlands. One of the peculiarities of the hydrological network of the Lower Rioni pilot watershed area is wetlands occupying significant areas of the territory. They are found in both Khobi and Senaki municipalities, where they are represented as separate patches. In 1996, the Parliament of Georgia designated Kolkheti wetlands with the status of a Ramsar Site of International Importance.

Kolkheti Protected Areas. Total area of protected areas within the boundaries of Khobi and Senaki makes up 17, 752 ha. It is represented by the KNP, which is divided into Anaklia-Churia, Nabada and Imnati sections. The park consists of unique riverine ecosystems of the Kolkheti Plain, swamp forests, peat bogs and sandy dunes of the coastal area. Detailed information on the KNP is given in chapter 2.6.2. (Please refer map 7, Annex 2).

5.2.2 Major Issues Related to Land Resources

Experts that previously worked under the INRMW Program have identified the following key issues related to land resources:

- **Soil bogging –** Secondary bogging of soils is a widespread phenomenon in the pilot watershed area, and it is attributed to the presence of obsolete and dilapidated drainage systems or the absence of such facilities;
- **Pasture degradation –** This is a consequence of overgrazing within the KNP and in its support zones, which leads to the degradation of habitats and hinders natural regeneration of degraded forests;
- **Delta and coastal zone degradation/erosion –** This phenomenon is caused by both natural and anthropogenic factors. The entire area along the city of Poti is heavily eroded due to the diversion of the Rioni River bed that happened during the Soviet era;
- **Soil pollution** – Soil pollution by agrochemicals, untreated municipal and industrial wastewaters, surface runoff and drain waters from controlled waste disposal sites is one of the major issues in the pilot watershed area;

[17] Source: Land cadastre data

- **Degradation of high ecological value wetlands, including peat bogs –** The reason behind this problem is the implementation of various construction and other economic activities without conducting proper environmental impact assessments, issuing environmental permits and carrying out proper spatial planning. Furthermore, peat bog degradation is primarily caused by uncontrolled peat extraction.

Given below is a detailed description of issues related to land resources, their underlying and root causes, type and scale of impacts.

Major pressures and impacts. Overall, major anthropogenic pressures on land resources of the Lower Rioni pilot watershed area are imposed by agricultural activities (extensive land cultivation, unsustainable pasture management, use of agrochemicals, etc.), infrastructure development, including construction and industrial activities. To serve as an example, the city of Poti and its port imposes significant pressures on land resources. Soils are polluted from storm water runoff, solid household wastes, drained waters from landfills and untreated municipal as well as industrial wastewater discharges. There are a number of industrial facilities of various kinds posing threat to local environment, including land resources.

In addition to the above, significant pressures are imposed on forests and wetlands of the pilot watershed area. Forests are cut intensively and overgrazed by livestock. Alder is cut to be used as construction material and fuel wood, as well as the cane for roofing.

Planned construction of large hydropower plants in the upper and the middle courses of the Rioni River Basin will have an impact on river hydrology and hydromorphology that will intensify coastal and river bank erosion processes.

Lower reaches of the Rioni basin are affected by floods, sea level rise, tectonic subduction of the land, alteration (reduction) of sediment flow and unsustainable use of wetland resources. All these factors have cumulative negative impacts on Rioni delta and coastal zone intensifying erosion processes in these areas.

Soil bogging – Secondary bogging of soils is a widespread phenomenon in the pilot watershed area that is directly induced by inadequate drainage of agricultural lands. Root causes for this issue are lack of state financing and low capacity of drainage users to properly operate and maintain the system.

Though, main drainage canals have been recently rehabilitated, secondary and tertiary channels are still in poor condition and have low efficiency. Large number of drainage systems has stopped functioning, and as a result, the secondary bogging of soil is ongoing in the pilot area. It should be noted that a sizable area of the Kolkheti lowland was drained out for agricultural land use during the Soviet period. There are still areas that have been drained, but have never been used for agricultural land use. These abandoned areas now are covered with secondary shrubberies, grasses and turned into marshy areas due to the rise in groundwater table.

Currently, there are drainage users associations established in the target municipalities located in the pilot watershed area. In Khobi Municipality, large drainage systems, both main canals and internal networks, have been rehabilitated. More specifically, in 2002, the drainage systems of Rioni-Khobi (600 ha) and Rioni-Choloki (630 ha) were rehabilitated.

Pasture degradation - This problem is caused by both natural and anthropogenic pressures. Among natural pressures, it is worth mentioning temporal fluctuation of hydrological regime of surface and ground waters, amounts of precipitation and composition of plant species of the vegetation cover. Among anthropogenic pressures, poor pasture management, including uncontrolled and/or overgrazing is an immediate cause of pasture degradation. The root causes are: absence of economic and regulatory mechanisms for pasture management, breach of the land owner's rights, low public awareness, etc.

Individual patches of humid and swampy alder groves within the KNP and its support zones, together with secondary forests, shrublands, meadows and areas adjacent to peat bogs, are used by local population all year round for grazing cattle and buffalos. There are no precise data available on the amount of livestock and thus, on the grazing loads within the KNP. Former collective farms along the Churia, Tsiva, Tsia and Pichora rivers are currently under private ownership. Grazing takes place in KNP and its buffer zones, because agricultural lands bordering villages of Patara Poti, Sagvamichaao, Sagvichio, and Zemo Chaladidi are located on the right bank of the Rioni river, which are basically used as arable and perennial crop lands.

Local inhabitants of the villages of Shavi Gele, Siriachkoni, Sakorkio, etc. located on the left-side of the Rioni River graze their livestock on the territory of KNP along the left bank of the river.

Grazing in the national park is illegal and has negative impact on the natural regeneration of forests of the strict protection and managed zones. Livestock destructs saplings while grazing.

There are a number of barriers for proper control and regulations of grazing practices and patterns. Grazing is considered sustainable only if the carrying capacity of the pasture/meadow is taken into account and local biodiversity is maintained.

From time to time (in early spring before vegetation season starts or in late fall) people burn vegetation cover. According to local people, fires in the pilot area are caused by: i) burning of peat bogs by herders with the notion that better grass will grow in place of the old grass; ii) burning of grass by hunters. Such periodic artificial fires impose negative pressures on swamp vegetation, nesting birds and reptiles. Unfortunately, proper studies on this area have not been conducted until now.

Cattle move freely on almost every territory of the lowland. Around 70% of local households heavily depend on state-owned lands for grazing their livestock. This uncontrolled grazing significantly damages important habitats. Moreover, around 68% of local people living on the park's territory claim that they use the protected lands for pasturing, hunting and fishing. Abandoned tea plantations as well as community farm lands are also used for livestock grazing.

Soil pollution – This is one of the major environmental issues facing the downstream areas of the Rioni River. Unfortunately, there is no soil quality monitoring data to determine the type and the level of pollution. Nevertheless, based on the economic development trends and the existing pressures on land resources, we can conclude that there are certain amount pressures imposed on agriculture lands from anthropogenic activities.

During Soviet era, land resources were heavily polluted by agricultural chemicals. This pattern continues to exist even today, though to a lesser extent due to decreased agricultural activities compared to those during the Soviet period. Currently, in Samegrelo, to fight against American butterflies, pesticides are used extensively that poses threats to land resources. Around 42% of small farm holders widely use pesticides and other agrochemicals, and the same could be said about Nitrogen fertilizers. Pollution of land resources by agrochemicals is considered as one of the underlying causes for environmental degradation, and around 11% of coastal zone population supports this notion.

Another important source of soil pollution is untreated sewage or industrial wastewater flowing into storm water drainage canals or directly on the land surface. This may lead to land pollution from nitrates, ammonia, heavy metals, microbial organisms and other parasites. It is noteworthy that the absolute majority of villages do not have centralized sewerage systems.

Soils are also polluted from storm waters drained from existing legal and illegal waste disposal sites as well as from operational and abandoned open pit mines. Municipal landfill located near the Poti City is dilapidated. It is 7-km from Poti, located in the north-west of the city, on the bank of the Rioni River. It is unfenced, without a drainage system, and does not meet the minimum sanitary requirement. Therefore, during rains, storm waters from the landfill drain directly into the river. Groundwater table is high and reaches the soil surface that increases the probability for its contamination.

Regarding the soil pollution from hazardous wastes, up to 20 pits were found with underground tanks half-filled with hazardous or other toxic substances and bearing warning labels. It can be assumed that this practice was widely used in the Lower Rioni pilot watershed area.

During heavy rains in KNP, peat bogs and swaps are flooded that causes pollution of wetlands from chemical and biogenic substances. Specific studies on chemical and biological contamination of the wetlands have not been carried out.

Land degradation from intensive land cultivation – The Local population is primarily engaged in livestock husbandry and crop production and utilizes agricultural lands to its maximum potential. Large areas of agricultural lands are used for growing annual and perennial crops. People produce agricultural output for both, its own consumption and subsistence income generation. Among grains, corn is the most important crop, and among perennial plantations, citruses, hazelnut, laurel and tea are most widely grown. Around a third of the pilot watershed area, including the lowland and foothills, were transformed in the past due to drying of wetlands. Since then, intensive agricultural and other human activities have been imposing significant pressures on the cultural landscapes.

Degradation of valuable wetlands as a result of construction and other industrial activities – One of the major anthropogenic factors imposing negative pressures on natural wetlands of the lower Rioni pilot watershed area is the economic activity involving extraction of peat used as mineral-organic fertilizer. This activity started from the 1930s, when peat was extensively extracted from Anaklia, Nabada and Imnati sections of Kolkheti wetlands. Peat layer in these areas is located 3-6 m below sea level. Due to the exploration, middle and low layers of the peat bog stratum decomposes/rots resulting in the creation of a significant chemical and organic pollution source and loss of natural ecosystems.

In 1990s, peat extraction stopped due to the post-Soviet economic crisis. However, the revival of this economic activity is observed currently. Local and foreign investors are interested in peat extraction from the central part of the Imnati peat bog. Local authorities and communities support this idea and consider peat extraction as one of the major source for their employment and income generation. However, peat reserves are exhaustible and cannot be considered as the main economic direction in the long-term perspective.

Peat bog cultivation for peat extraction will lead to degradation and loss of wetland ecosystems, change in ecological parameters of the Paliastomi Lake and its wetlands, increase in flood risk and decomposition/rotting of peat stratum.

Delta and coastal washout/erosion – this issue is caused by both natural and anthropogenic factors. Among natural factors, natural disasters such as floods and flash floods, tectonic subduction of the land, sea level rise and increase in the frequency of strong sea surges contribute to the delta and coastal zone washout/erosion. Among anthropogenic factors, river diversion, construction and operation of large regulating HPPs at the upper and middle courses of the Rioni River Basin, deforestation, uncontrolled extraction of sand and gravel from river beds and floodplains, construction and improper maintenance of flood control structures contribute to the problem. Absence of spatial planning can also be considered as one of the factors for delta and coastal erosion.

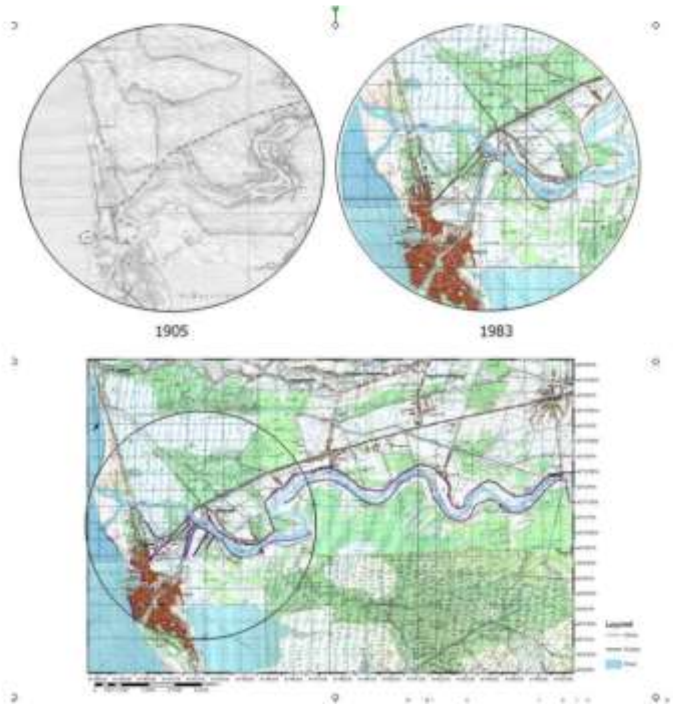
Extreme hydrometeorological events such as floods and flash floods pose significant threats to the land resources of the lower Rioni pilot watershed area. This area falls under the extreme flood risk zone, with particularly vulnerable areas being Rioni delta and Black Sea coastal line. Economic damage from these natural disasters are high and includes destruction of private properties, infrastructure, ecosystems and natural resources, including land resources (e.g. agricultural lands). Such extreme vulnerability of the Rioni delta and coastal line is also caused by tectonic sinking, river and coastal erosion, climate change and change in river regime.

The majority of the land of the coastal zone is 5 m below sea level and therefore, frequently inundated. During last two centuries, the frequency and the intensity of floods have increased. Strong floods occur once in every 10-15 years in the lower course of the Rioni River. This is caused by deforestation and consequent change in river runoff as well as by restricting free flow of water in the river bed due to the construction of dams and levees that lead to the destruction of flood control structures and flooding of areas adjacent to the river banks.

Kolkheti wetlands are significant natural mechanisms for flood control. They absorb large amounts of surface waters and reduce flooding of land areas as well as land erosion processes. However, transformation of these ecosystems to agricultural or other lands and their degradation reduce the wetlands flood retention capacity.

In contrary to the tectonic subduction of the land, there is a continuous process of accumulation of moraine sediments in the Rioni delta. This causes filling in and decrease in flood carrying capacity of the river bed. Thus, during floods, settlements located in the Rioni delta and coastal zone are heavily inundated. These areas are: Patara Poti, Chaladidi, Sabokuchao, Sagvamichao, Sakorkio and Sachochuo. Construction of large-sized regulating HPPs and dams has resulted in the reduction of sediment flow and ultimately, the accumulation of delta sediments. Frequency and intensiveness of sea surges increased as a result of climate change that adds to this problem. Delta and coastal zone erosion and loss at a high degree are predetermined by the diversion of the Rioni River bed. More specifically, the city of Poti was built on the river delta. In 1939, the river bed was diverted to the north by cutting a new canal in order to avoid regular flooding of the city. This caused erosion of the old delta. Ultimately, feeding of the old river branch (so-called South canal) with sediment has stopped, while it has increased in the new branch (so-called North canal) leading to the sediment accumulation, expansion of the river bank and the creation of a new delta named as Nabada delta. In 1959, construction works on installation of regulating sluices were completed. They are designed to distribute water (and sediment) through both Rioni branches in a controlled way. Past (left) and present (right) location of the Rioni River in its extreme downstream is given below on figure 1. (Tamar Tsamalashvili, 2010).[18]

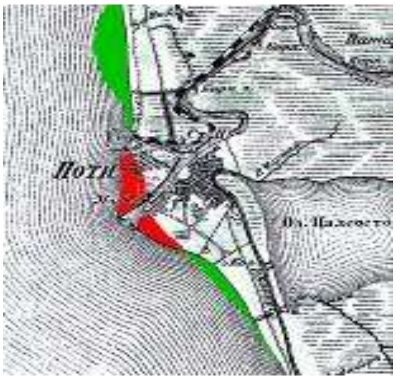
Figure 1. Past (Left) and Present (Right) Location of the Rioni River in its Extreme Downstream



As a result, over time, the sediment flow took a direction towards the South branch, though the erosion process did not stop. Current rate of river bank and coastal erosion is 8 m/sec. Figure 2. depicts the sections of the coast line with extensive coastal erosion and sediment accumulation. Red color indicates eroded areas and green color signifies areas with sediment accumulation.

[18] Flood risk assessment and mitigation measure for Rioni River, September, 2010. Tamar Tsamalashvili, MSc Thesis. Univerity of Twente. http://drm.cenn.org/Local_Case_studies/Flood%20risk%20assessment%20and%20mitigation%20measures%20%20for%20%20the%20%20Rioni%20River.pdf

Figure 2. Heavily Eroded Sections of the Coast Line (1906-1980)



River bank protection structures (dikes and dams) were constructed during the period from 1920 to 1938 for regulating water flow along the Rioni River. Protective dams spanning 60 kilometers pass along the river banks, representing 2-6 m high embankments made from clays, loams and silty sands. They were constructed on both side of the Rioni River to withstand peak discharges below 3,500 m^3/sec.[19]

Since 1930s, a number of measures have been carried out to protect agricultural lands from floods. The situation deteriorated in 1990s, when repair and maintenance of channels and other flood control structures were halted due to the post-Soviet economic crisis. At present, due to inadequate operations and maintenance of the flood control infrastructure, existing canals, dams and dikes are dilapidated and cannot withstand even average floods. Unrestricted access to floodplains and intensive cattle grazing in these areas has led to the damage and the destruction of dikes.

On 26-27 October, 2003, due to heavy rains, the peak discharge increased up to 2100 m^3/s. As a result, water breached the left embankment of the river and flooded the villages of Sagvichio, Chaladidi, Sakhorcio and Shavi Grele (NEA, unpublished data). Till date, this section of the embankment has not been rebuilt, and if ever the water discharge rate gets over 2,100 m^3/s, the southern section of the given area may be inundated. Figure 3. represents the current location of dikes and their damaged/destroyed section.

Figure 3. Current Location of Dikes and Destroyed Segments

[19] http://drm.cenn.org/Local_Case_studies/Flood%20risk%20assessment%20and%20mitigation%20measures%20%20for%20%20the%20%20Rioni%20River.pdf

Absence of land use planning as well as development of any area without proper environmental safeguards leads to uncontrolled spread of settlements and construction of infrastructure, destruction of unique natural ecosystems, loss of habitats, species corridors, etc. Uncontrolled construction activities takes place in floodplains and beaches that increase the risk of flood damages.

5.3. Forest Resources

5.3.1 Use of Forest Resources

Similar to other regions of Georgia, the condition of forests in the Lower Rioni pilot watershed area is poor. Vast majority of ecosystems in this area is significantly transformed and degraded, particularly near roads and settlements. Over the centuries, local communities have used wood for fire and for various construction activities. However, the efficiency of fuel wood utilization was extremely low. In the past century, commercial logging operations were taking place simultaneously that negatively affected forests. During the energy crisis of 1990s, extreme pressures were imposed on forest ecosystems. As a result, average density of forests all over Georgia, including the given pilot watershed area, dropped to 0.55. More than half of the country's forests has the density of less than 0.55 and is seriously degraded.

In the pilot watershed area, timber is produced to be used as fuel wood and construction material. In addition, significant amount of wood cutting is carried out to clear the area for land development, on the basis of construction projects approved by the Government of Georgia.

Commercial logging is carried out based on specific long-term licenses. Wood cutting for fuel wood is carried out on existing fuel needs in specially allocated forest land lots. No specific use licenses are issued for commercial logging in the Lower Rioni pilot watershed area.

For the purpose of supplying the local population with fuel wood, forest land areas near roads and settlements are allocated in advance. Wood cutting is carried out by the direct consumer under the supervision of local forester/ranger based on special tickets. Problems arise when logged wood does not coincide with the volume indicated in the tickets.

In the traditional use zone of the KNP where fire wood harvesting is a major activity, based on existing regulations, it is allowed to produce 9, 400 m^3 annually. This amount is used to meet fuel wood demands of the local population.

Forests located on the territory of Senaki Municipality are mostly former collective forests (roughly 96.4%), which are distributed between settlements or adjacent to settlements. Over the centuries, the local population extracted timber as a fuel wood and construction material. In most cases, local practices were unsustainable that resulted in forest degradation in terms of reduction of its density and species composition. The majority of forest groves has low productivity and is represented by young trees. High quality trees are only found in remote areas with difficult access.

Chestnut stocks found in the forests of the Lower Rioni pilot watershed area severely depleted by a fungal disease, *Endothea parasitica*. In recent years, massive dying of box trees has been observed caused by fungal disease unknown to Georgia until now.

Stemming from the above, no commercial logging is carried out in Senaki Municipality, and the local population uses timber produced in neighboring municipalities. Some percentage of the fuel wood is produced in municipalities outside Lower Rioni pilot watershed area. Precautionary measures should be undertaken to protect vulnerable forests from further degradation. In general, forest protection and maintenance measures should be carried out. Fuel wood can be produced using selective timber harvesting (sanitary cuts, collection of wood chips, restoration of forest stands, etc.).

In the forests of Senaki Municipality, it is only possible to harvest up to 3,000 m^3 of timber. However, average fuel wood demand is more than 25 m^3 annually. Therefore, fuel demand is generally met through timber harvesting in traditional use zone of the Kolkheti National Park. Currently, natural gas supply pipes are being laid in the villages of the pilot watershed area. So far, only 250 families are connected to the system in Senaki Municipality.

5.3.2 Major Issues Identified in the Field of Forest Management

- *Deterioration of the overall condition of high conservation value forests and their adjacent lands. Intensive wood cutting has resulting in severe degradation of individual forest groves;*
- *Unsustainable timber harvesting practices – cutting of young tree stands, logging on steep slopes in low density groves. Fuel wood is mostly harvested in forests adjacent to roads;*
- *Absence of common forest management policy/strategy, forest inventory and monitoring system and functional zoning. Presence of poor forest legislation and weak law enforcement capacities;*
- *Absence of forest restoration measures;*
- *Absence of accurate data on the demand for timber;*
- *Fuel wood utilization at low efficiency – part of the timber harvested is left in the forests, fuel wood is burnt in low-efficient stoves, houses are uninsulated and wood waste is not utilized.*

Given below is detailed description of issues related to forest resources, their underlying and root causes, type and scale of impacts.

Deterioration of overall condition of high conservation value forests and their adjacent lands is a serious problem in the Lower Rioni pilot watershed area. The underlying reason behind this is extensive timber harvesting for fuel wood. By the end of the 20th century, as a result of severe energy shortage, wood became the only source of energy to meet domestic heating and cooking needs. This resulted in the severe degradation of individual massifs of forests represented by almost virgin forest ecosystems. Currently, these forests are transformed into secondary forests, shrubberies and meadows. It is noteworthy that clearcutting of forests was a dominant practice in the forestry management unit of Kolkheti lowland that negatively affected humid and swampy forests and their biodiversity. Habitat loss and fragmentation is persistent problem in the pilot watershed area that is predominantly caused by agricultural activities fire wood harvesting.

Natural regeneration of forests occurs only when forest cutting rules are observed. As a result of uncontrolled livestock grazing and exposing the forests to other human activities, secondary forests, shrubberies and grass understories are developed. Saplings are destructed by livestock during grazing.

Currently there is no common forest management policy, proper legislation, including laws and sub-laws, standards and norms. Forest inventory and monitoring, together with forest maintenance and restoration measures are not carried out. Precise demand of timber and its derivatives, including wood and its by-products are not determined. Around 80-90% of energy used for heating and cooking is fire wood, and thus, illegal and uncontrolled timber harvesting exceeds the loads approved by the government. To make things worse, law enforcement is inadequate.

At present, both, wood harvesting and its use are inefficient. More specifically, a significant percentage of the wood logs are left behind in the forests, timber is not dried well enough and raw wood is burnt, high efficient wood stoves are not used and residential as well as public buildings are not insulated properly. Furthermore, there is no utilization of wood wastes and other alternative sources of energy, including solar energy and biogas.

Unsustainable timber harvesting practices are a significant problem in the pilot watershed area. Minimum environmental requirements are not met during logging operations. Harvesting occurs in low density forests as well as in forest groves located on steep slopes. Young tree stands are clear cut, particularly near roads and villages, roads are constructed without taking forest protection issues into consideration.

As aforementioned, the exact local demand for timber has not been determined. Population meets it needs through legal and illegal timber harvesting, which has a significant impact on the overall energy balance of Georgia. Other sources of energy are unavailable to the local population due to low exposure of technological resources and its high price.

Under such circumstances, local population harvests timber illegally, mostly near roads and settlements, and a result, these areas undergo serious stresses and become severely degraded. Forest density in the affected forest groves drops below the critical threshold that leads to soil degradation and erosion.

In general, utilization of wood for fire causes two important negative results: 1. 50% of timber is composed of carbon, and as a result of combustion, it releases carbon dioxide into the air, a major greenhouse gas. Simultaneously, the amount of forests is reduced which is a significant carbon sink; 2. As a result of deforestation and consequent soil erosion, soil fertility is reduced, agricultural lands are transformed into degraded lands, rivers and lakes are filled with sediments. All these bring about significant economic loss to the country.

5.4 Biodiversity

5.4.1 Utilization of Biodiversity

Grazing: Forests, shrublands and grass lands of Kolkheti wetlands are extensively used for cattle grazing that pose high negative pressures on wetland ecosystems and their biodiversity. This issue is discussed in detail in the land resources section above.

Fishing: In natural water bodies of the Lower Rioni pilot watershed area, mullet (*Mugilauratus*) and Zander (*Stizostedion lucioperca)* are commercially harvested. Fishing is a major source of income generation for a significant portion of local population living in support zones of the Kolkheti National Park. Fishing is carried out on the Paliastomi Lake, in Pichori and Chria rivers and their tributaries. Sustainable use of fish resources is only possible through proper fisheries management and strong monitoring.

Timber harvesting for fuel wood: During the past two centuries, high commercial value trees harvested in excessive volumes were replaced by fast-growing species with low commercial value that mainly consisted of Adler. For this reason, Kolkheti forests are dominated by Alder trees. It should be noted that timber production in humid forests requires high amount of physical labor. Species such as oak, Tilia *(Tilia caucasica Rupr*), maple, ash tree, European hornbeam, beech, box tree, wingnut, etc. that have high commercial value are endangered and thus, many of them are included in the Georgian "Red List."Consequently, harvesting of these species is banned. In the KNP, they represent small isolated islands of tree groves or are come across as individual trees from place to place.

According to Georgian Legislation, timber harvesting is only allowed for the production of fuel wood in traditional use zone of the KNP.

Peat extraction: Peat extraction has been carried out since the 1930s. The targeted peat bogs were of Anaklia, Nabada, Maltakva, Imnati and Grigoleti sections characterized by unfavorable hydrogeologic conditions. Namely, the peat layer in these sections is located 3-6 m below sea level. As a result, small lakes with contaminated water have emerged in these areas of peat extraction and wetland ecosystems are totally deteriorated.

Land uses: Article 46 of the Law on the Establishment and Management of Kolkheti Protected Areas, and land use regime defined by articles 13-18 of the same Law, is not applied to the areas that were leased to individuals (physical persons) or organizations (legal entities) before adoption of the bill. In accordance with the KNP management plan, the area leased to the companies "Lesa" (41.3 ha) and "Patara Ashenati" (6.4 ha) are land plots where restrictive land use regime is not effective. Both are located in the Imnati section of the KNP. In addition, similar types of lands are located on meadows and shrubbery-meadow of the forests in the middle course of the Pichori River[20]. Land leased to the companies "Tsiplnari" (47.1 ha) and "Tskava" (3.4 ha) belong to the above areas.

5.4.2 Major Issues identified in the Field of Biodiversity

- *Degradation, fragmentation and loss of habitats/ecosystems. The reasons for these issues are unsustainable land and natural resource use practices, extensive economic activities and natural disasters. Specific factors/pressures are as follows:*
  - *Timber harvesting to produce fire wood - these activities has resulted in severe degradation of separate forest groves in the Kolkheti Lowland;*

[20] Pichori River does not belong to the water bodies of the Rioni River Basin

- *New infrastructure and economic development projects - these projects are frequently implemented without any consideration/with poor consideration of environmental factors;*
- *Uncontrolled fishing and hunting - these activities lead to the loss of the local fauna;*
- *Uncontrolled grazing - this process negatively affects the natural regeneration of degraded forest ecosystems;*
- *Excessive peat extraction - results in full-scale degradation of peat bogs in areas conducting this economic activity;*
- *Natural and man-made fires have negative impacts on wetland ecosystems, including vegetation cover, nesting birds and reptiles;*
- *Depletion of natural resources;*
- *Pollution of local ecosystems;*
- *Loss of native species and transformation of local ecosystems due to introduction of invasive species.*

Major issues identified in the area of biodiversity, their underlying and root causes, type and scale of impacts are given below.

Degradation, fragmentation and loss of habitats/ecosystems – This issue is caused by human activities such as drying of wetland through land drainage, river diversion, cutting of humid and swampy forests, peat extraction, uncontrolled fishing, uncontrolled hunting of migratory and winter birds as well as other wild animals, polluting natural water bodies, extraction of construction materials from the surfaces of sandy dunes, construction of hydro-engineering structures, establishment of forest plantations and artificial fires on peat bogs. Among natural factors, floods and flash floods cause degradation of local ecosystems.

Timber harvesting for fuel wood production: this issue has been discussed thoroughly in the land and forest resource sections above.

Peat extraction: During the last two centuries, northern section of the Anaklia bog, extreme southern sections of Nabada and Imnati bogs, the largest area of Maltakhva bog and northern section of Grigoleti bog were used as mines for peat extraction, which resulted in full-scale degradation of wetland ecosystems of these areas. Peat layer in these bogs varies from 4 to 6 m deep. Extraction operations were carried out at a depth 2 m. As a result, middle and lower sections of the peat layers have started decomposing leading to the emergence of serious sources of chemical and organic pollution of the natural systems. Polluted water from these areas gets into wetlands, rivers, lakes and the sea.

Wetland lakes in the Kolkheti lowland undergo eutrophication as a result of inflow of transit rivers (Rioni, Pichori, Khobistskali, Tsiva, etc.) that discharge various chemical pollutants and biogenic substances (phosphorus and nitrogen) from the upstream areas of these rivers, resulting in the depletion of oxygen in swamps and consequently reduction and loss of aquatic biota.

Floods and flash floods: during last two centuries, the frequency of strong floods has increased significantly and occurs once in every 10-15 year. These events pose direct threats to natural ecosystems and represent the underlying causes of ecosystem/habitat degradation. Root causes for this issue include deforestation and consequent change in hydrological regime as well as river regulation and river bed change.

KNP wetlands have high flood control capacity of absorbing surface waters and reducing water-induced erosion. At the same time, water level in the rivers is decreased due to the flow of flood water into the wetlands that significantly reduces the risks of river overflow in new sections of the river bed.

Catastrophic floods on the Rioni River frequently cause inundation of many sections of the KNP. In many cases, this causes destruction of habitats/loss of mammals (wild boar, roe deer, etc.), reptiles and nesting birds (e.g. pheasant). However, floods also have positive impacts on the Kolkheti wetlands. Floods in the past carried large quantities of sediments that were deposited on the lowland and coastal bank, which in some way compensated the tectonic sinking of the land that occurs at an average rate of 1 mm annually.

Kolkheti lowland is located almost at the sea level and at certain places below. Therefore, floods that carry high volumes of inert materials play a significant role in the creation of the coastal line.

Artificial fires: Occasionally (early spring, before vegetation or late fall) people burn wetland vegetation. This is done by herders or by hunters that leads to the destruction of natural, semi-natural and cultural landscapes, habitats for nesting birds and reptiles as well as to the death of species. Serious researches on this issue have never been conducted.

New infrastructure and economic development projects: Kulevi Oil Terminal, located at the mouth of the Khobistskali River, has negative impacts on KNP. For the purpose of conducting construction activities, 96.43 ha of wetland area was granted to the investor. Out of which, 9.35 ha was forested land of the Khobi Forest management 27^{th} parcel that later became a part of the KNP. Railroad tracks leading to the Oil terminal passes sandy dunes, 4 km long section of these tracks were a part of the KNP. These ecosystems were known for its rare plant species and their associations that were completely destroyed during construction works. The road to the terminal required the cutting of 2 km long, 200 m wide and 18 m deep canal in the underwater slope of the coastal zone. This section belonged to the marine aquatory of the KNP and the canal carved underwater may cause change in hydrobiological and hydrochemical parameters of the marine ecosystems.

Construction of Kulevi Oil Terminal led to the change in ecological characteristics of the several areas of Nabada, and Anaklia-Churia sections of Kolkheti wetlands. These changes may intensify further as a result of full-scale operations of the Kulevi infrastructure.

Regardless of the multiple violations of the Ramsar Convention that was followed by a special mission of Convention Secretariat to Georgia and their findings, the issue of compensation is yet to be resolved.

Depletion of natural resources – In the 1990s, wood cutting for meeting cooking and heating needs of local people intensified, which negatively affected the forest ecosystems. During 1997-2001, roughly 8.6% of illegal logging was accounted to the wood cuts in areas adjacent to the KNP (Sugdidi, Khobi and Senaki municipalities and the city of Poti), which is a fairly high indicator. Throughout Soviet times, clearcutting was a common practice in Forestry Management branch/unit of the Kolkheti lowland that negatively affected the forest ecosystems of Kolkheti wetlands.

Over several years, uncontrolled fishing has been commonly practiced in inland, coastal and marine waters of the KNP (Black Sea coastal and marine waters, Paliastomi Lake, Churia, Pichori, Dedabera, Tsiva, Rioni, etc.). Rare and endangered species inhabiting these waters, include Atlantic sturgeon (Acipenser sturio), Black Sea sturgeon (Acipenser colchicus Marti), Stellate or Russian sturgeon (Acipenser stellatus Pallas), fringebarbel or ship sturgeon (Acipenser nudiventris lovetzky) and Black Sea or brown trout (Salmo Fario morpha labrax/Salmo trutta labrax).

Uncontrolled fishing activities are also conducted outside the KNP. In 1975, with a purpose to maintain the population of Atlantic sturgeon, fishing was completely banned in the coastal waters of the Black Sea from Poti to Ochamchira (5 miles). However, commercial fishing on European anchovy *(Engraulis encrasicolus)* was allowed, which made the measures to protect sturgeon populations completely ineffective, since with catching of the anchovy it was very easy to catch young individuals of sturgeon.

In 1980, fishing in the Paliastomi Lake was banned, but the ban was hardly observed and fishing continues till date. Mainly, zander *(Sander lucioperca, syn. Stizostedion lucioperca)* and mullet are harvested. Fishing is most extensively carried out in the Maltakhva Canal that connects the Paliastomi Lake with the Black Sea, which poses threats to migratory fishes (same as anadromous fish). As a result, the size and the quality of the fish population have declined significantly.

Over the years, illegal hunting was a serious problem in the KNP and its surroundings. The hunted species included wild duck, greylag goose *(Anser anser)*, Greater White-fronted Goose (*Anser albifrons*), quail, roe deer, wild boar, etc. Hunting is very extensive during spring and fall seasons which are bird migration periods. In winter, wintering animals and birds are hunted.

Overgrazing and uncontrolled grazing negatively affects the natural regeneration of degraded forests. Detailed analysis of this topic is given in land and forest resources section above.

Since 2007, extraction of sand and gravel from rivers are not subject to environmental impact assessment and permitting. This type of mining is very extensive in Rioni downstream areas as well as delta and has irreversible impacts on the habitats and aquatic species.

Ecosystem pollution – This is caused by both natural and anthropogenic factors.

During heavy floods, large areas of KNP wetlands are inundated. Flood waters bring chemical and biogenic pollutants to the wetland ecosystems. However, there is no data available on chemical and hydrochemical composition of the wetlands. Moreover, wetlands and aquatic ecosystems, including sandy dunes are polluted as a result of peat extraction, solid and medical wastes washed out from the Black Sea to the mouths of Churia, Khobistskali and Rioni rivers.

Terrestrial and aquatic ecosystems are also polluted from urban and agriculture runoff, discharges of untreated household and industrial wastewaters, storm waters drained from legal landfills and waste dumpsites. The underlying reasons are: absence of sanitation systems in rural or urban areas, absence of wastewater treatment facilities, poor sanitary conditions of existing landfills, inadequate drainage of agricultural lands and storm waters, unsustainable use of mineral fertilizers and agrochemicals, etc. The root causes are: lack of finances, low capacity to properly operate and maintain existing infrastructure, application of unsustainable agricultural practices, absence of proper wastewater and waste management legislation, poor law enforcement and low environmental awareness among general public.

Loss of native species and transformation of local ecosystems due to the introduction of invasive species – in 1932, nutria (*Myocastor coypus*) was introduced in the KNP. Since then, nutria populations have been growing in size and distribution. At present, small-sized populations of this invasive species is found in the western section of Imnati swamp in the surroundings of the Imnati Lake. Among other invasive/alien species, gambusia or mosquitofish (*Gambusia alfinus*) was introduced in the Kolkheti wetlands to fight against malaria.

In recent years, parasite insect North American Butterfly was introduced that has become a serious problem for local farmers.

5.5 Waste Management

5.5.1 Major Issues Identified in the Field of Waste Management

- *Presence of legal and illegal waste disposal sites not meeting the minimum sanitary and environmental requirements.*
- *Presence of poor household solid waste collection, transportation and disposal system.*
- *Absence of waste recycling and processing capacities.*

Issues in the field of waste management, their underlying and root causes as well as scale and impacts are described in detail below.

Presence of legal and illegal waste disposal sites not meeting the minimum sanitary and environmental requirements – The majority of the municipal landfills was built during Soviet era. They are located very close to settlements and rivers. None of them meet the minimum environmental and sanitary standards. More specifically, existing legal landfills are not fenced and freely accessible to people and domestic animals, they do not have impermeable layer to prevent leaching of toxic chemicals into the groundwaters and there are no drainage systems to collect storm water runoff and no on-site disinfection facilities. Accidental fires are also frequent that cause emission of PoPs by-products (dioxins and furans) into the air, hazardous wastes are mixed with solid household wastes that include medical wastes, used batteries, accumulators, capacitors, materials contaminated with oil products, etc. Thus, existing landfills represent serious threats to ambient environment. Root causes for the presence of unsanitary landfills and illegal dumpsites are: lack of finances and capacities to construct new, modern landfills or to properly operate and maintain existing ones; the absence of appropriate waste management legal-regulatory frameworks; poor law enforcement; low environmental consciousness of the general public.

More specifically, Senaki Municipal Landfill is not fenced, it does not have protective layer and drainage system, and wastes are not covered with soil. Accidental fires occur very frequently in this area.

Khobi Municipal Landfill is located outside the Rioni River Basin and thus, does not have any impact on the waters of the river.

Presence of poor household solid waste collection, transportation and disposal system - none of the villages is covered by waste collection service. They bury their wastes into the ground or dump them in ravines and river banks. Waste collection systems are only established in urban areas and roughly 30-40% of population is not covered by waste collection services. Tariff system for waste collection and disposal is ineffective. Municipal services lack proper infrastructure, including waste containers and waste collection and transportation means. Environmental consciousness of the local population is very low as well.

6.0 SETTING PRIORITIES FOR THE LOWER RIONI PILOT WATERSHED AREA

6.1 Major Functions of Ecosystems and Natural Resources and Links between the Use of Natural Resources and Functions of Ecosystems/State of Environment

Ecosystems of Rioni delta and coastline have high ecological value due to their complexity, vulnerability to various natural and anthropogenic pressures, species richness, level of endemism as well as rareness and relictness. Large area of the KNP is located in the Lower Rioni pilot watershed area. Wetlands play a significant part in water purification, regulation of the groundwater table, flood and erosion control. However, Rioni delta and coastal zone are significantly transformed due to urban development and draining of wetlands to use them for agricultural or other types of economic activities. Only a small area of unique swamps and marshes is maintained as natural ecosystems and designated special protection status. Nevertheless, high anthropogenic pressures are still imposed on such ecosystems located in the KNP and in its buffer zones, in the form of uncontrolled timber harvesting, overgrazing, unsustainable fishing and hunting, etc.

The Lower Rioni pilot watershed area is rich in fresh and brackish surface waters, which are not utilized for irrigation purpose. Hydropower potential of the waters of lower courses of the Rioni basin is also very low. Tthe Tekhuri River has higher potential than other transitory or local rivers of pilot watershed area.

Among mineral resources, ground and thermal hot waters are abundant in the Lower Rioni pilot watershed area that is underutilized. Groundwater is used for drinking and other household needs, while thermal hot waters are only utilized in green houses. Sand and gravel as well as brick clay and limestone is extracted for construction activities. Rioni delta is used for light-cargo ship navigation. Local population utilizes timber and non-timber (mushrooms, berries, medicinal plants, etc.) resources, peat and land resources for subsistence.

Regarding the aesthetical and recreational values of the Lower Rioni pilot watershed area, KNP administration offers a variety of tours for visitors to see the natural landscapes and caves as well as for bird watching. This creates a solid foundation for PA-based tourism development. Moreover, Khobi and Senaki municipalities within the boundaries of the Rioni River Basin have the potential for the development of spa resorts. Lower Rioni pilot watershed area has high cultural value since there are numerous cultural and historical sites of antic and medieval epochs (please refer map 17, Annex 2).

Overall, ecosystems and natural resources of the Lower Rioni pilot watershed area may provide following services based on their functions: i) maintaining of human health (fresh air and water, food base); ii) provision of drinking water; iii) maintaining of ecosystem integrity and high conservation value; iv) DRR (Disaster Risk Reduction) including flood and erosion control; v) hydropower generation (in the Techuri River Basin); vi) provision of fuel wood; vii) provision of inputs for agricultural activities (land resources, water resources, climate, agrobiodiversity, etc.); viii) provision of reserves of mineral resources; ix) provision of cultural resources; x) provision of tourism resources; xi) provision of spa-recreational resources; xii) small-cargo navigation.

It should be noted that the given functions and services of the existing ecosystems and natural resources are either underutilized or overutilized without considering the linkages among various ecosystem services and functions, and these practices may lead to severe ecosystem degradation and depletion of local natural resources.

Regardless the positive impacts of utilization of local natural resource base on the economic development of the pilot watershed area, such activities have negative influence on the natural ecosystems and particularly on ecosystems and natural resources of the KNP that causes their degradation, fragmentation and depletion. To serve as an example, Kulevi Oil Terminal poses significant threats to the Supsa section of the KNP. Furthermore, significant pressures were imposed on the KNP by Poti-Anaklia road and Senaki-Poti gas pipeline construction works. Peat extraction within the KNP and its buffer zones also have considerable negative impacts on the wetlands transforming natural ecosystems into significant sources of chemical and organic pollution.

Coastal erosion is very intensive along the coast line of the city of Poti, which is partially attributed to natural factors, but mostly are induced by human interventions, particularly by river bed diversion and flow regulation. Regulation of the river runoff has resulted in the destruction of fish migration routes in the lower reaches of the Rioni River.

Uncontrolled extraction of sand and gravel from river beds and terraces of Tekhuri, Tsiva and Rioni rivers have led to river bed and bank erosion and silting of river beds. This, in itself, leads to the decline of food carrying capacity of the given rivers.

In the Lower Rioni Pilot Watershed Area, the main point source of pollution is the sewerage system of the city of Senaki. Wastewater discharges from small-size enterprises and municipal buildings such as hospitals and carwash facilities add to this pressure as well. Non-point source of pollution is imposed by diffused sources of pollution, including agricultural land, landfill and urban surface runoff. Furthermore, pollution of downstream waters from upstream economic activities, including industrial and agricultural activities is high. More specifically, the lower courses of Rioni and Tekhuri rivers are polluted with biogenic substances including nitrogen, ammonia, phosphates. In addition,, impacts from the upstream water users (hydropower) are significant on sediment flow in the downstream waters that result in intensification of coastline erosion and loss and escalation of floods.

Pressures are also high on land resources from overgrazing, uncontrolled timber harvesting and poor land drainage.

It is expected that in the future, anthropogenic pressures will accelerate due to rapid infrastructural development in the downstream areas of Rioni and Tekhuri river basins as well as within the entire Tsiva River Basin. The development of free industrial zone in Poti will result in the increase of negative influences on local ecosystems and natural resources. As a consequence of climate change, sea level rise will intensify and river runoff in the downstreams of the Rioni basin will increase.

6.2 Issues Prioritization

Identification of priority watershed issues has been carried out in three phases: the initial phase encompassed identification and prioritization of issues by representatives of targeted communities and local authorities; the second phase encompassed study and identification of priority issues by Georgian experts hired under the INRMW Program; the final phase included merging of issues identified by local stakeholders and experts into one list and validation of this list by local stakeholders. Detailed descriptions of issues, evaluation methodology and evaluation results are given in Annexes 10; 11;12.

6.2.1 Identification and Prioritization of Watershed Issues by Targeted Communities and Local Authorities

To identify community and municipal level priority issues, a working meeting with local communities and government trustees was organized. Participants filled out evaluation score cards listing potential watershed issues with maximum attainable scores assigned to them as per specially elaborated environmental and social-economic criteria: 1. Negative impact on the health condition of villagers; 2. Negative impacts on the environment of the targeted villages and its surroundings; 3. Negative social-economic situation of the local population.

Evaluation results of the score cards revealed that the first priority is given to the issue of unavailability of the safe drinking water caused by absence of centralized rural drinking water supply systems, or presence of obsolete and dilapidated systems. Representatives of several villages indicated towards the dwindling of fresh water in their individual wells in areas without centralized systems. High risk of natural disasters, including floods and flash flood were also mentioned among top priority environmental issues, attributed to climate change, as well as the absence of proper agricultural and storm water drainage systems, existence of deteriorated flood control structures or non-existence of these structures. Furthermore, reduction of forest cover, wind and water erosion and secondary bogging of agricultural lands, water and soil pollution by solid household wastes as well as untreated wastewaters were considered as priority environmental issues by local communities and government trustees of these communities.

A list of priority issues and their causes identified by targeted communities and authorities is given in Annex 10.

6.2.2 Identification and Prioritization of Issues by Experts

Experts hired under the INRMW program have conducted comprehensive studies of watershed resources and have identified issues in each field of environmental and natural resource management. To prioritize these issues, experts discussed the topics and their interlinkages, following which, issues were evaluated on the following criteria: 1) negative health impacts; 2) negative environmental impacts on watershed; 3) negative social-economic impacts (e.g. housing, infrastructure, agriculture and etc.).

Full version of experts' evaluations of watershed issues is given in annex 11.

According to experts assessments, flooding of large areas resulting from floods and flash floods is a critical issue for the Lower Rioni pilot watershed area. This is caused by the deterioration of existing drainage systems or absence of such facilities as well as by degradation/absence of river bank embankments. Floods and flash floods damage household properties, including their houses, orchards and farm lands, local infrastructure and occasionally result in human casualties. Furthermore, as a result of inundation, flooded areas are bogged that leads to the spread of insects and algae, increase in ground water table and evaporation rates, which ultimately results in the degradation of natural landscapes and agricultural lands.

Deterioration of the overall quality of forest ecosystems is a major problem in the area of the forest management. This is directly caused by unsustainable utilization of timber resources that bring about forest degradation, soil erosion, deterioration of water, and climate regulation functions of the forests. Other areas of concern include, absence of common forest management policy, legal and regulatory framework, forest monitoring and inventory systems and function zoning of forests.

Poor waste management, including collection and disposal of solid household and industrial wastes was also identified as priority issues. More specifically, unsanitary municipal landfills compounded with illegal dump sites have negative impacts on the local environment, polluting water, soil and air with harmful substances. Environmental pollution and unsanitary conditions hinder tourism development in the PAs and other recreational zones.

Water and soil pollution from untreated sewage discharged from Senaki sanitation system that serves around 15% of the city’s population, as well as from dry pit latrines of rural households and public buildings, was also listed among priority issues.

Poor access to safe drinking water due to deterioration of existing centralized water supply systems or absence of such systems was named as one of the major issues in the area of water management. It should be noted that almost every village of Senaki and Khobi municipalities do not have centralized water supply system and abstract drinking water from individual or common wells. This is an unsustainable and an inefficient drinking water use practice in terms of water quantity and quality.

Land degradation and loss of the fertile topsoil is cited among priority issues. This problem is caused by wind and water induced soil erosion, deforestation, destruction of windbreaks and overgrazing. The last mentioned occurs in the Kolkheti National Park and its buffer zones leading to the degradation of valuable floodplain and swampy forests of the Kolkheti Wetlands.

In the area of biodiversity and agrobiodiversity, habitat/ecosystem degradation, disintegration and loss, species loss, depletion of natural resource base, transformation of natural ecosystems due to the introduction of invasive species as well as the widespread use of GMO seeds and products resulting from the absence of control mechanisms, and loss of traditional agrobiodiversity (lentils, chickpeas, etc.) caused by extensive distribution of species used for mass production agriculture (e.g. kidney beans, corn) were ranked high among priority issues.

6.2.3 Synthesis, Validation and Final Evaluation of the Priority Issues

Based on priorities identified by local communities and experts, a common list of priority issues was developed by the INRMW Program Team. Priority issues were categorized by environmental/natural resource management field, and underlying causes for each issue were identified.

- ***Water quantity***: 1. Poor access to drinking water and reduction of water sources; 2. Increase in the frequency and intensity of floods and flash floods.

  Immediate/underlying causes - problem 1: existence of inefficient and outdated centralized water supply systems in urban areas and few villages; absence of centralized rural water systems in the absolute majority of villages; extraction of drinking water from individual/common wells;

  Root causes – problem 1: lack of financial, technical and human resources for rehabilitating existing systems and/or building new efficient systems; absence of effective water use tariffs and implementation systems (appropriate institutions, billing and bill collection systems and penalties).

  Immediate/underlying causes – problem 2: deterioration of existing drainage systems and flood control structures and/or absence of such systems; river bank and bed erosion, riverbed sedimentation/silting, coastline erosion and loss, naturally occurring tectonic and geodynamic process including, eustasy, intensification of sea surges and storms, etc.

  Root causes – problem 2: lack of technical, human and financial resources to properly design, construct, operate and maintain drainage systems and flood control structures; climate change and change in seasonal river runoff due to: a) forest degradation/decline as a result of unsustainable timber harvesting and absence of proper legal-regulatory, policy and institutional frameworks; b) extensive extraction of sand and gravel from riverbanks and beds without any environmental consideration, river bed diversion, construction and operations HPPs in the upstream areas of the river basin, etc.

- ***Water quality***: 1. Pollution of surface and ground waters; 2. Contamination of tap water.

  Immediate/underlying causes – problem 1: discharge of untreated wastewaters from point sources of pollution (sewerage systems, upstream and local industries, etc.) into surface waters; agriculture and urban runoff; drainage of storm waters and seepage of leachates from controlled and uncontrolled waste disposal sites, open pit mines, dry pit latrines;

  Root causes – problem 1: deteriorated or absent sewerage systems; absence of wastewater treatment facilities; absence of standard-based sanitary landfills and poor condition of existing landfills; non-proper agricultural practice; lack of state finances to rehabilitate/build centralized sewerage systems and construct WWTPs and standard-based landfills; poor ambient water quality and soil monitoring; absence of effective regulations, including standard for wastewater discharges; absence of a common effective policy on waste and water management; weak law enforcement; low environmental consciousness of local communities.

Immediate/underlying causes - problem 2: deteriorated drinking water supply infrastructure or absent infrastructure in the majority of the villages; absence of sanitary zones/lack of protection of zones around existing water sources; absence of tap water treatment in virtually all communities with centralized water supply systems;

Root causes – problem 2: shortage of funds to rehabilitate existing centralized systems or to build new systems; absence of effective regulations, weak law enforcement and monitoring mechanisms; low local capacity for tap water quality and environmental pollution control; low environmental consciousness of local communities

- ***Waste management:*** 1. Poor sanitary-hygienic conditions in urban and rural settlements; 2. Pollution of streams, rivers, groundwater and soil from waste dumped in dry ravines, drainage canals and riverbeds, as well as from seepage of pollutants from controlled and uncontrolled waste disposal sites.

  Immediate/underlying causes - problem 1: substandard waste collection, transportation and disposal systems in the urban areas and nonexistence of these systems in the vast majority of villages; existence of illegal and uncontrolled dumpsites

  Root causes – problem 1: lack of financial, technical and human resources/capacity to organize effective waste collection, transportation and disposal systems; absence of effective waste collection and disposal tariffs; poor enforcement of tariff collections.

  Immediate/underlying causes - problem 2: unsanitary and poor ecological conditions of existing legal landfills, proximity of waste disposal sites to streams and settlements; improper operation and maintenance of existing waste disposal sites.

  Root causes problem 2: lack of financial, technical and human resources to build standard-based sanitary landfills and/or properly operate and maintain existing facilities; absence of waste recycling and processing practices and amenities; absence of common standard-based legal-regulatory, policy and institutional frameworks in the area of waste management; weak environmental monitoring and law enforcement; low environmental consciousness of local communities.

- ***Land resources:*** 1. Soil bogging, wind and water induced soil erosion, river bank and coastal erosion; 2. Loss of productive agricultural lands and high conservation value natural ecosystems, including floodplain forests, wetlands, etc.; 3. Soil contamination.

  Immediate/underlying causes - problem 1: poor land reclamation caused by improper drainage of agricultural lands or absence of such mechanisms; lack of flood control structures on river banks, river bed diversion or other changes in river hydromorphology as a result of various instream manipulations; eustasy and tectonic subduction of land; uncontrolled and excessive grazing, uncontrolled land cultivation, unrestrained forest cutting;

Root causes – problem 1: lack of financial, technical and human resources to rehabilitate existing drainage and flood control systems, design and build new and more efficient systems as well as to implement erosion control/land reclamation measures; absence of policy/plan for sustainable land management; absence of effective land use tariffs and implementation mechanisms; low awareness of local farmers on sustainable water and land use and good agriculture practices; lack of the scientific knowledge on human and climate change impacts on coastal erosion, etc.

Immediate/underlying causes - problem 2: application of unsustainable agricultural practices; destruction/elimination of windbreaks; overgrazing and uncontrolled timber harvesting; infrastructure development activities without considering and mitigating expected environmental impacts; uncontrolled peat extraction;

Root causes – problem 2: absence of effective agricultural land management policy, including land use planning and its implementation mechanisms (e.g., land use zoning, land inventory and monitoring, land use fees, land allocation, etc.); absence of proper zoning or other regulatory or economic mechanisms for sustainable pasture management; absence of sustainable forest management laws, policies and effective mechanisms for law enforcement; lack of local knowledge on good agriculture practices; absence of common effective policy and its implementation mechanisms for forest management.

Immediate/underlying causes - problem 3: leaching of pollutants from waste dumps or waste burial sites, open-pit mines and pit latrines; pollution from urban and agriculture runoff; discharge of untreated wastewaters into the earth's surface.

Root causes – problem 3: improper use of agrochemicals; poor knowledge on the optimum agrochemical inputs; absence of regulatory and law enforcement mechanisms for soil quality; absence of effective environmental pollution control regulatory and/or economic mechanisms; absence of financial and technical resources for implementing effective environmental control policies, including policies for waste and wastewater management.

- ***Forest resources:*** 1. Deterioration in the overall quality of high conservation value forests; 2. Reduction of timber resources.

  Immediate/underlying causes – problem 1 and 2: unsustainable use of timber resources, including uncontrolled cutting of trees for firewood; overgrazing in forest ecosystems; cutting of forests for implementation of land development projects; absence of forest maintenance and/or restoration measures.

  Root causes – problem 1 and 2: application of unsustainable silviculture methods, e.g. clearcutting; lack of financial, technical and financial resources to carry out afforestation/reforestation measures; underutilization of alternative energy sources;

poor economic sense of local population that limits access to secure energy sources (gas, electricity, etc.); local population's lack of awareness on energy saving and efficiency measures; absence of a common forest management policy, effective legislation and regulations; absence of forest inventory and monitoring systems; absence of effective law-enforcement system.

- ***Biodiversity:*** 1. Degradation (destruction, modification/transformation) of natural ecosystems and biomes (e.g., wetlands, floodplain forests, sand dunes, etc.); 2. Species loss and decrease in wildlife populations; 3. Loss of traditional and endemic species (e.g. lentil, chickpea, flax, wheat etc.); 4. Widespread use of GMOs

  Immediate/underlying causes - problem 1: overgrazing; intensive forest cutting; introduction of invasive species; poaching and unsustainable tourism; uncontrolled peat extraction; instream operations, including extraction of sand and gravels from river beds and terraces; artificial fires; land clearing for infrastructure and other economic development activities in protected wetlands and its buffer zones.

  Immediate/underlying causes - problem 2: poaching; overfishing; distribution of invasive species; implementation of infrastructural projects in areas rich in biodiversity without conducting environmental impact assessment and mitigation measures; unsustainable tourism.

  Root causes – problem 1 and 2: inadequate legal-regulatory, policy and institutional frameworks for biodiversity conservation and sustainable utilization; poor biodiversity monitoring and law enforcement capacities, including the lack of technical and financial resources and qualified staff; high local poverty level and low environmental awareness of the local population.

  Immediate/underlying causes – problem 3: widespread use of mass-production crops.

  Root causes – problem 3: absence of state policy and its implementation mechanisms on Georgian agrobiodiversity, and the decline of local knowledge on traditional agriculture.

  Underlying cause – problem 4: wide availability and low cost of GMO seeds and products compared to ecological seeds and products.

  Root causes – problem 4: low public awareness and absence of legal, policy and institutional frameworks for regulating the use of GMO raw materials and products.

The final list of issues was presented to local stakeholders to reach a consensus and an agreement of interested parties on priority issues. The stakeholders confirmed the validity of presented issues.

Final priorities were set based on maintaining the key ecosystem functions of the Lowe Rioni pilot watershed area: (1) preserve human health; (2) supply drinking water; (3) maintain ecosystem integrity and health; (4) reduce risk from natural disasters; 5. Provide hydropower generation[21]; (6) provide fuel wood; (7) support agricultural productivity; (8) provide mineral

[21] This function is only attributed to the surface waters of the Tekhuri River Basin

resources; (9) provide cultural resources; (10) provide tourism resources; and (11) provide recreational and spa resources.

For methodology and outcomes of evaluation refer Annex 12.

7.0 RECOMMENDED MEASURES

Experts hired under the INRMW Program have developed recommendations for watershed interventions to address major issues identified during the detailed watershed studies. These include both structural and non-structural measures. This list of suggested measures may serve as a basis for a watershed planning exercise that will follow detailed watershed assessments[22].

Water Resources

- Conduct flood control measures in high flood risk sections;
- Clean river beds on a regular basis;
- Rehabilitate/upgrade existing drainage systems or build new effective ones;
- Rehabilitate existing water supply systems in villages with centralized water supply systems;
- Construct new systems in villages without centralized water supply systems;
- Rehabilitate existing urban water supply system (Senaki) in the pilot watershed area;
- Fence sanitary zones at the intakes;
- Install drinking water treatment facilities/devices;
- Set GIS database on existing water supply infrastructure;
- Strengthen drinking water quality monitoring and state control capacities;
- Rehabilitate and expand Senaki sewerage system;
- Construct urban biological wastewater treatment plant;
- Construct on-site wastewater treatment facilities for small villages, industries or public buildings;
- Install aerobic bio-toilets in public buildings and/or structures holding small businesses;
- Study current patterns of the use of pesticides and fertilizers, develop and implement integrated pesticide and fertilizer management program and apply other good agriculture practices to reduce effluent discharges from agriculture lands;
- Establish drainage systems and wastewater treatment facilities on existing landfills, construct dams/levies near waste disposal sites located near riverbanks to protect them from flooding;
- Improve existing legislations in the areas of water resources protection and sustainable utilization;
- Expand existing ambient water quality monitoring system (reopen water quality monitoring site on the Tekhuri River and add new sites), as well as hydrological monitoring system ;
- Establish groundwater monitoring system;
- Improve state statistical accounting system for water uses, upgrade existing databases and link them with GIS systems.

Land Resources

- Develop national, regional and local sustainable land management policies;
- Develop general strategies for land use and spatial planning which will become a basis for developing detailed local spatial plans;

[22] Integrated Natural Resources Management Plan for the Lower Rioni Pilot Watershed Area will be developed based on this assessment and consultations with local stakeholders

- Set-up and/or strengthen interagency coordination mechanism;
- Develop/update the KNP management plan and develop management plans for its buffer zones;
- Plan and implement forest restoration measures;
- Develop guidelines for preventing/reducing land erosion during implementation of infrastructural projects;
- Set grazing norms for pastures and implement sustainable pasture management measures;
- Study soil quality, and based on this information, implement relevant land cultivation practices;
- Conduct an inventory of eroded and degraded agriculture lands and implement land reclamation measures;
- Support establishment of livestock farms to reduce grazing pressures on forest ecosystems as well as to generate alternative incomes;
- Promote revival traditional herding practices;
- During designing of infrastructure or economic development projects, take into consideration the principles of integrated coastal zone management;
- Strengthen legislation and law enforcement capacities, as well as raise public awareness.

Forest Resources

- Develop forest policies, laws, and sub-laws, including regulations on forest use;
- Create forest inventory and monitoring system and establish comprehensive forest database;
- Implement functional zoning of forests and establish geographic information systems;
- Enhance law enforcement mechanisms and develop institutional and staff-level capacities for law enforcement;
-
- Develop integrated land, water and forest management plans for entire watersheds/municipalities including measures for using, maintaining, protecting and restoring forests;
- Set optimal quota for timber use that does not exceed the annual increase of timber;
- Restore degraded forest ecosystems;
- Determine the annual fuel wood demand at municipality level and develop alternative energy sources in case of shortage;
- Promote conventional fuels (e.g., gas, coal) or alternative energy sources, including hydropower, wind and solar energy, for heat generation;
- Promote efficient use of fuel wood using wood chips, pellets, briquettes, energy-efficient stoves, better thermo-insulation, etc.;
- Control livestock grazing in the forests bordering pastures and settlements;
- Lease large areas of forests (sub-catchments) for long-term commercial use;
- Conduct inventory of forest lands to be leased;
- Build roads leading to locations allocated for fuel wood extraction;
- Establish special crews for cutting fuel wood;
- Distribute fuel and non-fuel wood from central locations.

Biodiversity

- Improve law enforcement mechanisms and enhance the capacities of law enforcement agencies to protect biodiversity (this particularly refers to law enforcement against poachers and illegal forest loggers);
- Improve existing biodiversity monitoring system;
- Raise public awareness on the importance of local biodiversity and sustainable practices for its utilization;
- Promote extracurricular environmental educational activities and introduce biodiversity conservation in school curricula;
- Implement non-structural and structural measures to reduce/avoid forest and land degradation;Strengthen management effectiveness of the Kolkheti National Park through developing/updating and implementing PA management plans;
- Promote sustainable tourism within the Kolkheti National Park;
- Promote alternative livelihood programs for rural population living within the territory of the Kolkheti National Park or within its buffer zones to reduce pressures on local natural resources.

Waste Management

- Develop waste management strategies and plans for Senaki and Khobi municipalities;
- Improve the fee system for waste management;
- Construct new EU-standard based landfill(s) in Samegrelo Region for disposal of household solid wastes generated and collected in Senaki and Khobi municipalities;
- Build transit point in Senaki Municipality, where wastes from different locations will be stored temporarily and subsequently transported and disposed in the municipal/regional landfill;
- Decommission and conserve old waste disposal sites;
- Eliminate illegal dumpsites;
- Procure 4-5 closed waste transportation trucks each for Khobi and Senaki municipalities;
- Procure 250-300 waste collection containers, 1.1 m^3 in volume, each for Khobi and Senaki municipalities;
- Establish waste separation system, for waste recycling ;
- Raise awareness and build capacity of municipal authorities.

8.0 CONCLUDING REMARKS

These conclusions summarize the findings of the detailed watershed study:

Lower Rioni pilot watershed area is characterized by relatively high population density in comparison with the upstream areas of the basin. These areas are highly susceptible to floods and flash floods, undergo intensive coastal and delta erosion, caused partially by climate change and changes in river regime, uncontrolled logging, sea level rise and sea surges/storms. The coastal zone requires regular accumulation of/feeding with sediments. It is anticipated that the construction of regulating HPPs in upper and middle courses of the Rioni River Basin will intensify coastal and delta erosion processes.

A large section of the Kolkheti National Park is located in the Lower Rioni pilot watershed area, representing the Ramsar site. However, special protection status does not guarantee complete protection of these lands and ecosystems. Local population of these areas illegally harvests timber, grazes livestock, catches fish and extracts peat, albeit at lower rates. The most critical pressure on the biodiversity is the illegal scale of fishing, which is very large, and it poses threats to anadromous fish – the Sturgeon.

Any medium to large-scale infrastructural project implemented in upper and lower courses of the river basin have significant impacts on the sensitive ecosystems of Kolkheti lowlands, including wetlands, floodplain forests, coastal ecosystems, etc. These biomes are distinguished for its fish and wildlife diversity, presence of many endemic and relict plant and animal species. Moreover, Kolkheti wetlands are wintering areas for many migratory birds. At the same time, the city of Poti, representing the largest port of Georgia, is a regional transport and logistics hub and many infrastructure projects are implemented in this area. Additionally, several industries are concentrated in Poti. All of these have a negative influence on the wetland ecosystems and the delta.

Apart from above the anthropogenic pressures, in the absence of clean energy sources/poor access to them, timber is harvested at unacceptable rates for fuel wood production. The share of the local population covered by centralized drinking water supply and sanitation systems is low, and the majority of villages are without such systems. Existing water infrastructure, including water supply, sanitation, drainage and flood control systems are obsolete and deteriorated. The same can be said about the existing waste collection, transportation and disposal systems, which is very poor and in the majority of villages, such facilities do not exist at all.

The Lower Rioni pilot watershed area falls under the high risk zone of floods and flash floods, induced by the change in unequal distribution of precipitations and climate change as well as by the crumbling flood control and drainage infrastructures.

The above pressures together with stresses imposed by industrial and agricultural activities inflict significant negative impacts on land resources as well. Soils are polluted with sewerage and storm waters discharged from urban areas, municipal solid wastes and leachates from legal and illegal landfills.

Existing environmental policies do not ensure integrated watershed management. Water is not allocated in a way that takes into consideration the differing water use needs of various sectors and minimum environmental flows of the rivers. Water quantity and quality monitoring is significantly weak in terms of the number of monitoring points and hydrological, chemical and biological parameters monitored. There is no monitoring data available on groundwaters and soil quality, and compliance assurance monitoring and control is not conducted by the state.

Impacts of climate change are not considered during designing of infrastructure projects. There is no common early warning and communication system for natural disasters in the country, though its separate elements exist at central and local levels.

9.0 ANNEXES

Annex 1: List of selected communities
Annex 2: Maps
Annex 3: Assessment of climate vulnerability of hydrological resources of the Upper Alazani pilot watershed area based on WEAP hydrological model
Annex 4: i) 4.a Hydrological data; ii) 4.b Water quality data
Annex 5: Land Resources
Annex 6: Hydrology
Annex 7: Forest Resources and Use
Annex 8: Use of Water Resources
Annex 9: Water Supply and Sanitation Systems
Annex 10:Priority Issues Identified in Targeted Communities
Annex 11: Matrix of Priority Issues Identified by Experts
Annex 12: Final Evaluation of Priority Issues identified by communities and experts
Annex 13: Estimated costs of the measures to be implemented in the waste management field
Annex 14: Socio-economic indicators

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Annexes

Annex 1. INRMW project list of target communities of the Lower Rioni Pilot Watershed Area

Table 1. List of Selected Communities in the Khobi Municipality (Downstream Watershed Area of the Rioni River Basin)

	Community	Village	Population (Persons)	Share of Vulnerable Groups[1] (%)
1	**Patara Poti**		**1241**	**15%**
		I Hamlet	549	188
		II Hamlet	242	197
		III Hamlet	239	52
		IV Hamlet	211	88
2	**Chaladidi**		**2316**	**31%**
		Sachochuo	422	128
		Sabazho	1894	499
3	**Sagvichio**		**650**	**22%**
		Sagvichio	650	142
4	**Shavgele**		**1043**	**7%**
		Shavgele	1043	68

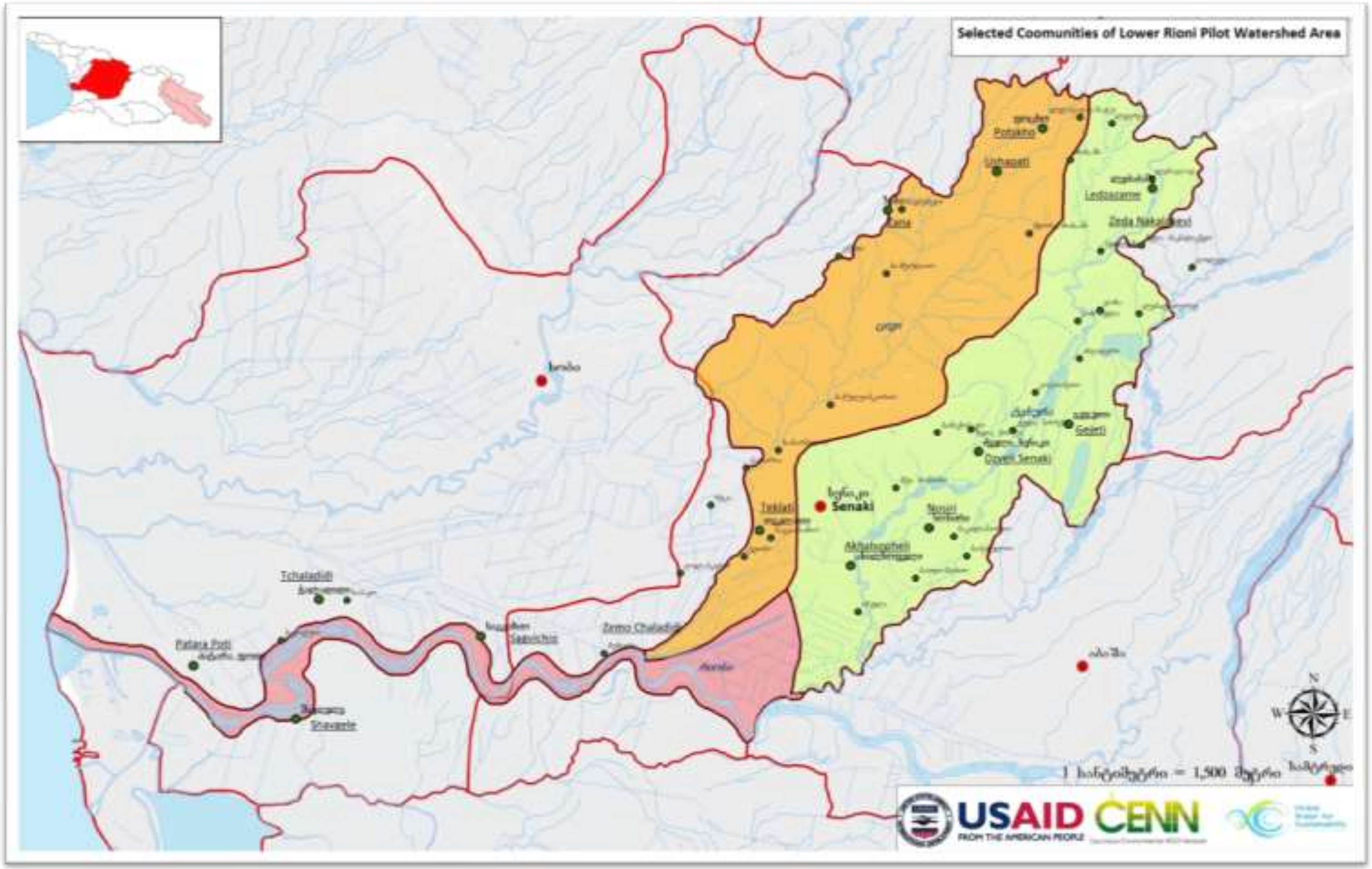
Table 2. List of Identified Communities in the Senaki Municipality (Downstream Watershed Area of the Rioni River Basin)

	Community	Village	Population (Persons)	Share of Vulnerable Groups (%)
1	**Teklati**		**3000**	**26%**
		Sagvaramio	840	208
		Teklati	650	228
		Golaskuri	590	91
		Tkiri	460	100
		Reka	460	156
2	**Akhalsopeli**		**2023**	**24%**
		Akhalsopeli	1327	299
		Isula	696	185
3	**Zemo Chaladidi**		**786**	**26%**
		Mukhuri	726	188
		Siriachkoni	60	18
4	**Dzveli Senaki**		**4453**	**31%**
		Kveda Sorta	386	92
		II Nosiri	942	259
		Zeda Sorta	208	76
		Sachiqobavo	80	28
		Kotianetio	705	279
		Dzveli Senaki	2132	627
5	**Nosiri**		**3313**	**20%**
		Saodishario	900	195
		Sakilasonio	513	35

[1] Vulnerable groups include community residents with income below the poverty line and Internally Displaced Persons (IDPs).

		Sabeselio	650	174
		Shua Nosiri	580	91
		Nosiri	670	172
6	**Gejeti**		**1250**	**37%**
		Gejeti	1250	459
7	**Nokalakevi**		**1398**	**34%**
		Zemo Nokalakevi	24	12
		Jikha	351	134
		Lebagaturie	283	100
		Gakhomila	573	178
		Dziguderi	167	53
8	**Menji**		**1293**	
		Bataria	635	136
		Sakharbedio	350	81
		Satsuleiskirio	155	35
9	**Ledzadzame**		**1095**	**14%**
		Ledzadzame	193	40
		Betlemi	288	29
		Lesajaie	242	45
		Legogie	104	21
		Jolevi	189	13
10	**Zana**		**1502**	**30%**
		Zana	440	166
		Etseri	245	68
		Saesebuo	191	49
		Sashurgaio	287	81
11	**Potskho**		**2003**	**36%**
		I mokhashi	229	97
		II mokhashi	217	95
		Legogie-Nasaju	487	153
		Potskho	1070	379

Map of the Identified/Selected Communities of Lower Rioni Pilot Watershed Area

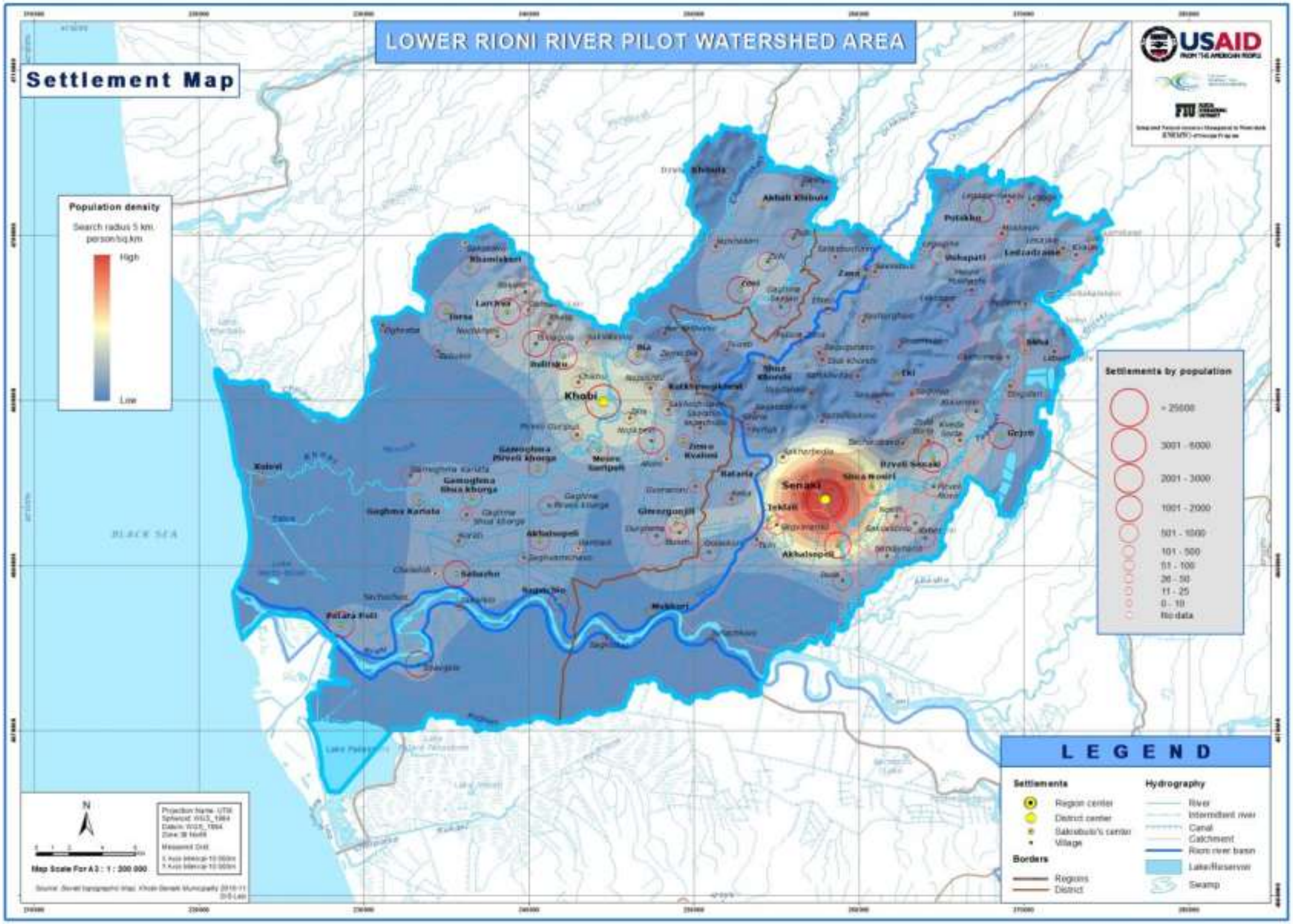


Annex 2: Thematic Maps

Map 1.

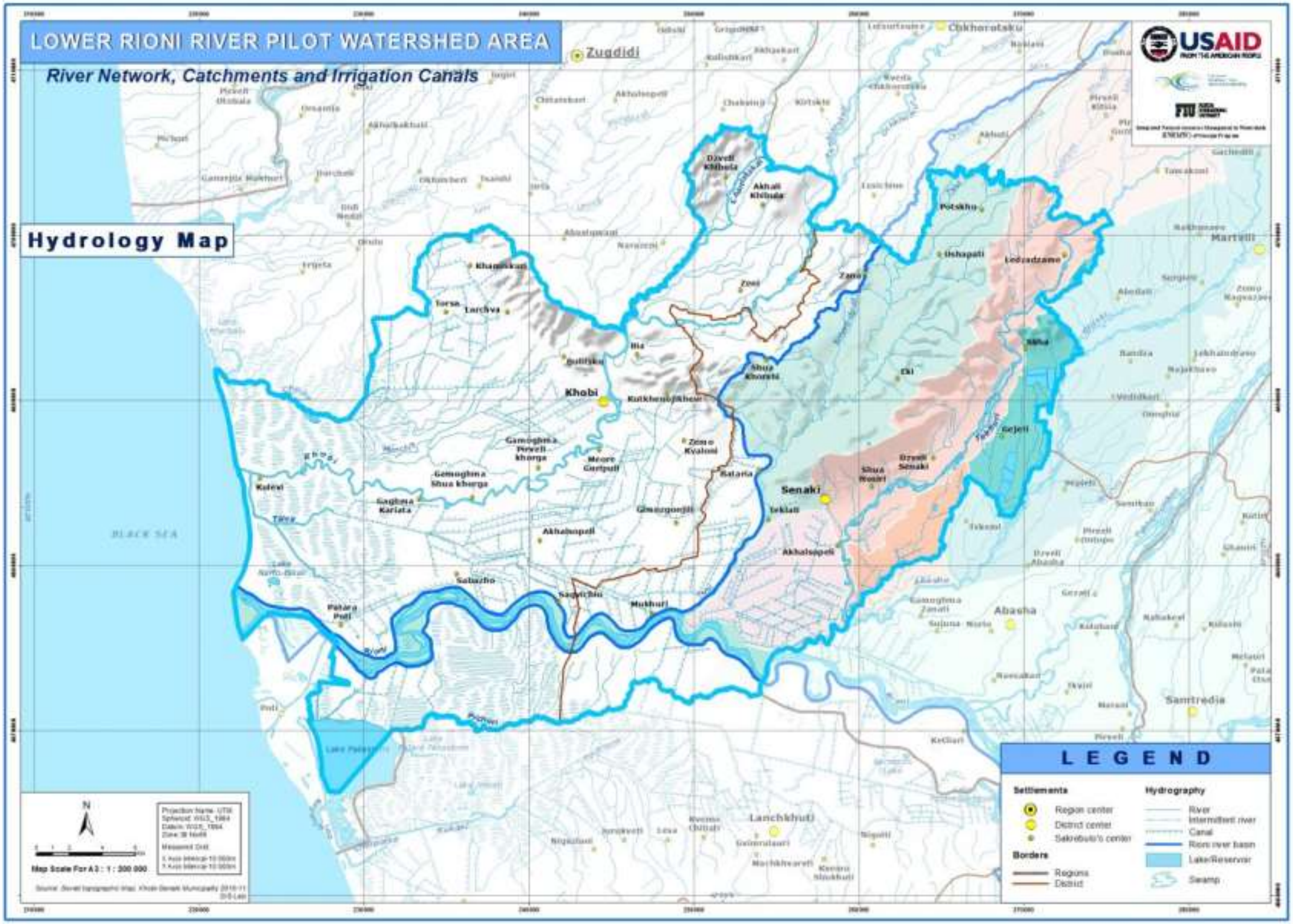
LOWER RIONI RIVER PILOT WATERSHED AREA
General Map
USAID
BLACK SEA
Anaklia
Khobi
Senaki
Abasha
Martvili
Lanchkhuti
Poti
Chkhorotsku
Elevation
Erosion
Hydrography
Settlements
Borders
Roads & Railway
Vegetation
Protected Area
Relief/Relief forms
LEGEND

Map 2.



LOWER RIONI RIVER PILOT WATERSHED AREA
Settlement Map
USAID
Population density
Search radius 5 km
person/sq.km
High
Low
Settlements by population
BLACK SEA
Khobi
Senaki
LEGEND
Settlements
Region center
District center
Village
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Catchment
Rioni river basin
Lake/Reservoir
Swamp
Map Scale For A3 : 1 : 200 000

Map 3.


LOWER RIONI RIVER PILOT WATERSHED AREA
River Network, Catchments and Irrigation Canals
Hydrology Map
USAID
FROM THE AMERICAN PEOPLE
Zugdidi
Khobi
Senaki
Abasha
Martvili
Samtredia
Lanchkhuti
BLACK SEA
Rioni
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
Map Scale For A3 : 1 : 200 000

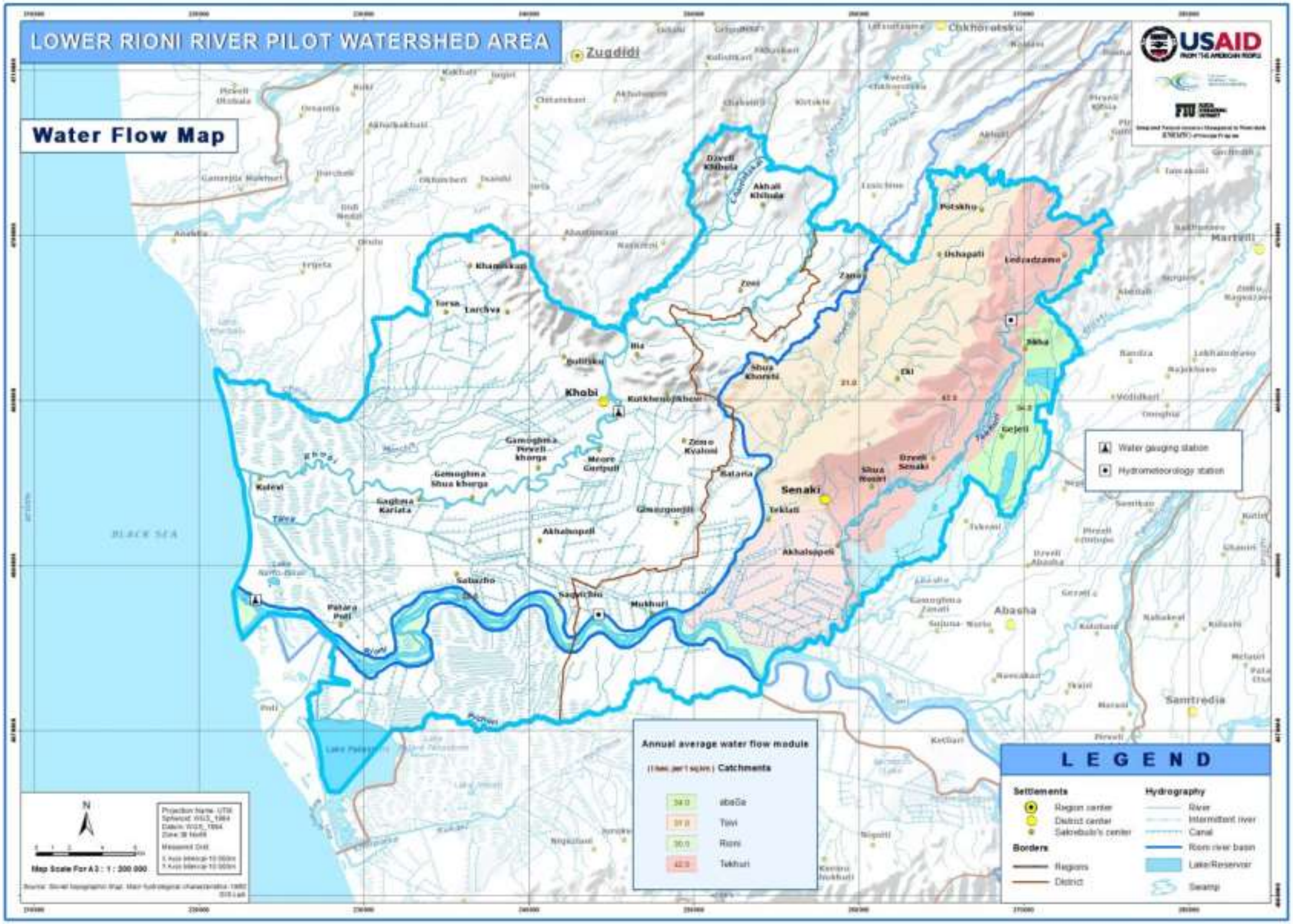
Map 4.


LOWER RIONI RIVER PILOT WATERSHED AREA
Elevation Map
USAID
Zugdidi
Chkhorotsku
Martvili
Khobi
Senaki
Abasha
Samtredia
Lanchkhuti
Poti
BLACK SEA
Anaklia
Elevation
Tops (m)
Geodetic points (m)
Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
Regions
District
Roads & Railway
Main road
Local road
Railway(R station)
Hydrography
Spring
Waterfall (m)
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
LEGEND
Map Scale For A3 : 1 : 200 000

Map 5.


LOWER RIONI RIVER PILOT WATERSHED AREA
USAID
Hydro-Measuring Stations
Water gauging station
Non-operated
Hydrometeorology station
Operated
BLACK SEA
Khobi
Senaki
Abasha
Samtredia
Martvili
Settlements
Region center
District center
Sakrebulo's center
Village
Roads & Railway
Main road
Local road
Railway(R station)
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Catchment
Rioni river basin
Lake/Reservoir
Swamp
LEGEND
Map Scale For A3 : 1 : 200 000

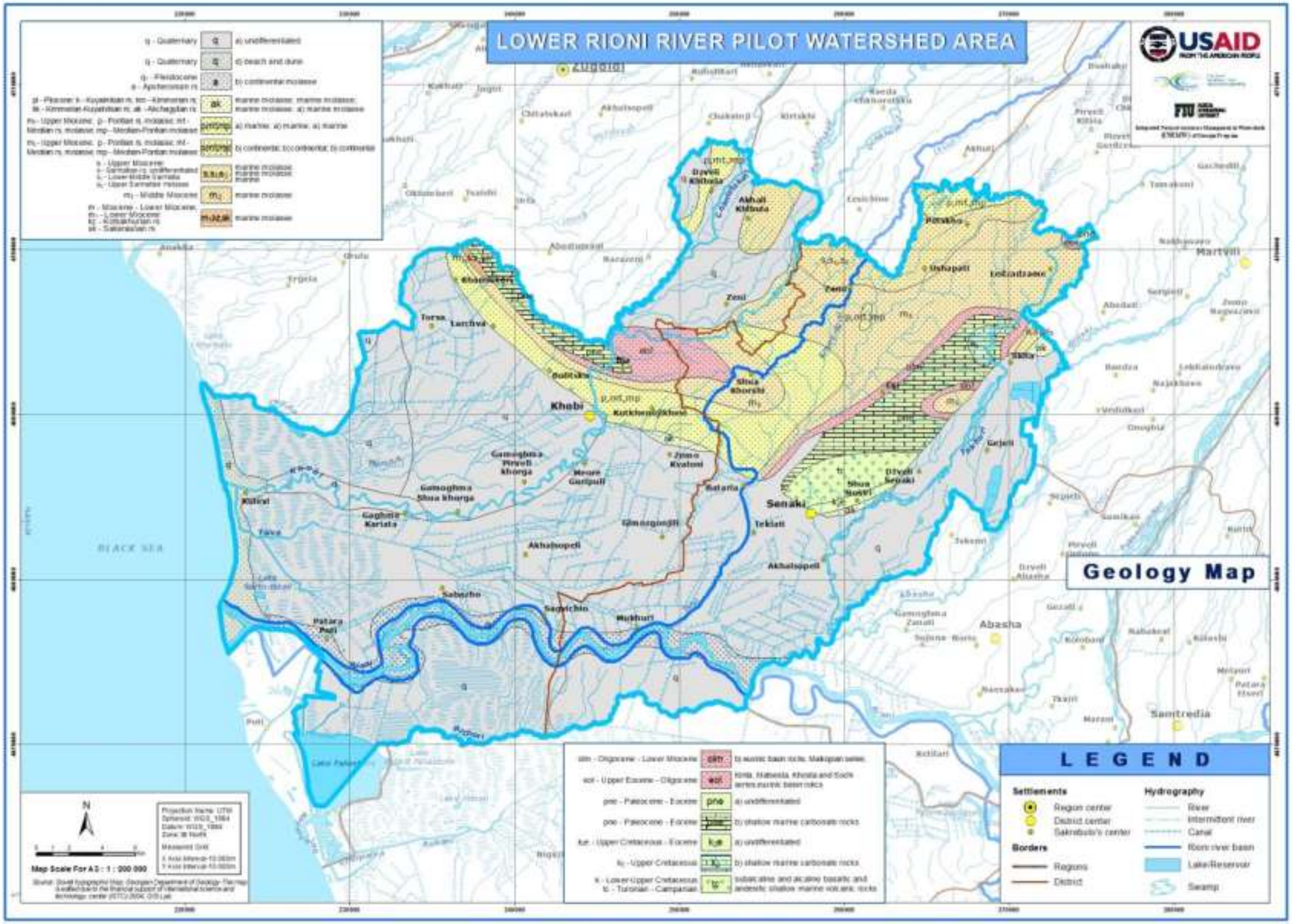
Map 6.


LOWER RIONI RIVER PILOT WATERSHED AREA
Water Flow Map
USAID
Zugdidi
Khobi
Senaki
Abasha
Samtredia
Martvili
BLACK SEA
Water gauging station
Hydrometeorology station
Annual average water flow module
Catchments
abaSa
Tsivi
Rioni
Tekhuri
LEGEND
Settlements
Region center
District center
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
Map Scale For A3 : 1 : 200 000

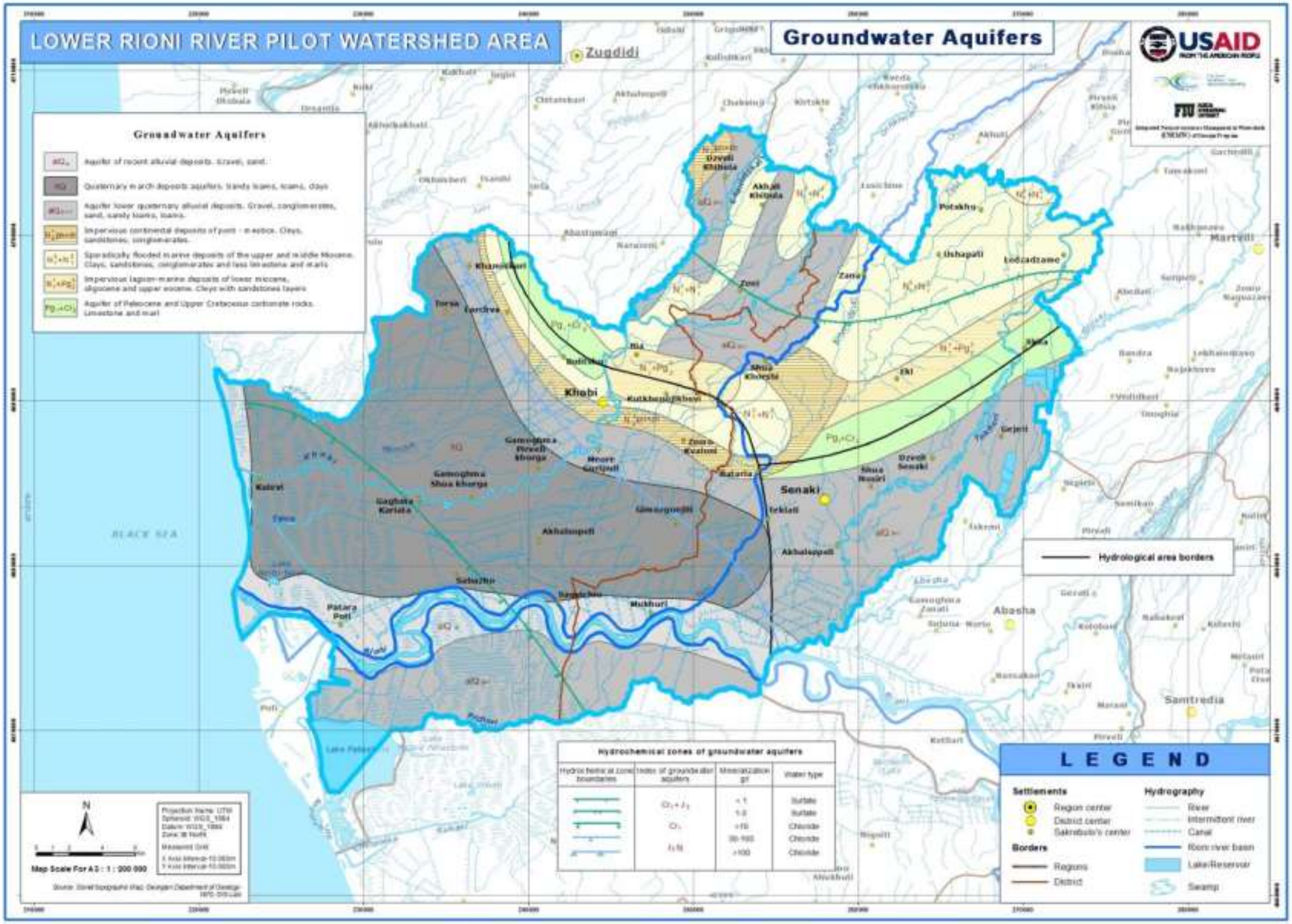
Map 7.

LOWER RIONI RIVER PILOT WATERSHED AREA
Protected Areas
USAID
BLACK SEA
Khobi
Senaki
Abasha
Martvili
Lanchkhuti
Samtredia
Chkhorotsku
Settlements
Region center
District center
Sakrebulo's center
Borders
Regions
District
Roads & Railway
Main road
Local road
Railway(R.station)
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
Vegetation
Bush
Forest
Protected Areas
Kolkheti National park
Katsobuni Managed Reserve
Ramsar sites
LEGEND

Map 8.


LOWER RIONI RIVER PILOT WATERSHED AREA
USAID
Geology Map
LEGEND
Settlements
Hydrography
Borders
Khobi
Senaki
Abasha
Martvili
Samtredia
BLACK SEA

Map 9.

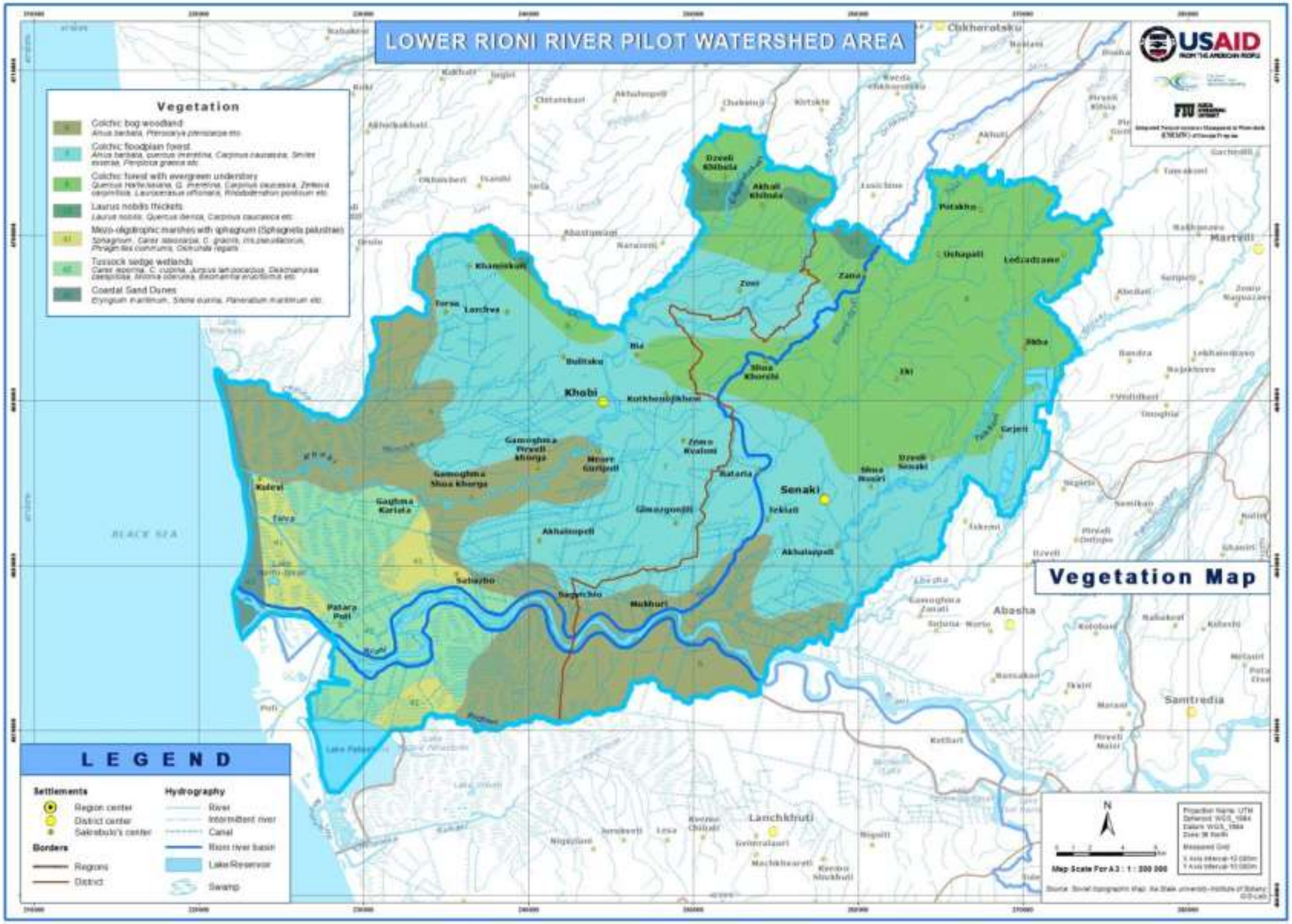


LOWER RIONI RIVER PILOT WATERSHED AREA
Groundwater Aquifers
USAID
Groundwater Aquifers
Aquifer of recent alluvial deposits. Gravel, sand.
Quaternary march deposits aquifers. Sandy loams, loams, clays
Aquifer lower quaternary alluvial deposits. Gravel, conglomerates, sand, sandy loams, loams.
Impervious continental deposits of pont - meotice. Clays, sandstones, conglomerates.
Sporadically flooded marine deposits of the upper and middle Miocene. Clays, sandstones, conglomerates and less limestone and marls
Impervious lagoon-marine deposits of lower miocene, oligocene and upper eocene. Clays with sandstones layers
Aquifer of Paleocene and Upper Cretaceous carbonate rocks. Limestone and marl
Zugdidi
Khobi
Senaki
Abasha
Samtredia
Martvili
BLACK SEA
Hydrological area borders
Hydrochemical zones of groundwater aquifers
Map Scale For A3 : 1 : 200 000
LEGEND
Settlements
Region center
District center
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp

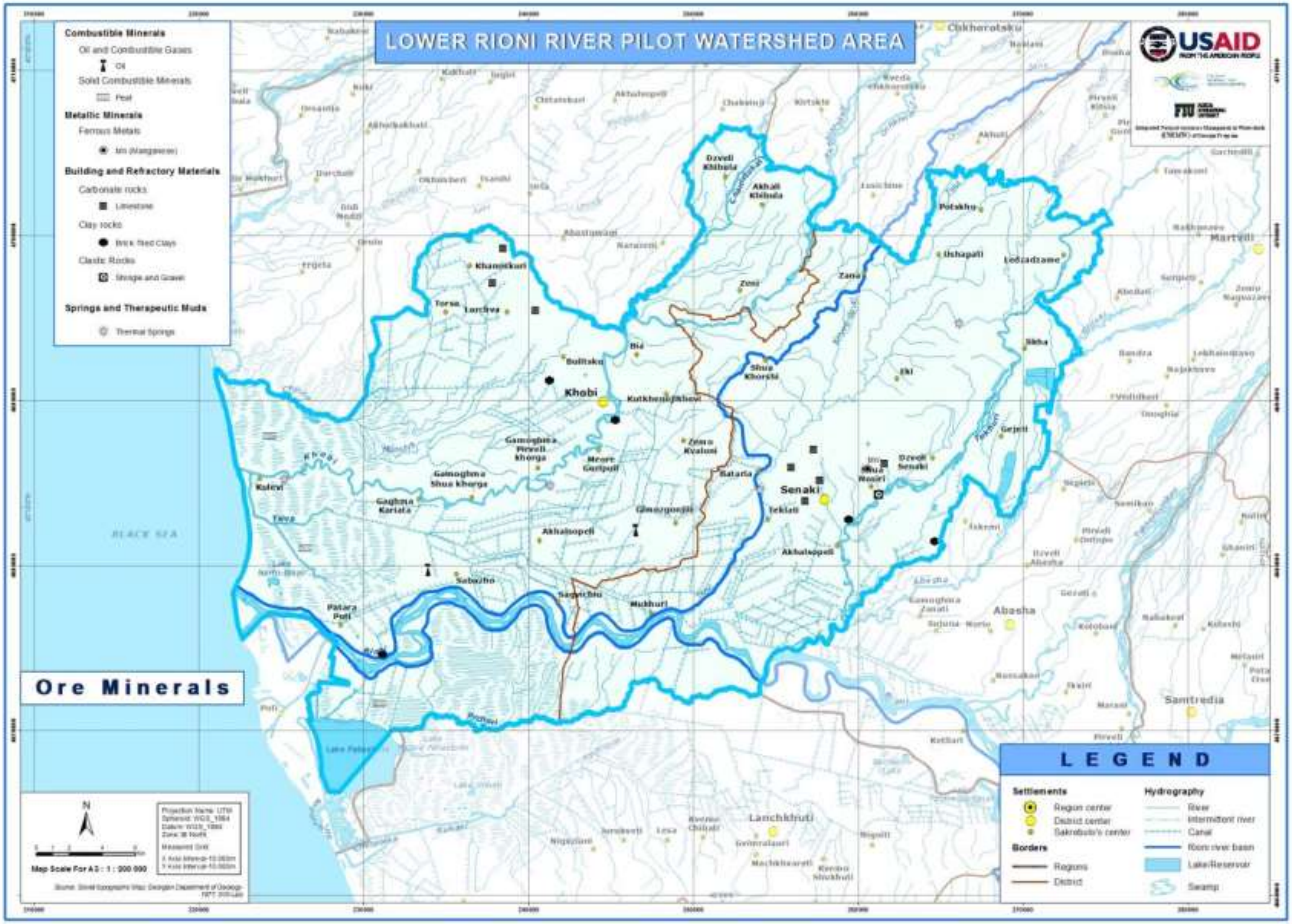
Map 10.


LOWER RIONI RIVER PILOT WATERSHED AREA
Forest Cover
USAID
Other Symbols
Deciduous
Solitary tree
Young forest
Shrubs
Field
Orchard
Deforestated area
Wind breaker
Wineyards
Tea
BLACK SEA
Khobi
Senaki
Abasha
Lanchkhuti
Chkhorotsku
Martvili
Poti
Elevation
Topo (m)
Geodetic points (m)
Pass
Water level mark(m)
Settlements
Region center
District center
Sakrebulo's center
Borders
Regions
District
Roads & Railway
Main road
Local road
Railway(R station)
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
Vegetation
Bush
Forest
LEGEND
Map Scale For A3 : 1 : 300 000

Map 11.

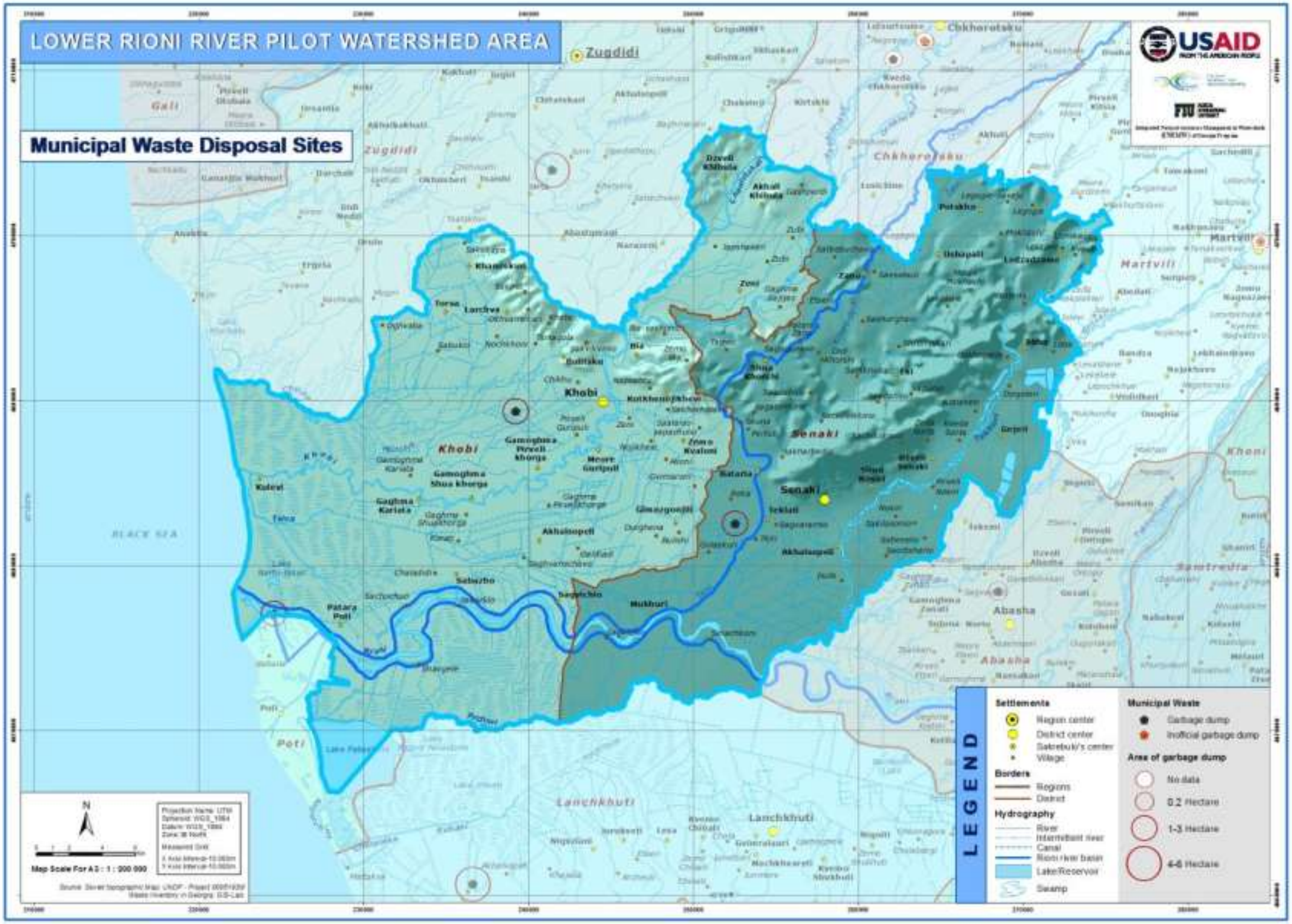

LOWER RIONI RIVER PILOT WATERSHED AREA
USAID
FROM THE AMERICAN PEOPLE
Vegetation
Colchic bog woodland
Colchic floodplain forest
Colchic forest with evergreen understory
Laurus nobilis thickets
Mezo-oligotrophic marshes with sphagnum (Sphagnetia palustrae)
Tussock sedge wetlands
Coastal Sand Dunes
Vegetation Map
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
BLACK SEA
Khobi
Senaki
Abasha
Lanchkhuti
Samtredia
Martvili
Map Scale For A3 : 1 : 200 000

Map 12.



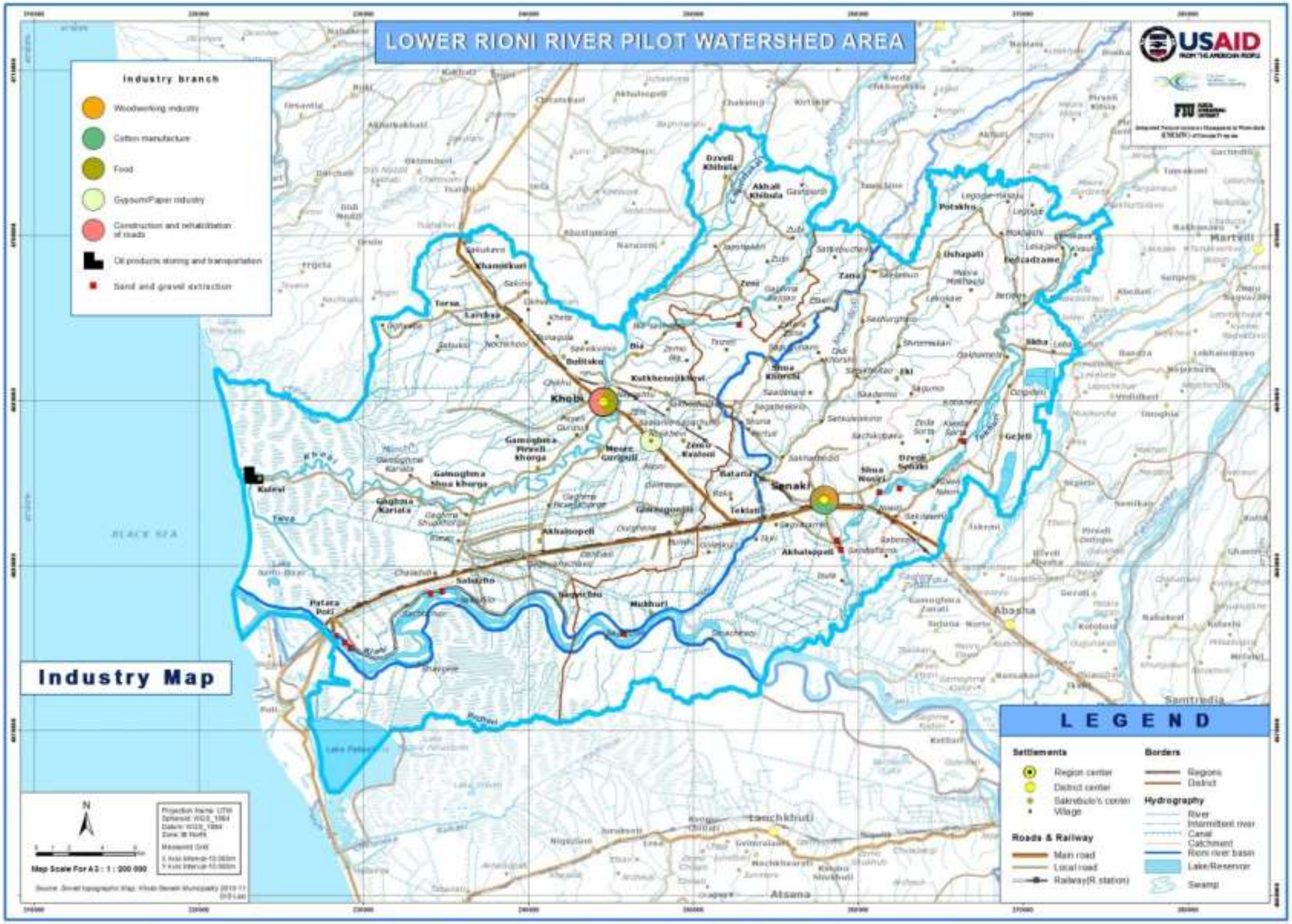
LOWER RIONI RIVER PILOT WATERSHED AREA
USAID
Combustible Minerals
Oil and Combustible Gases
Oil
Solid Combustible Minerals
Peat
Metallic Minerals
Ferrous Metals
Mn (Manganese)
Building and Refractory Materials
Carbonate rocks
Limestone
Clay rocks
Brick fired Clays
Clastic Rocks
Shingle and Gravel
Springs and Therapeutic Muds
Thermal Springs
Ore Minerals
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
BLACK SEA
Khobi
Senaki
Abasha
Samtredia
Lanchkhuti
Martvili
Map Scale For A3 : 1 : 200 000

Map 13.

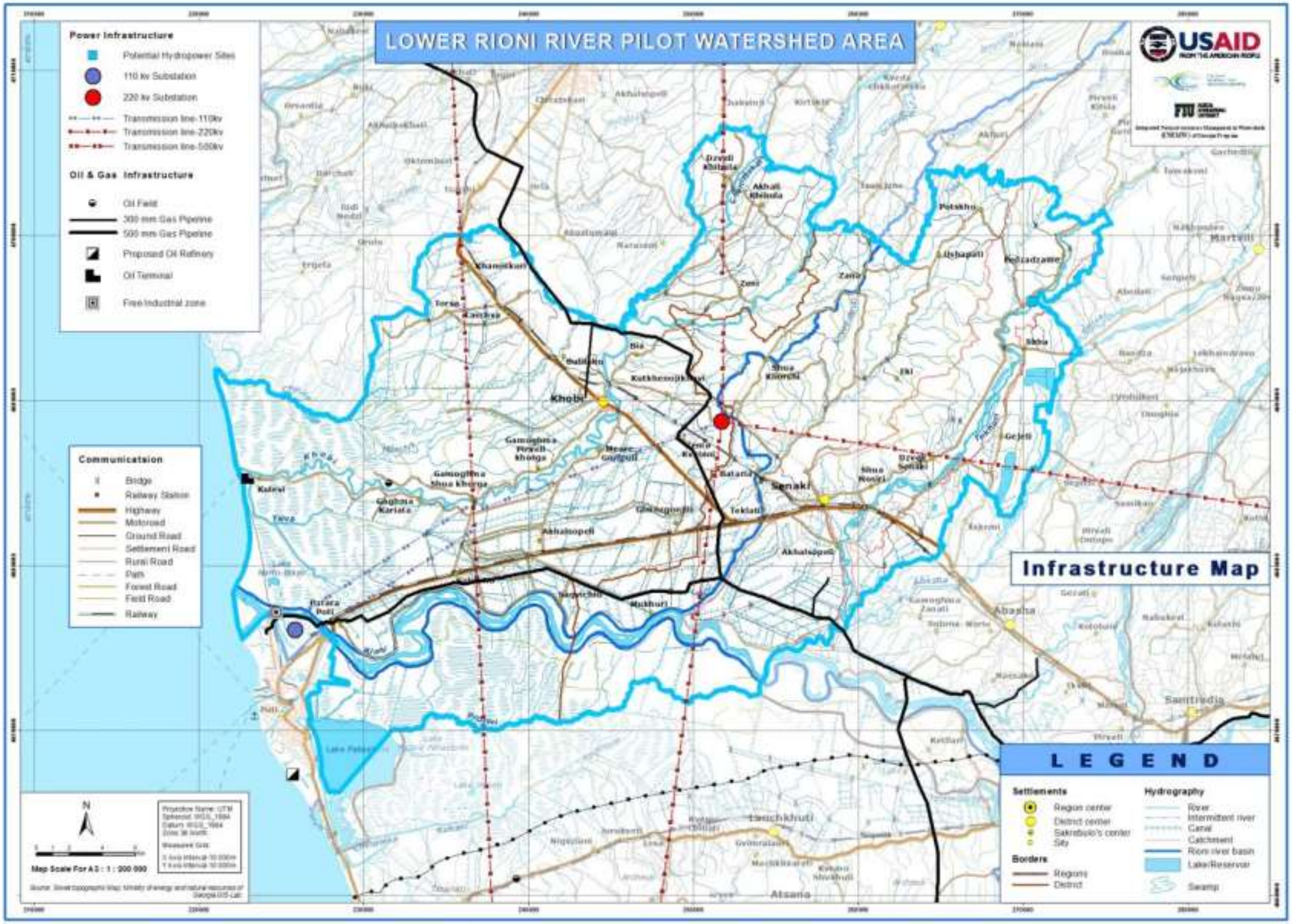


LOWER RIONI RIVER PILOT WATERSHED AREA
Municipal Waste Disposal Sites
USAID
FROM THE AMERICAN PEOPLE
Zugdidi
Chkhorotsku
Martvili
Khobi
Senaki
Abasha
Samtredia
Lanchkhuti
Poti
Khoni
BLACK SEA
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Village
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin
Lake/Reservoir
Swamp
Municipal Waste
Garbage dump
Unofficial garbage dump
Area of garbage dump
No data
0.2 Hectare
1-3 Hectare
4-6 Hectare
Map Scale For A3 : 1 : 200 000

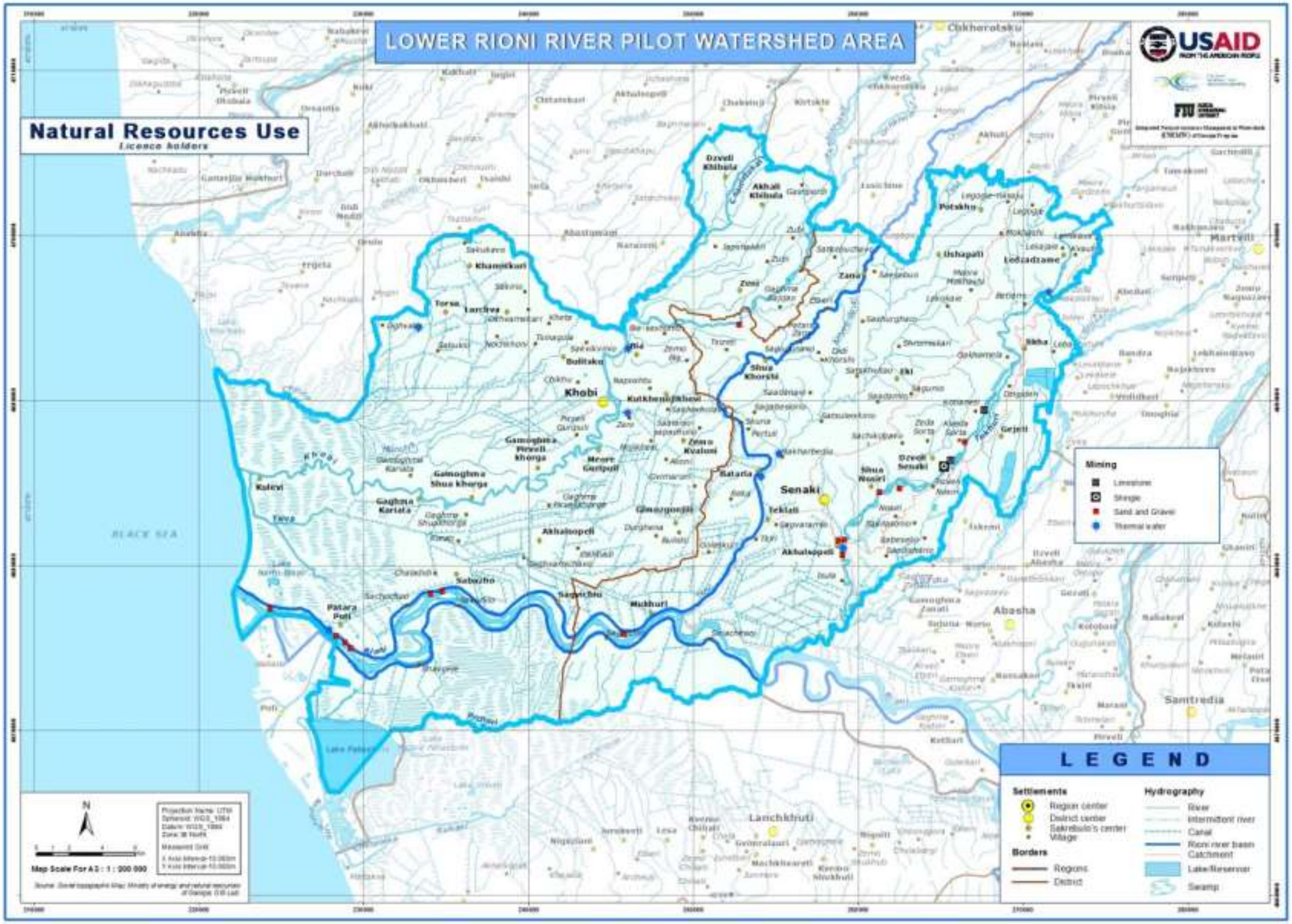
Map 14.


LOWER RIONI RIVER PILOT WATERSHED AREA
USAID
Industry branch
Woodworking industry
Cotton manufacture
Food
Gypsum/Paper industry
Construction and rehabilitation of roads
Oil products storing and transportation
Sand and gravel extraction
Industry Map
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Village
Roads & Railway
Main road
Local road
Railway(R station)
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Catchment
Rioni river basin
Lake/Reservoir
Swamp
Map Scale For A3 : 1 : 200 000
Khobi
Senaki
Abasha
Lanchkhuti
Martvili
Poti
BLACK SEA

Map 15.


LOWER RIONI RIVER PILOT WATERSHED AREA
USAID
FROM THE AMERICAN PEOPLE
Infrastructure Map
Power Infrastructure
Potential Hydropower Sites
110 kv Substation
220 kv Substation
Transmission line-110kv
Transmission line-220kv
Transmission line-500kv
Oil & Gas Infrastructure
Oil Field
300 mm Gas Pipeline
500 mm Gas Pipeline
Proposed Oil Refinery
Oil Terminal
Free Industrial zone
Communicatsion
Bridge
Railway Station
Highway
Motoroad
Ground Road
Settlement Road
Rural Road
Path
Forest Road
Field Road
Railway
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Sity
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Catchment
Rioni river basin
Lake/Reservoir
Swamp
Map Scale For A3 : 1 : 200 000
Khobi
Senaki
Abasha
Samtredia
Martvili
Poti
Kulevi
Lanchkhuti
Atsana

Map 16.


LOWER RIONI RIVER PILOT WATERSHED AREA
Natural Resources Use
Licence holders
USAID
FROM THE AMERICAN PEOPLE
Mining
Limestone
Shingle
Sand and Gravel
Thermal water
LEGEND
Settlements
Region center
District center
Sakrebulo's center
Village
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Rioni river basin Catchment
Lake/Reservoir
Swamp
BLACK SEA
Khobi
Senaki
Abasha
Samtredia
Lanchkhuti
Martvili
Map Scale For A3 : 1 : 200 000

Map 17.


LOWER RIONI RIVER PILOT WATERSHED AREA
Cultural resources
USAID
Zugdidi
Khobi
Senaki
Abasha
Samtredia
Lanchkhuti
Martvili
BLACK SEA
Symbols
Church
Fortress
Cave
Settlements
Region center
District center
Sakrebulo's center
Village
Borders
Regions
District
Hydrography
River
Intermittent river
Canal
Lake/Reservoir
Swamp
Roads & Railway
Main road
Local road
Railway(R station)
LEGEND
Map Scale For A3 : 1 : 200 000
N

Annex 3. Evaluation of the Vulnerability of River Runoff of the Lower Rioni Pilot Watershed Area to the Climate Change

Introduction

The lower pilot watershed area of the Rioni River Basin is one of the densely populated regions of Georgia. This territory is highly susceptible to natural disasters, including floods, flash floods, geodynamic processes, tectonic subduction of the coastline, coastal and delta erosion, etc. These processes intensify over time due to increased anthropogenic and natural pressures imposing significant threats to the region's environment and economy.

For the purpose of having scientific knowledge and for taking knowledgeable decisions on the prevention/mitigation of negative impacts of the natural disasters on the Lower Rioni pilot watershed area, we have assessed the vulnerability of the river runoff of the pilot region against the ongoing and future climate change impacts. For this assessment, we have used two computer models: PRECIS (Providing Regional Climates for Impacts Studies) [1], a regional climate change model, and WEAP (Water Evaluation and Planning System) [2, 3], a hydrological model.

In order to make a forecast/prognosis of the river runoff by the end of the 21st century, we have entered expected values of climate parameters received through climate simulation using the PRECIS model. These parameters include precipitation, temperature, relative humidity and average wind velocity. Following which, we have modeled the change in average annual and seasonal river runoff.

1. Hydrological Description of the Lower Pilot Watershed Area of the Rioni River Basin

Downstream Kutaisi, on the Kolkheti lowland, the Rioni River bed widens up to 250 m with a depth of 0.8 m and flow velocity at 0.7-1.5 m/sec. In the extreme lower courses, the river flows in swamps and marshes. Here, its width is 100-150 m and depth ranges between 1-5 m with a flow velocity of 0.6-1.2 m/sec. On the river delta, the slope is 1‰ and the delta is considered as very deep, which indicates that sea surges and storms have significant impacts on the coastal line.

River runoff is equally distributed among all seasons. At the river mouth, the river regime is determined by regimes of numerous smaller tributaries. Here, the Rioni River is characterized with flash floods throughout the year as well as with relatively high winter runoff. The river originating in high mountains has prolonged flood/high water seasons from March through June. The Tkhenistskali and Kvirila rivers have the same river regime. The minimum water discharge is recorded in early fall and the minimum in winter that slightly exceeds the discharge in fall.

Groundwaters of Kolkheti lowlands (Lower Pilot Watershed Area): the extreme downstream of the Rioni River basin, predominately in the coastal zone, are represented by upper aquifers contained in recent coastal marine and alluvial, marshy and alluvial sediments. Recent (quaternary) alluvial sediments are composed of sands, sandy gravels and clays and are found at a depth of 10-15m. The water is composed of bi-carbonates, calcium and magnesium. Black Sea recent marine and alluvial sediments are represented by sands and loams and are found at a depth of 5-10 m. The water is of bicarbonate, calcium and magnesium type. Recent marshy formations are represented by sands, clays, turf and peat at 5-30m depth. The groundwater is bicarbonate calcium-magnesium type and is fed mainly by rain water (in Poti, atmospheric precipitation is 1,660mm). Recent marine and alluvial sediments are the most common in the coastal areas with alluvial sediments varying from several hundred meters to several km wide. The water is mostly found at a depth of 1-5 m in the sands and gravels on the coastline and 0.5-1 m deep in marshes. The proximity of the groundwater column to the ground surface is the major determining factor for the existence of marches. The water discharge here is 0.1-1 l/s. Overall, groundwater salinity is 0.3-0.5 g/l and it flows from east to west at a very slow pace. Water recharge rate exceeds discharge rate.

2. Inventory of Hydrometeorological Data of the Lower Rioni Pilot Watershed Area

We have selected one hydrological gauging site of Sakochakidze, on the lower reaches of the Rioni River and used its data for calibration and validation of the hydrological model. Apart from this, we have used the data of other gauging posts located on the Rioni River and its tributaries. One post is located at the Gumati HPPs (Rioni) and 4 others on the tributaries of the Rioni River, which are: Nakhshirgele on the Kvirila River; Didvela on the Khanistskali River, Khidi on the Tskenistskali River; Nakalakevi on the Tekhur River. Regardless of the fact that 3 out of 4 hydrological observation sites are located outside the Lower Rioni pilot watershed area, we have taken into consideration the changes in the hydrological regime at these sites in order to make more accurate forecasts of the river runoff in the lower reaches of the Rioni River.

It has to be noted that hydrological observations on the Kvirila, Khanistskali, Tskhenistskali and Tekhuri rivers started in the early 1920s. However, the majority of the gauging sites discontinued operations in 1990s. Regardless of the facts that hydrological monitoring continued until 1990, the official observation data were published only for the period until 1987.

Average monthly and annual water discharge (same as runoff) values for the Rioni River (on the territory of Senaki and Khobi municipalities) and its tributaries are given below on figure 1, table 1.

Figure 1. Multi-year Monthly Average River Runoff (m^3/sec) of the Downstream Rioni and its Tributaries

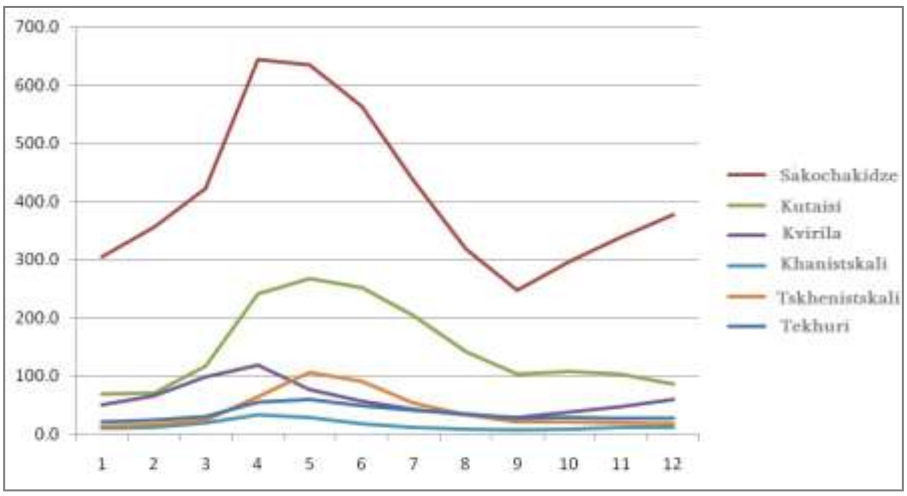


Table 1. Multi-year Annual Average River Run-off (m^3/sec) of the Lower Course of the Rioni River and its Tributaries (1943-1985)

	Minimum	Maximum	Average
Sakochakidze	310.583	523.833	405.831
Kutaisi (Gumati)	111.125	179.467	145.661
Kvirila	37.508	93.392	59.537
Khanistskali	8.490	20.034	15.261
Tskhenistskali	23.551	53.058	39.690
Tekhuri	26.742	47.742	35.423

3. Modeling of River Runoff in Downstream Sub-catchments of the Rioni River Basin by Applying WEAP

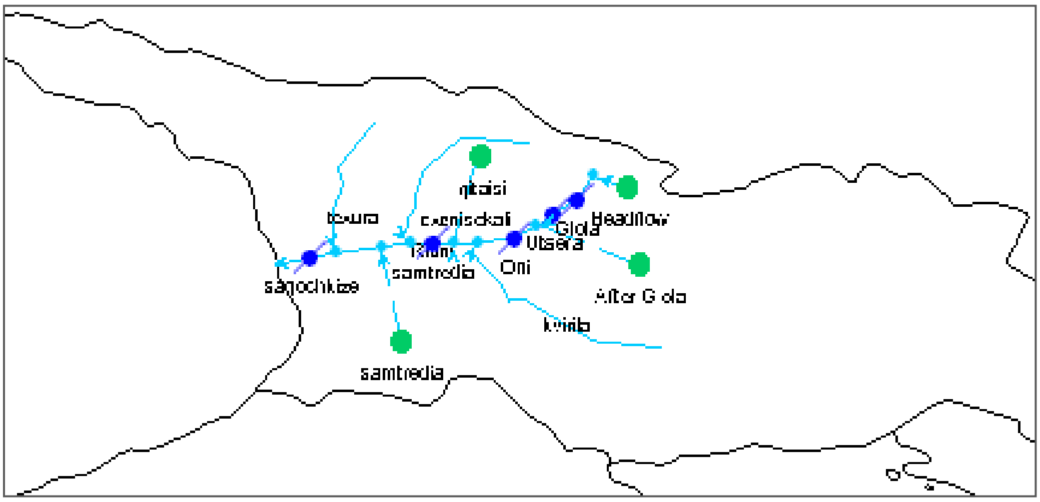


Figure 2. Sketch of the Downstream Sub-Catchments of the Rioni River Basin Generated by WEAP

We have modeled the upstream river runoff of the Rioni River until the gauging site of Khidikari. Near Gumati HPP, two left tributaries Kvirila and Khanistskali flow into the Rioni River. In this section of the River, we have used meteorological data recorded at the Kutaisi meteorological station. For a description of hydrometeorological conditions of the sections from Kutaisi to the Sakochakidze gauging site, we have used the data on Samtredia station. In Senaki Municipality, Techuri and Tsiva rivers flow into the Rioni River.

Hydrological modeling for Khanistskali and Kvirila sub-catchments has been conducted for one watershed unit comprising both rivers. For description of climate conditions in this section, we have used data on two meteorological stations: Mta-Sabue and Chiatura. Climatic conditions in the Tskhenistskali sub-catchment have been described based on meteorological data of Koruldashi and Lentekhi. The climate of the Tekchuri sub-catchment has been evaluated based the data on Senaki Meteorological Station.

4. Description of WEAP Input Parameters and Simulation Methods

Water catchments can be divided into different types depending on climate conditions, vegetation cover, soil type and other characteristics. The applied hydrological model simulates two hydrological situations [3]. The first scenario is a catchment that creates underground flows beginning with complicated topographic conditions, inclined slopes and mountainous landscape and finally flowing into the river [8].

The second scenario describes the lower course of rivers flowing on plain territories. The river may have connections with groundwater which, based on different hydrological processes, is either fed by or feeds the river. The model also considers the possibilities of modeling the characteristics of underground aquifers.

For hydrological modeling of the lower courses of the Rioni River Basin, we have applied two-bucket methods, which is one dimensional, 2-compartment soil moisture accounting scheme based on empirical functions describing evapotranspiration, surface runoff, sub-surface runoff (i.e., Interflow) and deep percolation[1] for a watershed unit (e.g. sub-catchment).

Similar to all models, WEAP requires input of data from external sources. The following represents the data variables included in the model:

Climate parameters per given time step/series (decade, month, year depending on the period of modeling)

- Total atmospheric precipitation for the given time step (P, mm);
- Average temperature during the given time step (°C);
- Relative humidity for the given time step (%);
- Average wind velocity for the given time step (m/sec);
- Melting and freezing temperatures (°C);
- Geographic coordinates (°).
- **Soil and vegetation cover/canopy:**
- Catchment area (km^2);
- Crop/plant coefficient (Kc);
- Relative soil capacity in root and deep zones at the starting point of the given time step, equivalent to relative storage (initial z_1 and z_2) (%);
- Soil water retention capacity (Sw, mm);
- Deep water storage capacity (Dw, mm);
- Hydraulic conductivity of the soil upper layer same as root zone (k_1, mm/month);
- Hydraulic conductivity of the soil lower layer same as deep conductivity (k_2, mm/month);
- Infiltration coefficient - quasi-physical adjustment factor related to soil, land cover type, and topography that fractionally partitions water either horizontally or vertically (f, 0-1);
- Leaf and Stem (Canopy) Area Index (LAI, 0.1-10).

Based on the above parameters, the model calculates the following values:

[1] The deep percolation within the watershed unit can be transmitted to a surface water body as baseflow or directly to groundwater storage if the appropriate link is made between the watershed unit node and a groundwater node. http://www.weap21.org/webhelp/two-bucket_method.htm

- Snow accumulation (SA, mm);
- Snow melting rate (Mr, mm/month);
- Efficient precipitation ($P_{e,}$ mm). This is the function of precipitation (P), accumulated snow (SA) and snow melting speeds (Mr);
- Potential evapotranspiration (PET, mm). The Penman-Monteith method is used to calculate this value depending on climate parameters and geographic location;
- Real evapotranspiration (Et, mm). This is a function of potential evapotranspiration (PET), the crop ratio (KC) and the ratio of water content of upper layer of soil (z_1);
- Surface runoff (SR, m^3/month) is a function of the resistance index (LAI), the ratio of water storage of the top layer of the soil (z_1) and efficient precipitation (P_e);
- Deep percolation (Per, m^3/month). This is the function of the ratio of water storage of the upper layer of soil (z_1), hydraulic conductivity of the upper layer of soil (k_j) and distribution parameter (f);
- Interflow (If, m^3/month). This is a function of the ratio of water storage of the upper layer of soil (z1), hydraulic conductivity of the upper (root zone) layer of soil (kj) and the distribution parameter (f);
- Base flow (Bf, m^3/month). This is the function of the ratio of water storage of lower layer (z_2) and hydraulic conductivity of the lower (deep) layer of soil (k_2).

By calculating the above values, the model solves the following equation of the mass balance:

$$Sw_j \frac{dz_{1,j}}{dt} = P_e(t) - PET(t)k_{c,j}(t)\left(\frac{5z_{1,j} - 2z_{1,j}^2}{3}\right) - P_e(t)z_{1,j}^{\frac{LAI_j}{2}} - f_j k_j z_{1,j}^2 - (1-f_j)k_j z_{1,j}^2 \tag{1}$$

The mathematical expression 1 solves the equation using a fourth-order rank Kutta algorithm, for which iteration numbers and accuracy can be indicated.

Before using meteorological parameters in the model, they must be carefully assessed to determine how well they reflect the climate of the relevant water catchments. Climate parameters may be measured at a height different from the average height of the water catchments. If so, relevant functions or procedures must be applied to elevate them as necessary.

5. WEAP Calibration for Lower Pilot Watershed Area/ Downstream of the Rioni River

The model was **calibrated** before making projections using the model. Not all necessary parameters for the model can be measured. The values of such variables can be assessed by calibration. Calibration means selecting the values of the parameters that will result in the values of the simulated (modeled) and observed streamflow as close as possible. WEAP has a special module for automatic calibration; however, this function was added recently and needs further development. On the other hand, manual calibration is a long and labor-intensive process.

To verify the goodness of fit of the selected parameters and the models, they must be **validated**. During validation, the calibrated model is run for the period of existing measured streamflow values and then modeled and measured values are compared. It is a common practice to use the same time steps/intervals for both calibration and validation.

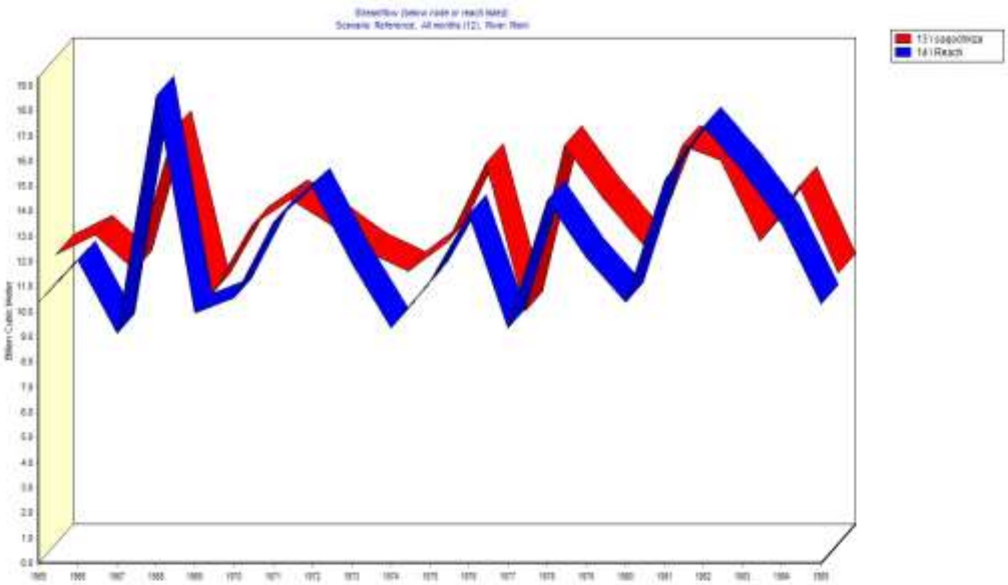
The correlation (goodness of fit) of the annual modeled river runoff with the annual observed runoff is the validation criterion. Relative deviation was used to evaluate the goodness of fit: [2]

$$bias = \frac{\sum_{i=1}^{T} |Obs_i - Sim_i|}{\sum_{i=1}^{T} Obs_i} \times 100\%$$

Where:

Obs_ii is the value of observed runoff, while Sim_i is the modeled runoff for the same time series. The smaller the relative deviation, the more acceptable/accurate is the model.

Projection of the future with absolute accuracy is impossible. Any projection generated using a model is characterized by uncertainty. In the case of a hydrological model, the lack of certainty can be attributed to: a) error in measuring the parameters; b) error made while elevating climate data for different altitudes; or c) error of the model itself caused by its simplified hydrological system. While projecting the impact of climate change, additional errors may be caused by socio-economic scenarios and climate models.



Graph 3. Rioni Streamflow at the Sakochakidze Gauging Site (1965-1985)

The chart provides observed and modeled values at the Sakochakidze gauging site and demonstrates the proximity of simulated values to the measured ones. The maximum absolute deviation is 22% and relative deviation is 3.7%.

[2] Standard deviation expressed in percentages

6. Calculation of Climate and Hydro-Geological Parameters based on Empirical Observation Data

After the model calibration, the following data variables and values were entered into the model:

- Absolute water storage/capacity of the root zone of the soil – 1000 mm;
- Absolute water storage/capacity of the deep zone – 1000 mm;
- Crop index;

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Kc	3	3	0.1	0.1	0.1	0.3	0.1	0.1	4	4	2	4

- Runoff resistance factor RRF =1;
- Root conductivity – 30. This parameter is measured as a ratio between deep/base and surface flows. Hydraulic conductivity of the deep soil – 20. This parameter measures the flow of the groundwater. Preferred runoff flow direction – 0.15, measured as a ratio of surface runoff and interflow;
- Initial Z1 - percentage share of absolute root water storage capacity, same as relative soil root zone water storage capacity– 40;
- Initial Z2 – percentage share of the absolute deep soil storage capacity, same as relative soil water storage capacity–40;

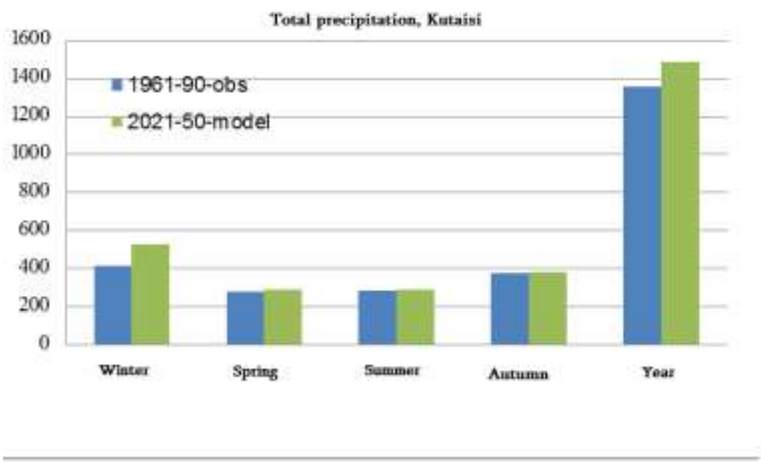
7. Streamflow Modeling of Lower Courses of the Rioni River Basin under Various Climate Change Scenarios

For modeling of climate parameters, a regional model PRECIS was applied using ECHAM4 global model limits and A2 and B2 GHG emission scenarios for 2020-2050 time horizon.

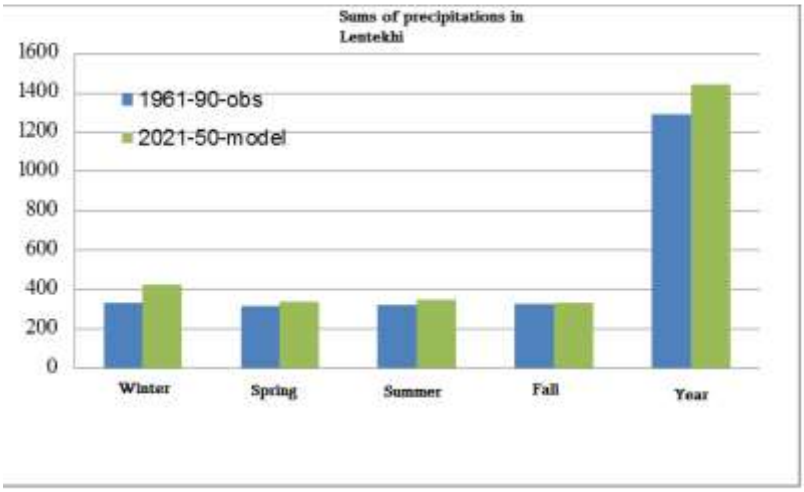
Climate forecasting requires identification of the changes in greenhouse gas emissions [2, 6]. The Special Report on Emissions Scenarios (SRES) developed by the Intergovernmental Panel on Climate Change (IPCC) identifies various scenarios of greenhouse gas emissions under different socio-economic development trends/patterns while considering expected changes in population, economy, energy and technology. Greenhouse gas emission scenarios within the frames of possibility, demonstrate future emissions of substances characterized by active radiation (greenhouse gases) or admixtures characterized by active radiation (sulphur dioxide-producing sulphate particulates). The scenarios are based on factors causing emissions (socio-economic development and technological changes) and their linkages. The SRES scenarios comprise 4 main families: A1, A2, B1, and B2 [6].

The A2 scenario, the most pessimistic, characterized by a very high emission of greenhouse gases, was used to prepare this report together with B2 scenario predicting optimistic level emissions of GHGs into the atmospheric air. Forecasts of future streamflow were made based on A2 scenario.

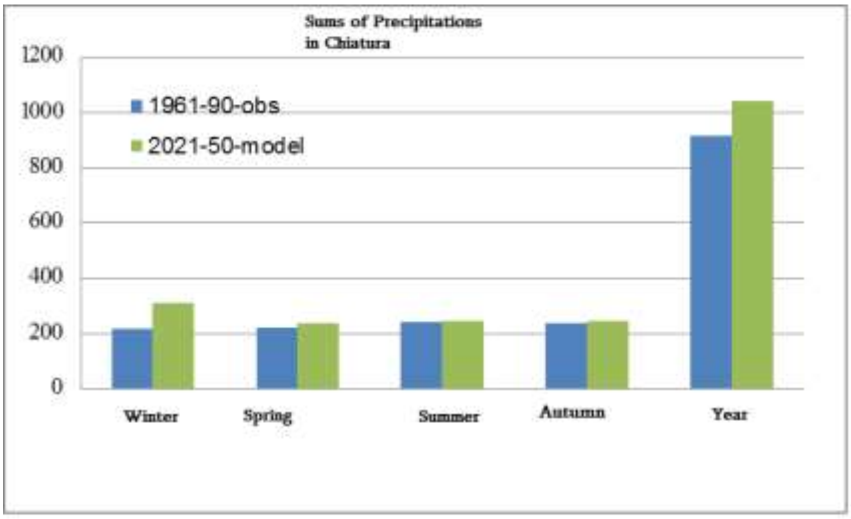
According to A2, increase in average annual temperature by 2 **degree Celsius** (°C) on the selected meteorological observation sites is expected together with precipitation amounts ranging from 1 to 11%. Graphs 4-6 illustrate forecasted/simulated precipitation values for Kutaisi, Chiatura and Lentekhi meteorological stations.



Graph 4. Observed and Modeled Values of the Sums of Precipitation in Kutaisi



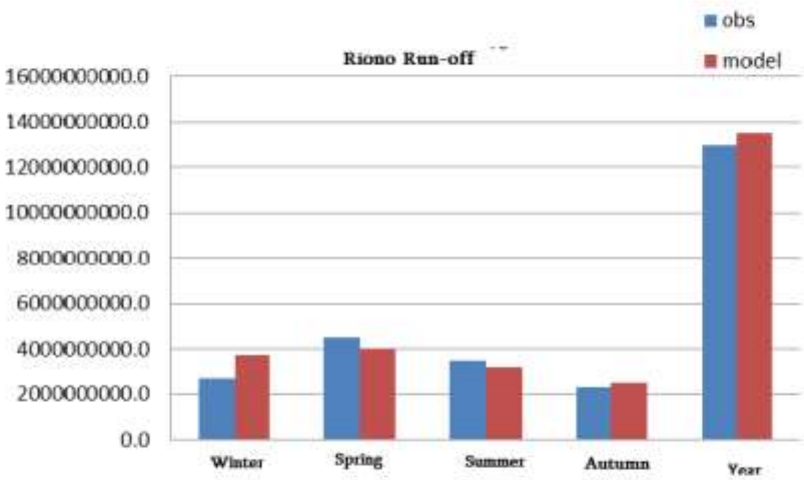
Graph 5. Observed and Modeled Values of the Sums of Precipitation in Lentekhi



Graph 6. Observed and Modeled Values of the Sums of Precipitation in Chiatura

Under the above forecasted precipitation values, the runoff in the catchments of Kvirila and Khanistskali rivers will increase by 7% and the amounts of precipitation will increase by 10%. It should be noted rain water's share of total river runoff is 45%.

The amounts of precipitation in the catchment of the Tskhenistskali River will increase by 16% that will lead to 10% increase in the river runoff. In the Tekhuri River, catchment runoff increase will reach 14%, while in the extreme downstream of the Rioni River only 2% increase in the stream flow is expected. Seasonal distribution of Rioni runoff is given on graph 7.



Graph 7. Simulated and Observed Values of the Rioni River Runoff at the Sakochakidze Gauging Site (m^3/y).

As demonstrated in the graph, the river runoff will increase in winter and this will impact annual water flow. At the majority of meteorological sites, sums of precipitation for winter seasons will increase significantly (20-28%). This factor coupled with the notable rise in winter temperature, the total amount of precipitations will increase within the entire areas on the lower courses of the Rioni River and the sub-catchments of its tributaries. During spring and summer seasons which are characterized with frequent floods and flash floods, river runoff will decrease, and then slightly increase in fall season. Change in river runoff at the Sakochakidze gauging site is given in Table 2. This simulation considers changes in the upstream of the River as well as in the catchments of its tributaries joining the Rioni River in its lower courses.

Table 2. Seasonal and Annual River Runoff Change in the Downstreams of the Rioni River (2021-2050).

	Winter	Spring	Summer	Fall	Year
Percentage change (%)	38.19028	-10.43477	-7.07085	9.36742	6.03026

Table 3. Observed and Forecasted Average Annual Runoff Values for the Rioni River

Period and Time Step	Total Runoff (million m^3/y)
1956-1985 observed	12582.9
2021-2050 ECHAM_A2	14163.3

The table above shows that roughly 6% water flow increase is expected in the downstreams of the Rioni River by the year 2050, using A2 scenario of the ECHAM4 model.

8. Conclusions

According to the modeling of the Rioni River runoff on its lower courses from Gumati to Sakochakidze gauging site, a 6% streamflow increase is expected by the year 2050. The runoff will increase during the winter season. The same can be said for the fall runoff. On the other hand, runoff decrease in spring and summer seasons will reduce the risks of floods and flash floods, though floods risks will remain high due to the presence or acceleration of other negative pressures leading to the low DRR capacity of local ecosystems, population and infrastructure. In addition, it is noteworthy that the amounts of precipitation will increase together with the number and duration of rainy periods that will contribute to the increase in risks of flash floods.

Unfortunately, it is impossible to forecast floods and flash floods applying WEAP together with the forecast of glacier accumulation and retreat. Therefore, we have predicted the Rioni River runoff without taking into consideration glacier share of total streamflow. This issue needs separate investigation.

9. Bibliography

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Annex 4a. Hydrological Data

Table 1. Multi-year Annual and Monthly Average Runoff of the Rivers of Senaki and Khobi Municipalities that Belong to the Rioni River Basin at Gauging Sites (m^3/sec)

River	Gauging Site	F (km^2)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Rioni	Sakochakidze	13300	277	352	445	635	654	551	407	280	237	310	295	331	399
Tekhuri	Nakalakevi	558	20.2	22.8	28.2	49.0	57.1	45.7	34.3	27.2	24.5	30.0	25.4	24.9	32.4

Table 2. Multi-year Annual and Monthly Average River Flow Volumes of the Rivers of Senaki and Khobi Municipalities that Belong to the Rioni River Basin at Gauging Sites

Runoff	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
Rioni – Sakochakidze: F=13300 km^2; M_0=30.0 l/sec/km^2													
Runoff Q (Q_0 m^3/sec)	277	352	445	635	654	551	407	280	237	310	295	331	**399**
Volume (10^{6}m^3/year)	741.9	851.6	1191.8	1645.9	1751.7	1428.2	1090.1	750.0	614.3	830.3	764.6	886.6	**12582.9**
Tekhuri– Nakalakari naqalaqevi: F=558 km^2; M_0=58.1 l/sec/km^2													
Runoff Q (Q_0 m^3/sec)	20.2	22.8	28.2	49.0	57.1	45.7	34.3	27.2	24.5	30.0	25.4	24.9	**32.4**
Volume (10^{6}m^3/year)	**54.1**	**55.2**	**75.5**	**127.0**	**152.9**	**118.4**	**91.9**	**72.8**	**63.5**	**80.4**	**65.8**	**66.7**	**1021.8**

Table 3. Peak Discharges of Various Reccurances of the Rivers of the Rioni River Basin Located in Senaki Municipality

River	Gauging Site	F (km^2)	Reccurance τ year					
			1000	100	50	20	10	5
Rioni	Sakochakidze	13300	4110	3145	2850	2460	2160	1780
Tekhuri	Nakalakevi	558	1380	985	850	655	560	460

Table 4. Minimum Discharges of Various Probabilities of the Rivers of the Rioni River Basin Located in Senaki Municipality

River	Gauging Site	F (km²)	Probability P %						
			75	80	85	90	95	97	**99**
Rioni	Sakochakidze	13300	92.5	86.8	80.0	72.7	62.7	56.2	**46.0**

Annex 4.b. Surface Water Quality Data

Tables and Figures 1-10: Rioni Downstream (Poti Downstream) Water Quality Data and Trends for 2002-2012.

Table 1

Year	BOD_5 (mg/l)		
	Minimum	Maximum	Average
2002	2.35	3.10	2.81
2003	2.40	2.95	2.64
2004	2.22	3.10	2.79
2005	2.48	3.28	2.85
2006	1.06	2.00	1.35
2007	1.45	2.57	2.04
2008	1.50	2.40	1.99
2009	1.40	2.40	1.88
2010	1.50	2.70	2.00
2011	1.60	2.50	2.02
2012	1.50	2.50	1.95

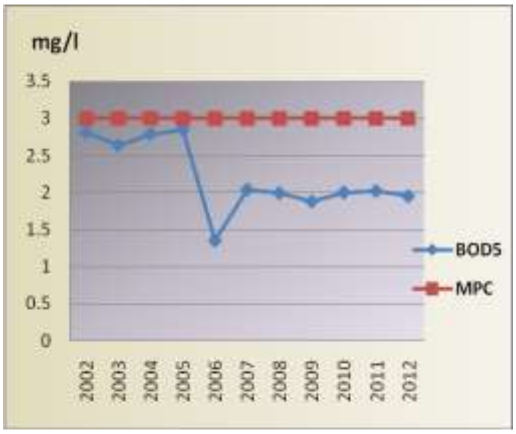


Figure1. Concentration of BOD5

Table 2

Year	Ammonia, NH_4/N (mg/l)		
	Minimum	Maximum	Average
2002	0.29	1.53	0.90
2003	0.38	1.27	0.96
2004	0.51	1.45	1.03
2005	0.80	1.89	1.36
2006	0.18	1.26	0.59
2007	0.26	1.57	0.89
2008	0.58	1.97	1.12
2009	0.25	1.22	0.94
2010	0.32	1.98	1.21
2011	0.48	2.86	1.38
2012	1.48	2.66	0.64

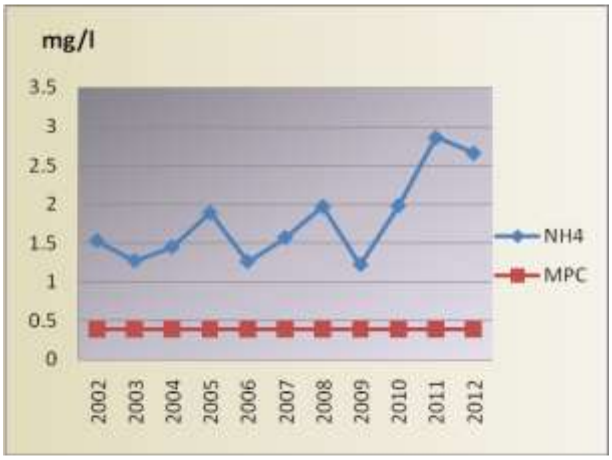


Figure 2. Concentration of Ammonia Ions

Table 3

Year	Nitrate, NO_3/N (mg/l)		
	Minimum	Maximum	Average
2002	0.20	0.92	0.54
2003	0.20	1.74	0.87
2004	1.20	1.96	1.54
2005	0.44	1.72	0.89
2006	0.03	0.36	0.16
2007	0.28	1.24	0.72
2008	0.24	1.44	0.77
2009	0.36	1.00	0.61
2010	0.26	1.32	0.82
2011	0.36	1.92	1.02
2012	0.46	1.62	0.93

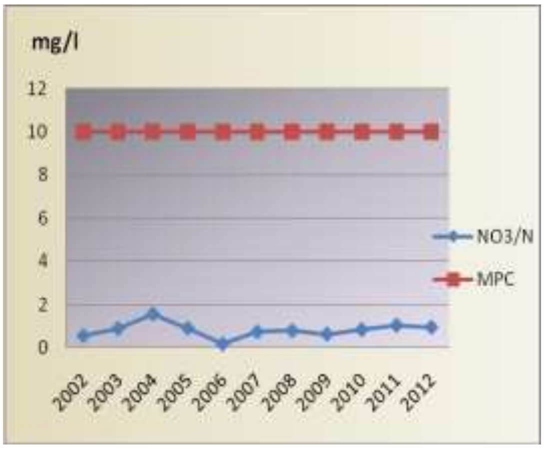


Figure 3. Concentration of Nitrate Ions

Table 4

Year	Nitrite, NO_2/N (mg/l)		
	Minimum	Maximum	Average
2002	0.026	0.400	0.127
2003	0.020	0.055	0.033
2004	0.026	0.040	0.032
2005	0.010	0.042	0.029
2006	0.008	0.136	0.049
2007	0.015	0.086	0.034
2008	0.020	0.062	0.037
2009	0.028	0.076	0.043
2010	0.011	0.071	0.032
2011	0.015	0.075	0.036
2012	0.024	0.062	0.056

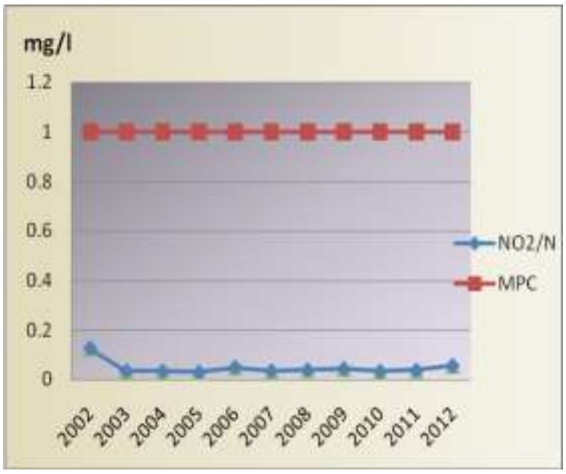


Figure 4. Concentration of Nitrite Ions

Table 5

Year	Phosphate, PO_4 (mg/l)		
	Minimum	Maximum	Average
2002	0.012	0.080	0.043
2003	0.034	0.103	0.069
2004	0.057	0.086	0.070
2005	0.074	0.103	0.086
2006	0.017	0.098	0.058
2007	0.034	0.122	0.079
2008	0.030	0.105	0.065
2009	0.031	0.098	0.062
2010	0.029	0.080	0.051
2011	0.040	0.105	0.066
2012	0.052	0.098	0.073

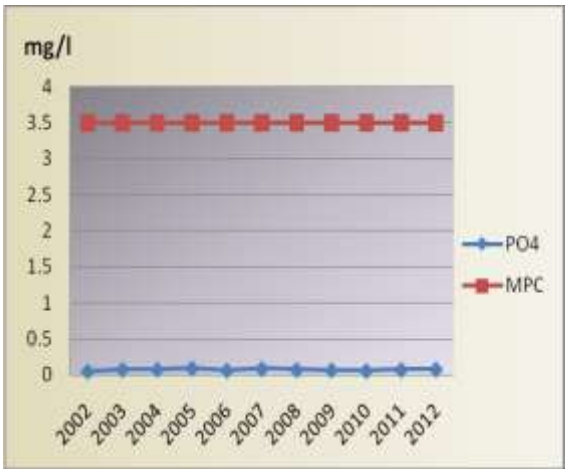


Figure 5. Concentration of Phosphate Ions

Table 6

Year	Copper (mg/l)		
	Minimum	Maximum	Average
2005			
2006	0.007	0.017	0.012
2007	0.004	0.100	0.030
2008	0.008	0.015	0.012
2009	0.002	0.017	0.060
2010	0.012	0.014	0.013
2011	0.025	0.036	0.031
2012			

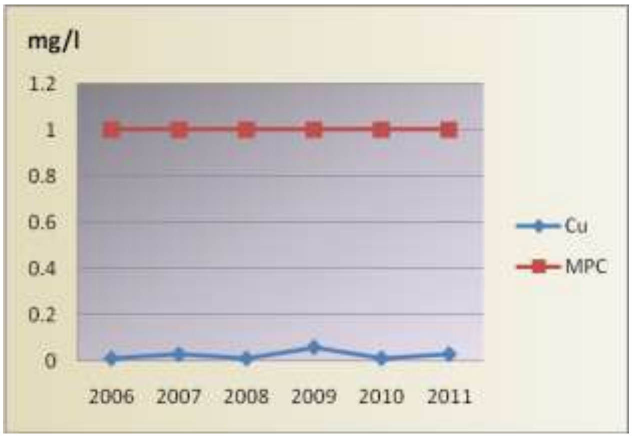


Figure 6. Concentration of Copper Ions

Table 7

Year	Iron, Fe (mg/l)		
	Minimum	Maximum	Average
2002	0.46	0.66	0.55
2003	0.39	0.92	0.59
2004	0.42	0.58	0.50
2005	0.31	0.70	0.52
2006	0.10	0.60	0.29
2007	0.20	0.58	0.36
2008	0.19	0.62	0.43
2009	0.27	0.54	0.36
2010	0.23	0.54	0.36
2011	0.23	0.39	0.34
2012	0.27	0.62	0.42

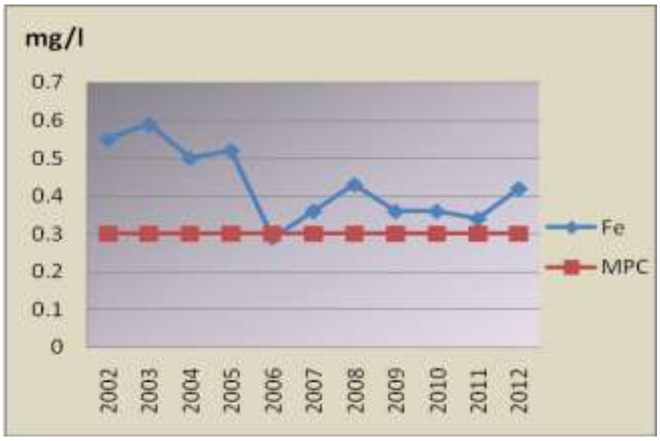


Figure 7. Concentration of Iron Ions

Table 8

Year	Manganese, Mn (mg/l)		
	Minimum	Maximum	Average
2002			
2003			
2005			
2006	0.010	0.091	0.035
2007	0.035	0.296	0.082
2008			
2009	0.006	0.314	0.089
2010	0.035	0.052	0.042
2011	0.037	0.049	0.043
2012			

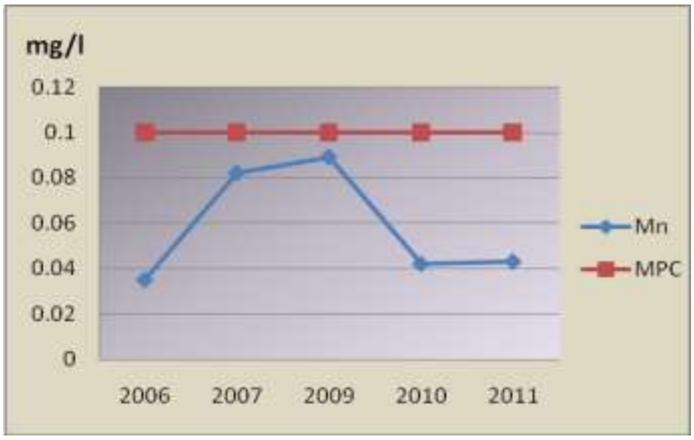


Figure 8. Concentration of Manganese Ions

Table 9

Year	Dissolved Oxygen (mg/l)		
	Minimum	Maximum	Average
2002	8.20	9.38	8.91
2003	7.15	9.28	7.84
2004	8.10	8.45	8.20
2005	7.65	9.15	8.34
2006	7.25	10.50	8.24
2007	6.40	10.10	8.11
2008	7.00	12.80	9.92
2009	7.30	10.60	8.80
2010	6.10	10.60	8.50
2011	7.20	10.40	8.68
2012	8.00	10.00	8.95

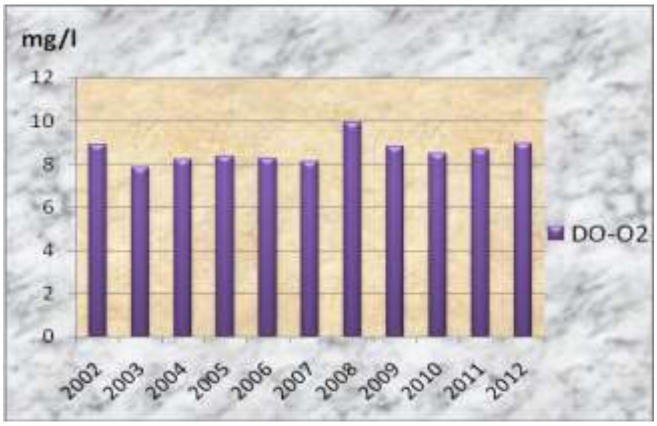


Figure 9. Concentration of Dissolved Oxygen

Table 10

Year	Mineralization (mg/l)		
	Minimum	Maximum	Average
2002	234.3	283.6	260.2
2003	237.4	312.9	265.2
2004	217.0	285.5	267.1
2005	221.3	367.3	315.9
2006	170.3	315.0	246.9
2007	236.0	290.4	265.0
2008	231.3	310.0	257.5
2009	235.4	281.3	253.5
2010	223.3	285.4	252.8
2011	219.2	275.0	247.1
2012	213.3	285.0	241.0

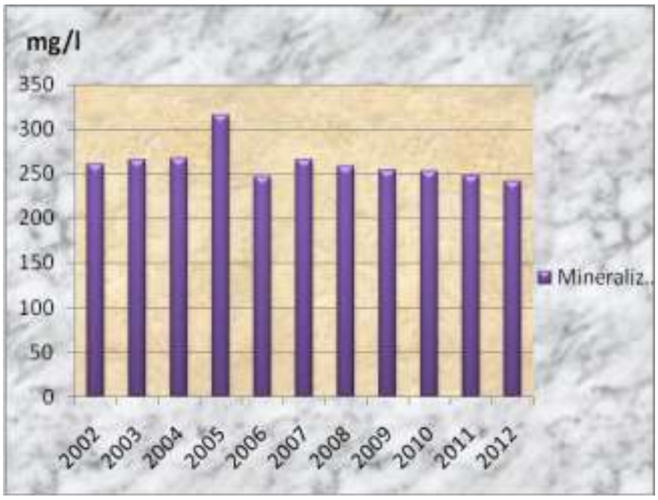


Figure 10. Concentration of Mineralization

Rioni – Poti (North)

Tables and Figures 11-20. Lower Rioni (Poti Upstream) Data and Trends for 2002-2012.

Table 11

Year	BOD_5 (mg/l)		
	Minimum	Maximum	Average
2002	2.05	3.25	2.73
2003	2.42	3.15	2.70
2004	2.20	2.63	2.46
2005	2.45	3.20	2.83
2006	1.07	2.58	1.65
2007	1.35	2.25	1.99
2008	1.60	2.50	2.05
2009	1.50	2.30	1.95
2010	1.50	2.90	1.99
2011	1.60	2.50	2.05
2012	1.50	2.50	1.97

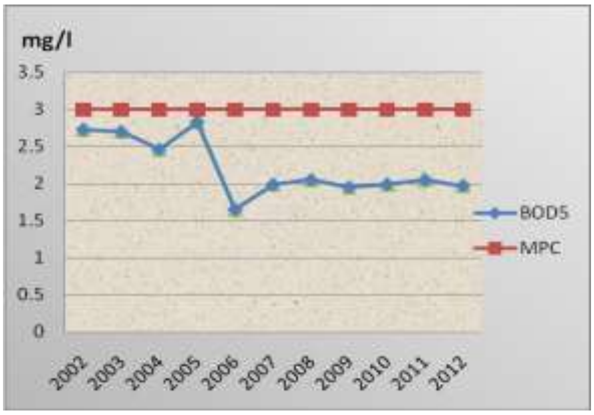


Figure 11. Concentration of BOD5

Table 12

Year	Ammonia, NH_4/N (mg/l)		
	Minimum	Maximum	Average
2002	0.79	1.31	0.97
2003	0.48	1.21	0.91
2004	0.77	1.85	1.22
2005	0.79	1.53	1.17
2006	0.29	0.38	0.35
2007	0.38	1.61	0.87
2008	0.63	2.07	1.07
2009	0.25	1.41	0.99
2010	0.46	1.98	1.17
2011	0.58	3.01	1.41
2012	0.56	2.56	1.40

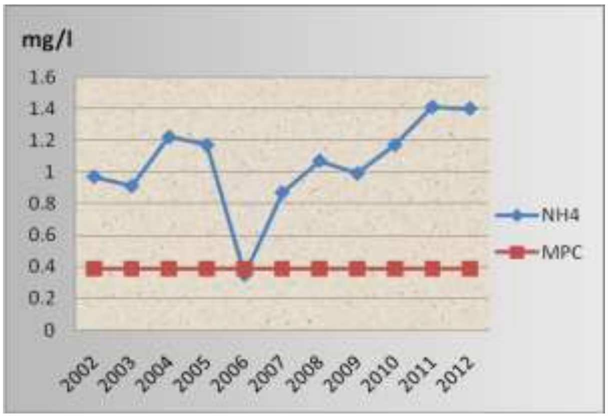


Figure 12. Concentration of Ammonia Ions

Table 13

Year	Nitrate, NO_3/N (mg/l)		
	Minimum	Maximum	Average
2002	0.24	1.58	0.704
2003	0.24	1.64	0.848
2004	1.12	1.64	1.380
2005	0.40	1.54	0.835
2006	0.04	0.20	0.127
2007	0.32	1.16	0.664
2008	0.24	1.20	0.710
2009	0.28	1.02	0.675
2010	0.28	1.24	0.860
2011	0.40	2.04	1.100
2012	0.50	1.41	0.960

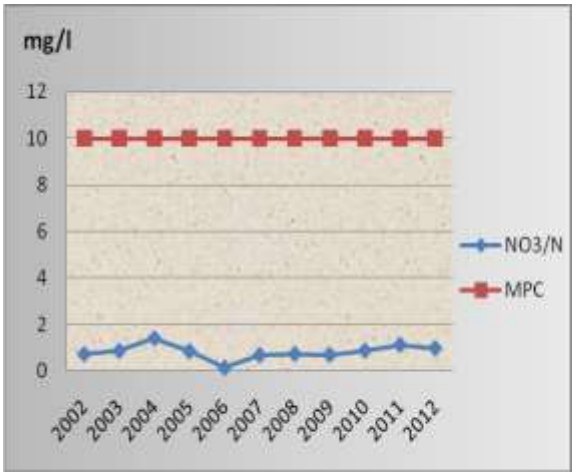


Figure 13. Concentration of Nitrate Ions

Table 14

Year	Nitrite, NO_2/N (mg/l)		
	Minimum	Maximum	Average
2002	0.028	0.477	0.123
2003	0.031	0.061	0.039
2004	0.012	0.034	0.026
2005	0.012	0.040	0.027
2006	0.004	0.020	0.011
2007	0.018	0.080	0.033
2008	0.018	0.068	0.039
2009	0.025	0.076	0.043
2010	0.015	0.072	0.035
2011	0.018	0.084	0.039
2012	0.020	0.062	0.046

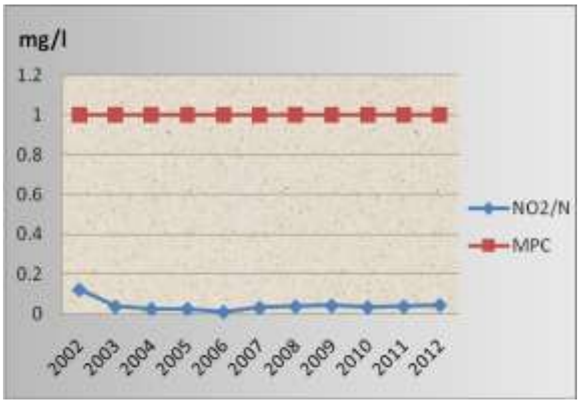


Figure 14. Concentration of Nitrite Ions

Table 15

Year	Phosphate, PO_4 (mg/l)		
	Minimum	Maximum	Average
2002	0.023	0.091	0.064
2003	0.051	0.103	0.083
2004	0.103	0.069	0.081
2005	0.046	0.103	0.074
2006	0.003	0.046	0.025
2007	0.034	0.110	0.075
2008	0.046	0.116	0.074
2009	0.046	0.110	0.063
2010	0.034	0.092	0.059
2011	0.046	0.118	0.073
2012	0.028	0.085	0.067

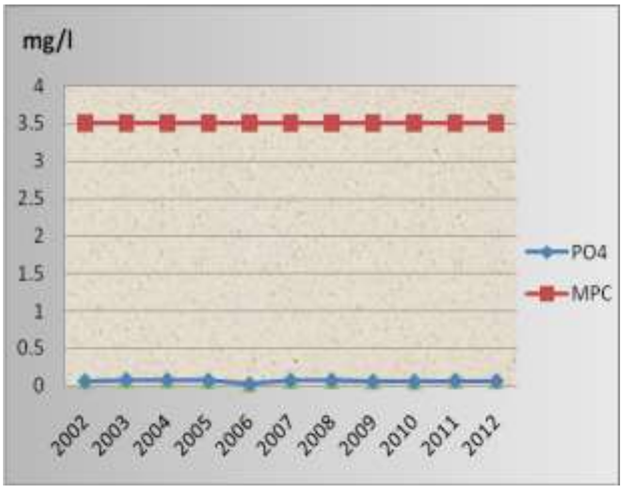


Figure 15. Concentration of Phosphate Ions

Table 16

Year	Copper (mg/l)		
	Minimum	maximum	average
2005			
2006	0.004	0.015	0.008
2007	0.008	0.195	0.041
2008	0.005	0.010	0.008
2009	0.003	0.092	0.022
2010	0.005	0.011	0.008
2011	0.027	0.048	0.036

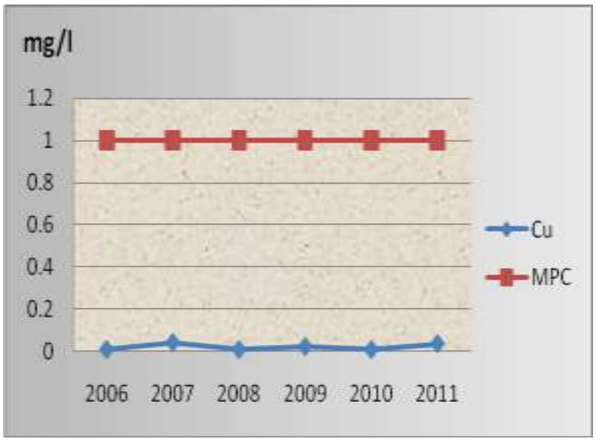


Figure 16. Concentration of Copper Ions

Table 17

Year	Iron, Fe (mg/l)		
	Minimum	Maximum	Average
2002	0.31	0.77	0.51
2003	0.39	0.77	0.55
2004	0.46	0.53	0.49
2005	0.23	0.70	0.51
2006	0.10	0.60	0.27
2007	0.16	0.54	0.33
2008	0.18	0.50	0.39
2009	0.23	0.46	0.36
2010	0.23	0.46	0.37
2011	0.27	0.54	0.38
2012	0.27	0.58	0.38

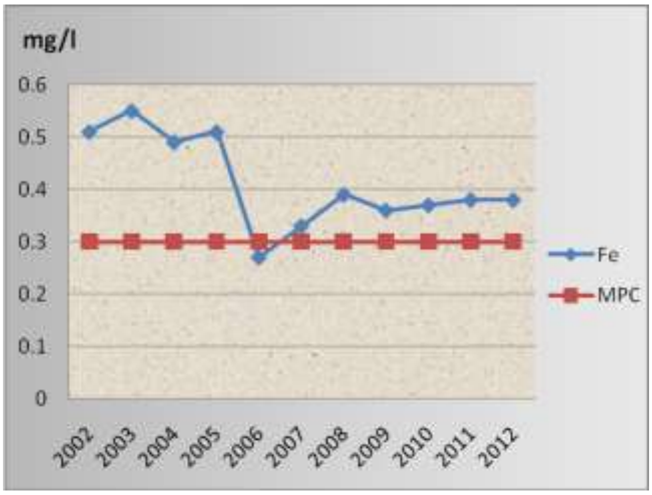


Figure 17. Concentration of Iron Ions

Table 18

Year	Manganese, Mn (mg/l)		
	Minimum	Maximum	Average
2002			
2003			
2004			
2005			
2006	0.018	0.036	0.027
2007	0.004	0.171	0.045
2008			
2009	0.004	0.226	0.084
2010	0.027	0.045	0.038
2011	0.017	0.028	0.023
2012			

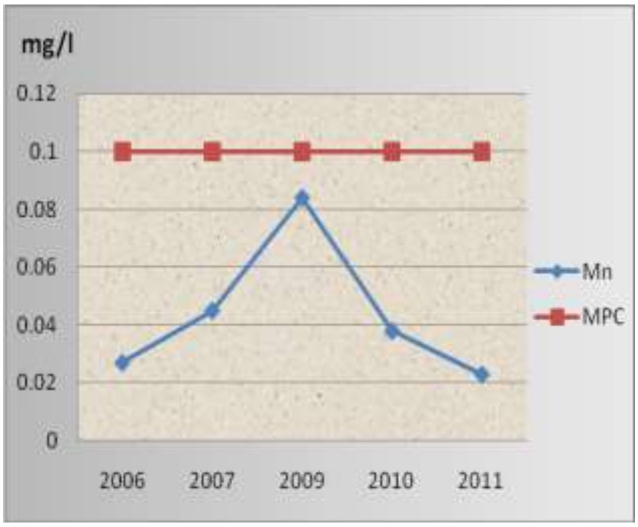


Figure 18. Concentration of Manganese Ions

Table 19

Year	Dissolved Oxygen (mg/l)		
	Minimum	Maximum	Average
2002	9.60	9.18	8.91
2003	7.05	8.82	7.76
2004	8.60	8.95	8.74
2005	7.75	8.90	8.23
2006	7.54	9.46	8.37
2007	6.59	10.00	8.35
2008	6.90	12.60	9.79
2009	7.20	10.50	8.58
2010	5.90	10.60	8.43
2011	7.00	10.00	8.65
2012	7.80	10.20	8.95

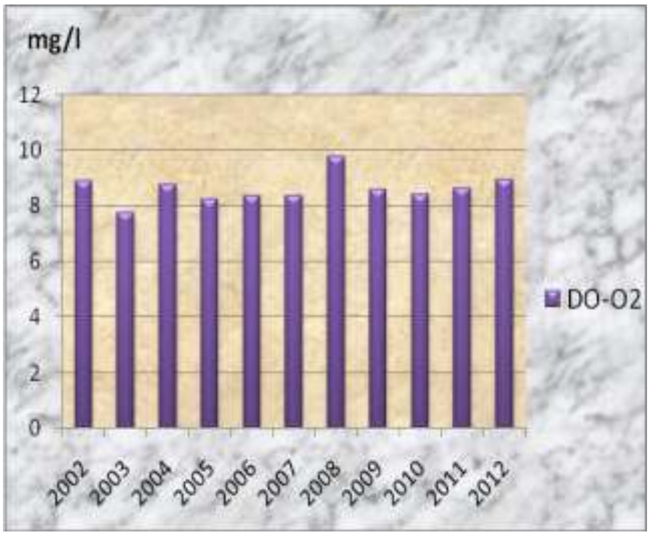


Figure 19. Concentration of Dissolved Oxygen

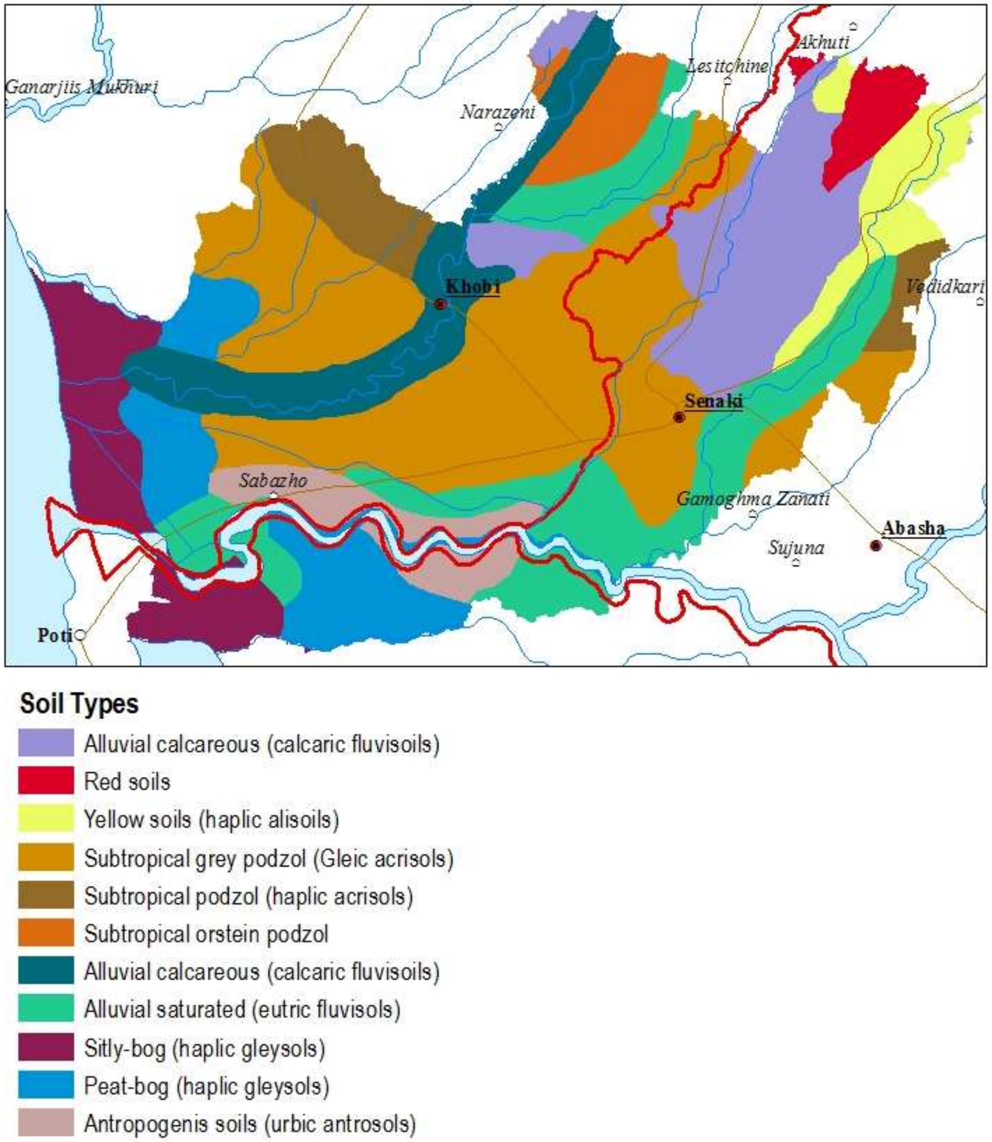
Table 20

Year	Mineralization (mg/l)		
	Minimum	Maximum	Average
2002	208.9	268.6	243.1
2003	209.6	198.4	246.1
2004	230.1	296.7	268.9
2005	258.8	315.6	290.2
2006	161.9	209.7	179.8
2007	240.6	288.6	258.9
2008	227.8	185.1	253.2
2009	235.4	300.5	257.6
2010	221.6	300.5	257.5
2011	210.2	280.3	246.6
2012	220.8	283.4	240.0

Figure 20. Concentration of Mineralization

Annex 5. Land Resources

Map 1. Soil Type of the Rioni River Lower Watershed Area[1]



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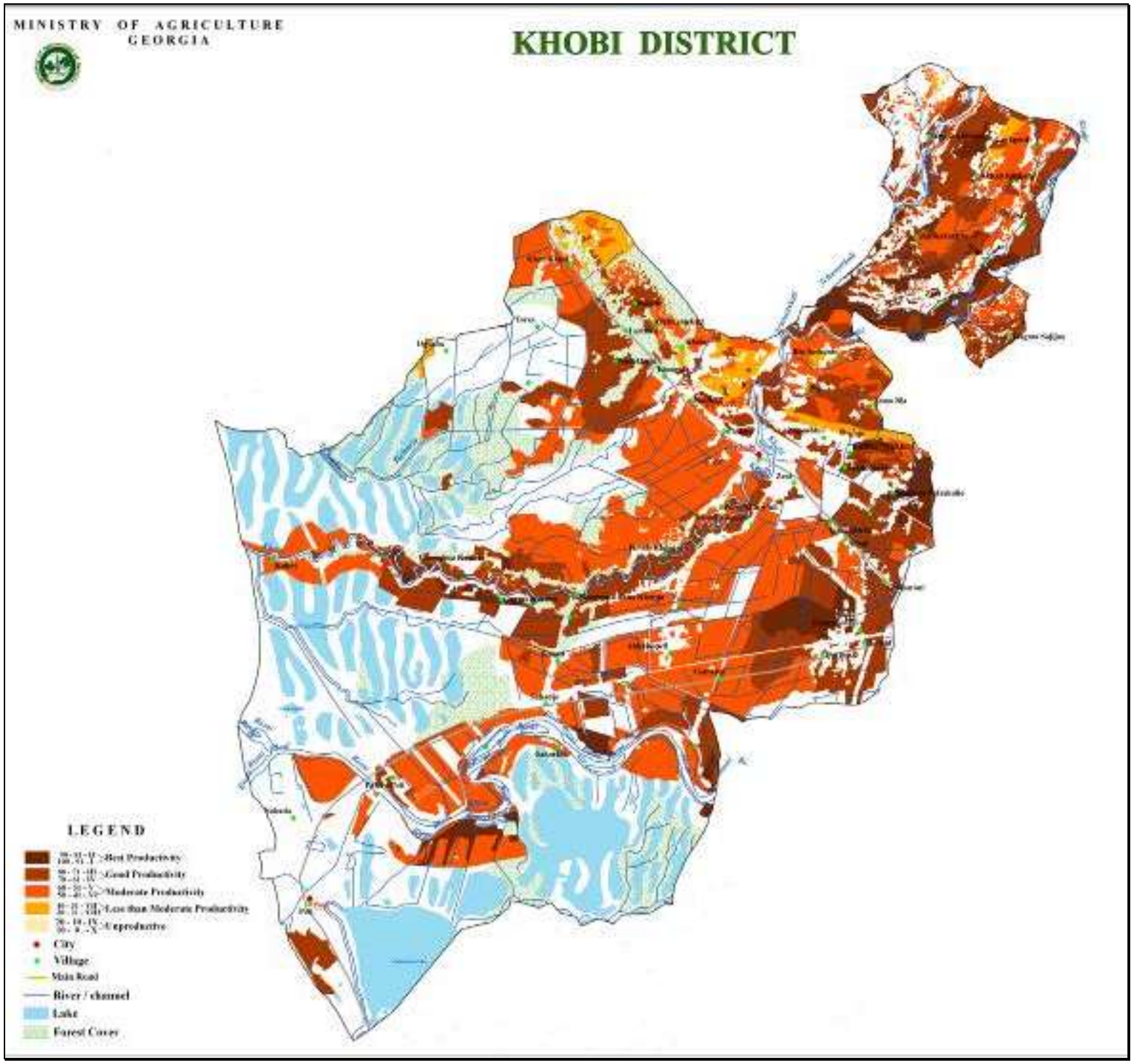
[1] Source: Cadastre and Land Register Project

Map 2a. Soil Productivity of Khobi Municipality[2]



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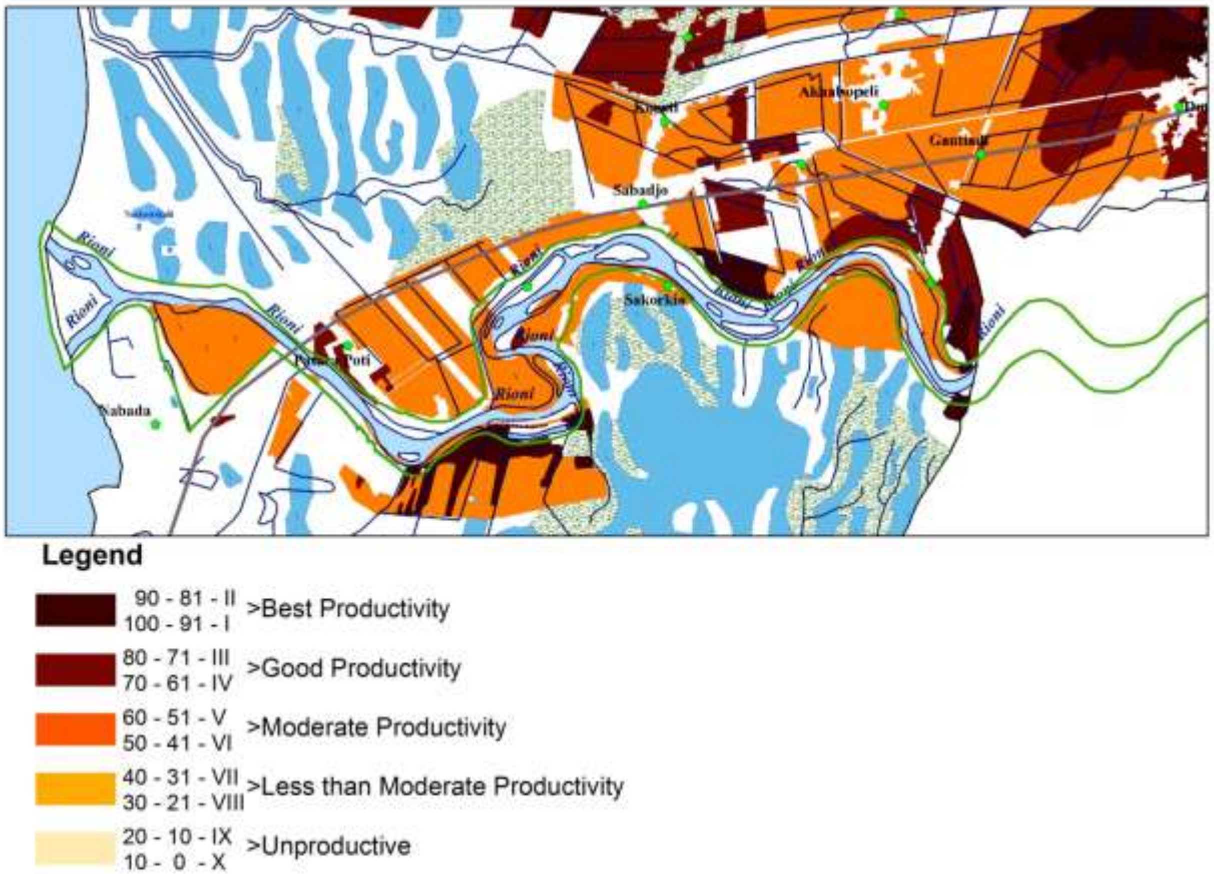
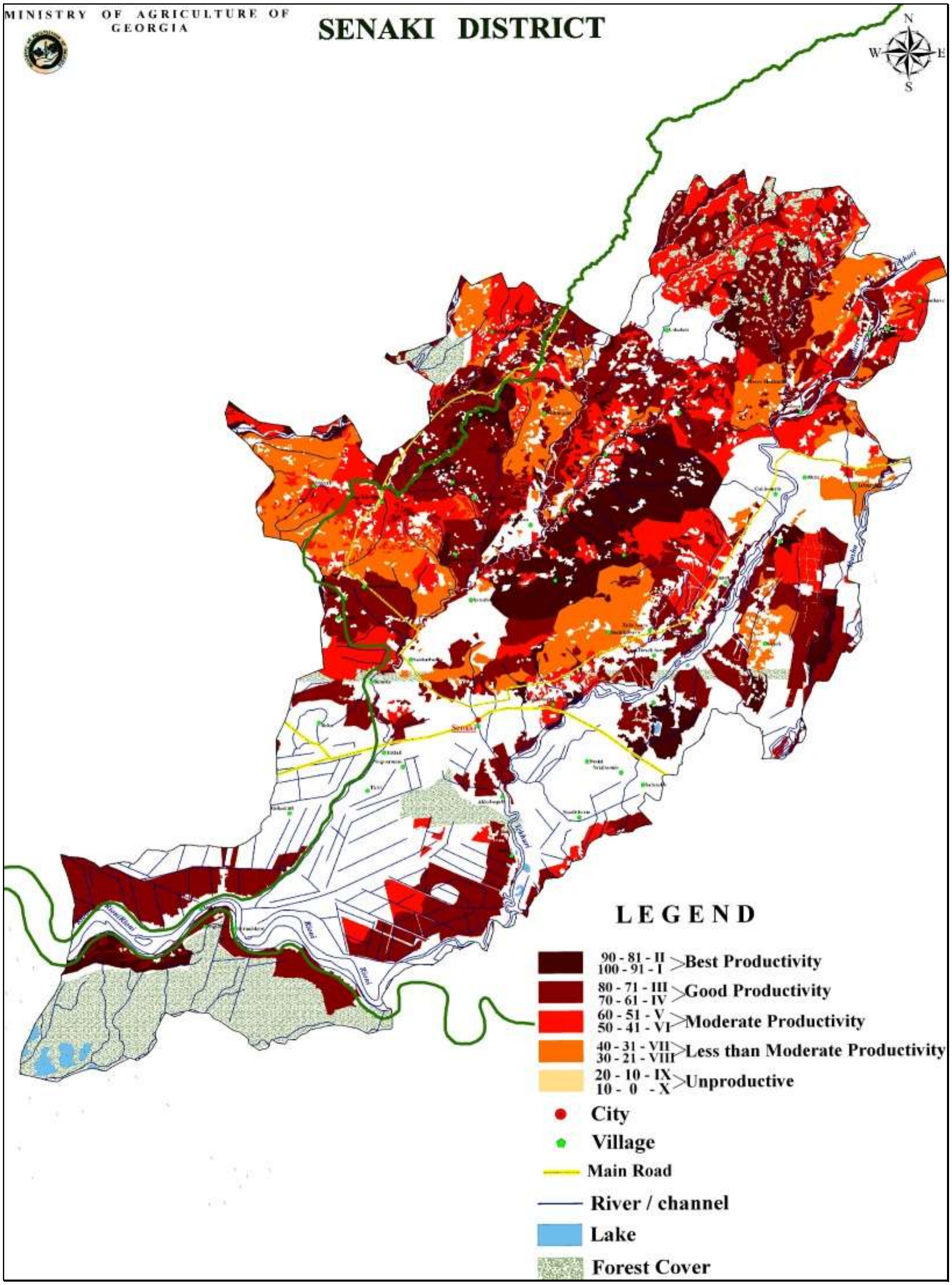
[2] Source: Ministry of Agriculture of Georgia

Map 2b. Soil Productivity of Khobi Municipality within the Rioni River Watershed[3]



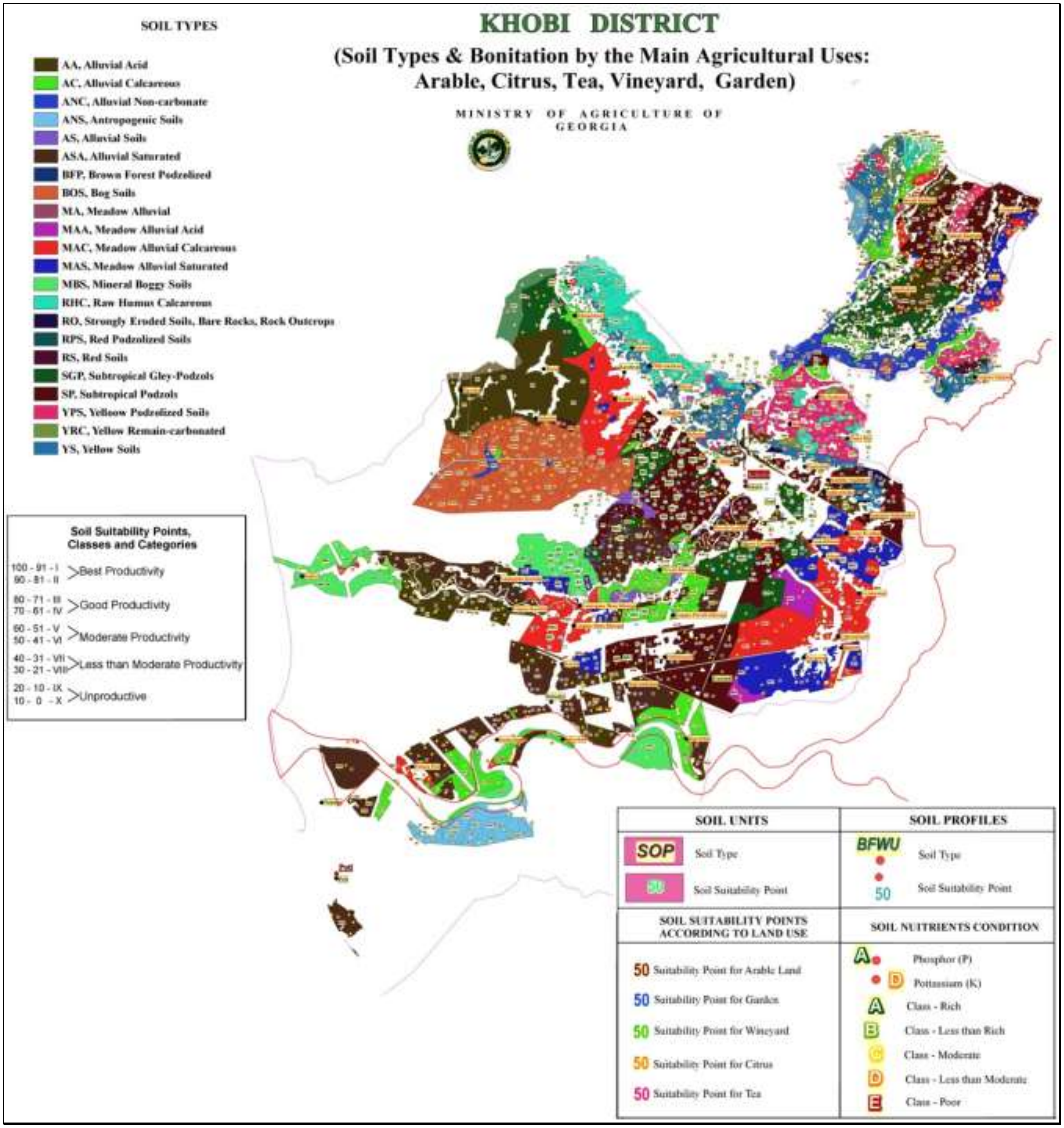
[3] Source: Ministry of Agriculture of Georgia

Map 2c. Soil Productivity of Senaki Municipality[4]

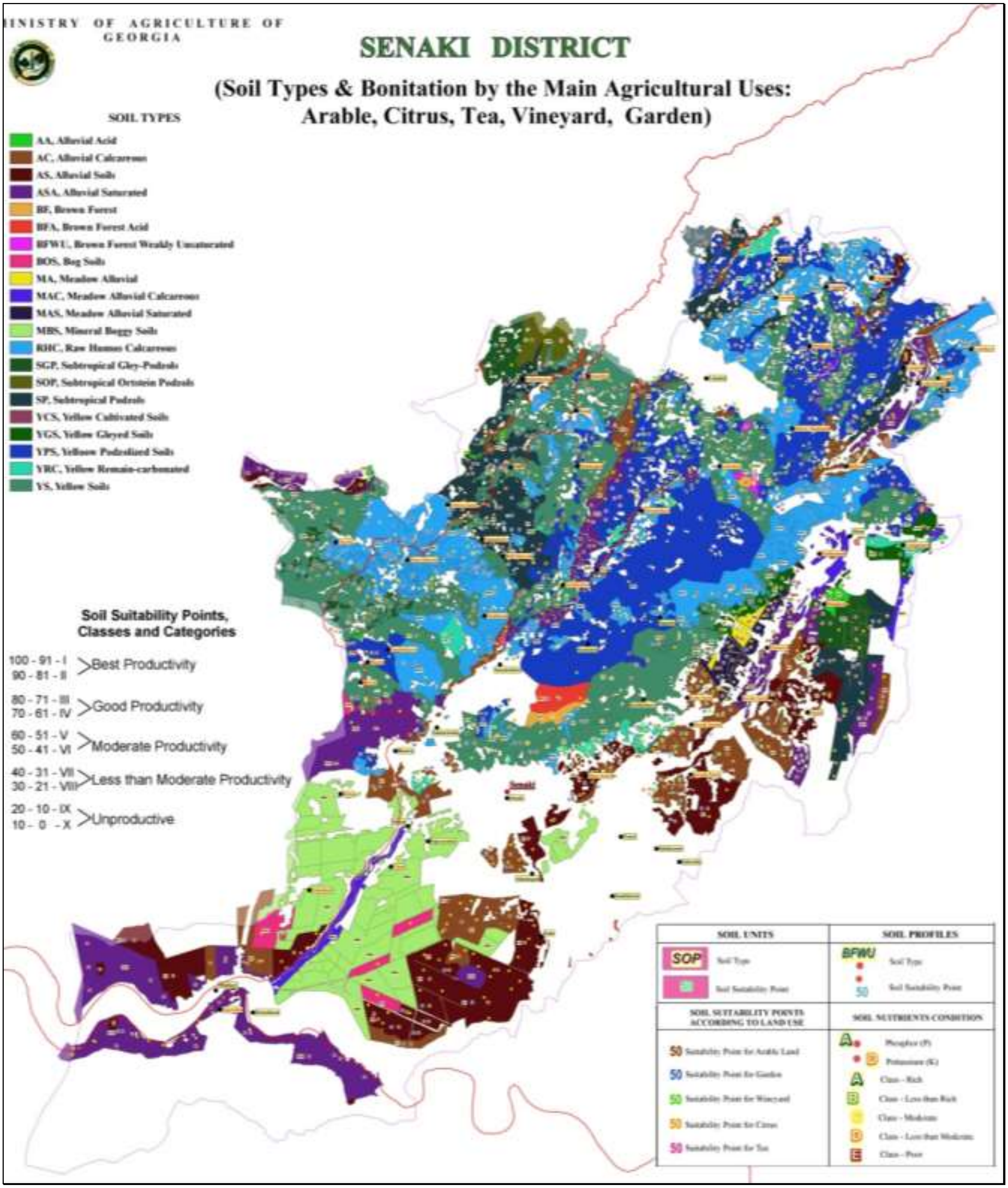


[4] Source: Ministry of Agriculture of Georgia

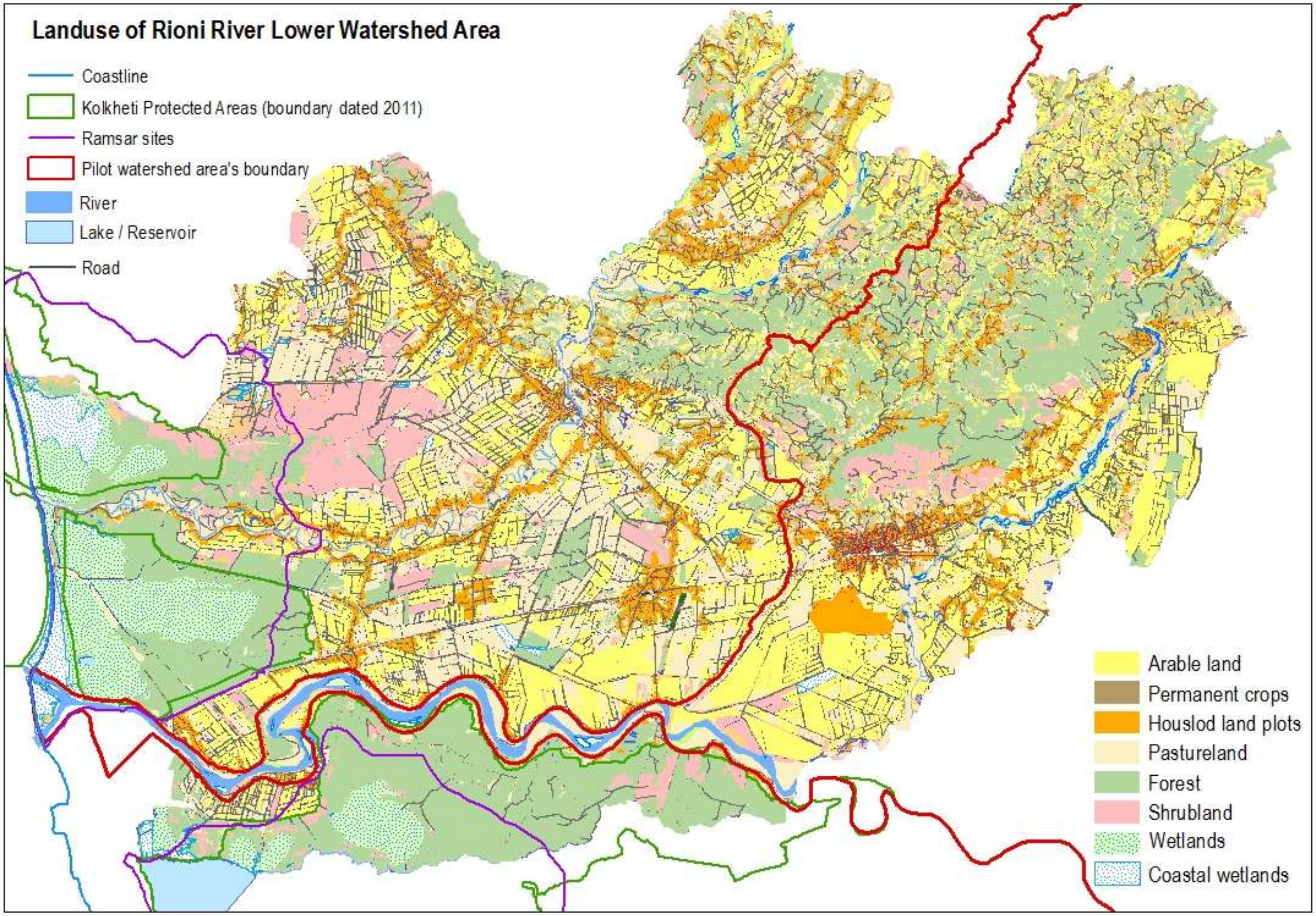
Map 3a. Soil Bonitation of Khobi Municipality by the Main Agriculture Uses



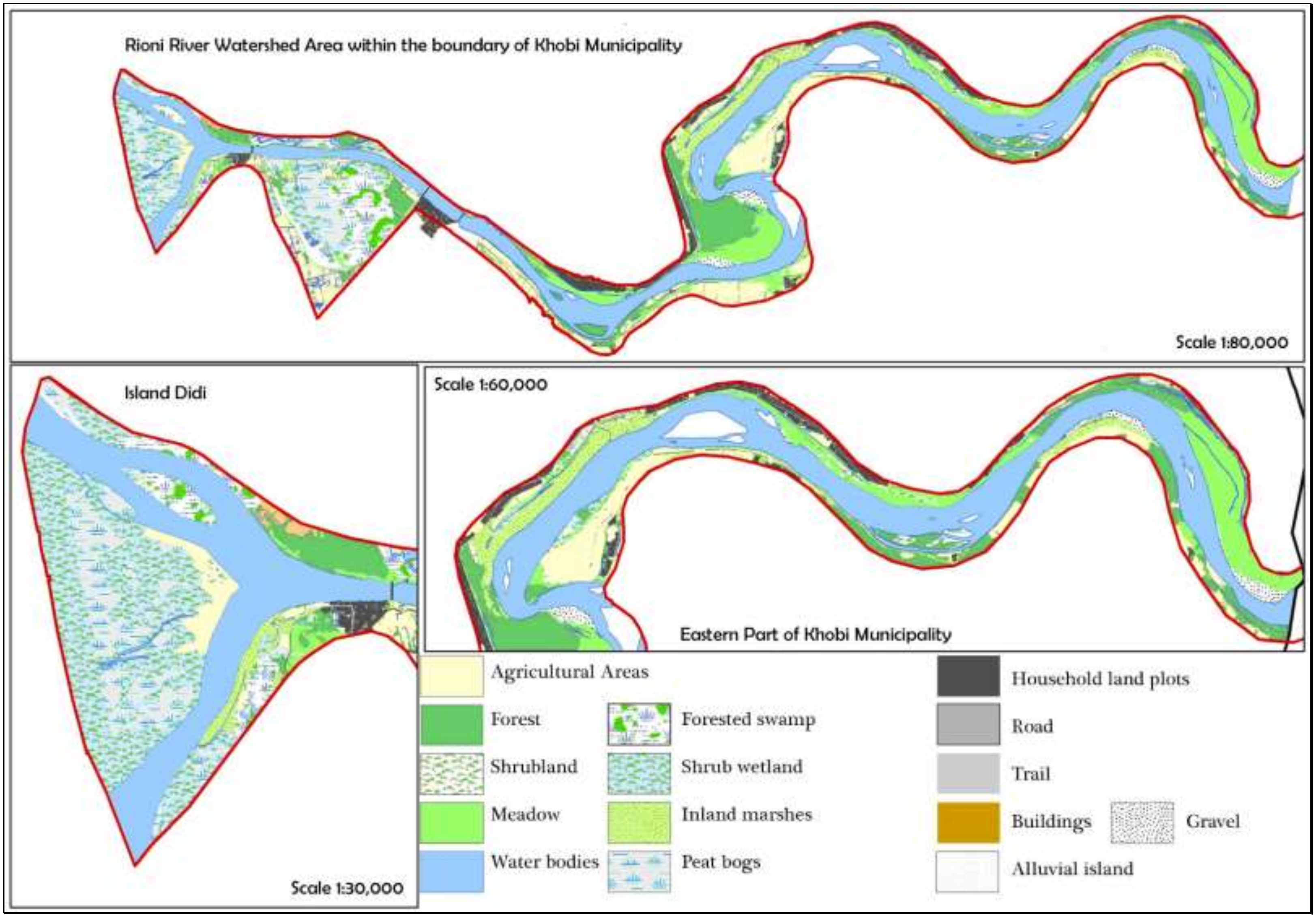
Map 3b. Soil Bonitation of Senaki Municipality by the Main Agriculture Uses



Map 4a. Land Use Map of the Rioni River Lower Watershed Area

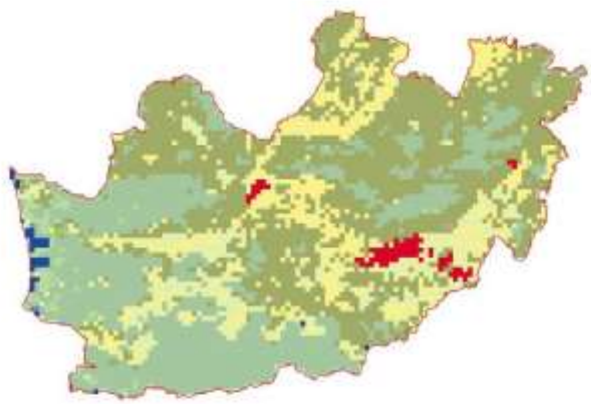


Map 4b. Land Cover of the Rioni River Watershed Area (Within the Boundaries of Khobi Municipality)

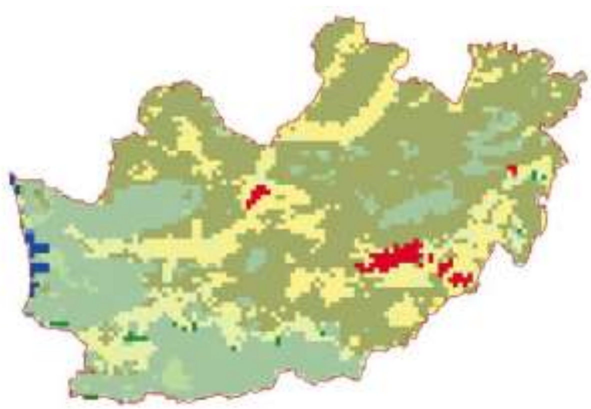


Map 5. Land Cover Geo-images

Modis-Land Cover 2001



Modis-Land Cover 2007



Modis-Land Cover 2009

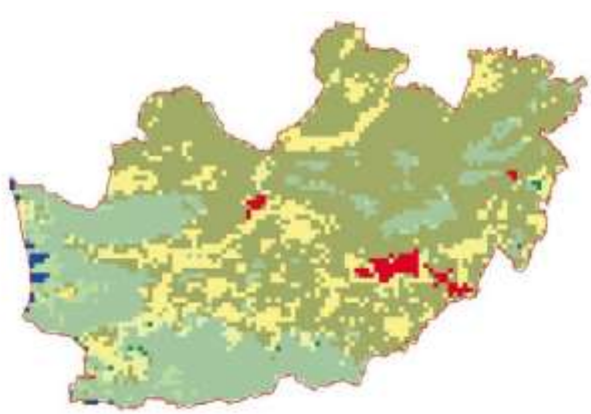


Table 1. MODIS Land Cover Classified into 17 Categories by Geosphere-Biosphere Programs

	Land cover classification	MODIS 2001	MODIS 2007	MODIS 2009	Change 2009/2001	Change 2009/2007	Change 2007/2001
0	Water						
1	Evergreen Needle-leaf forest		534	316	316	-218	534
2	Evergreen Broad-leaf forest						
3	Deciduous Needle-leaf forest		63		-21	-63	42
4	Deciduous Broad-leaf forest	1,902	2,584	3,546	1,644	962	682
5	Mixed forest	36,257	29,353	28,681	-7,576	-672	-6,904
6	Closed shrublands	85	63	85	0	22	-22
7	Open shrublands						
8	Woody savannas	13,176	10,236	3,730	-9,446	-6,506	-2,940
9	Savannas	21	21		-21	-21	0
10	Grasslands	84		42	-42	42	-84
11	Permanent wetlands	127	212	42	-85	-170	85
12	Croplands	14,800	16,469	17,622	2,822	1,153	1,669
13	Urban and built-up	1,695	1,695	1,651	-44	-44	0
14	Cropland/Natural vegetation mosaic	49,145	56,220	61,820	12,675	5,600	7,075
15	Permanent snow and ice						
16	Barren or sparsely vegetated						

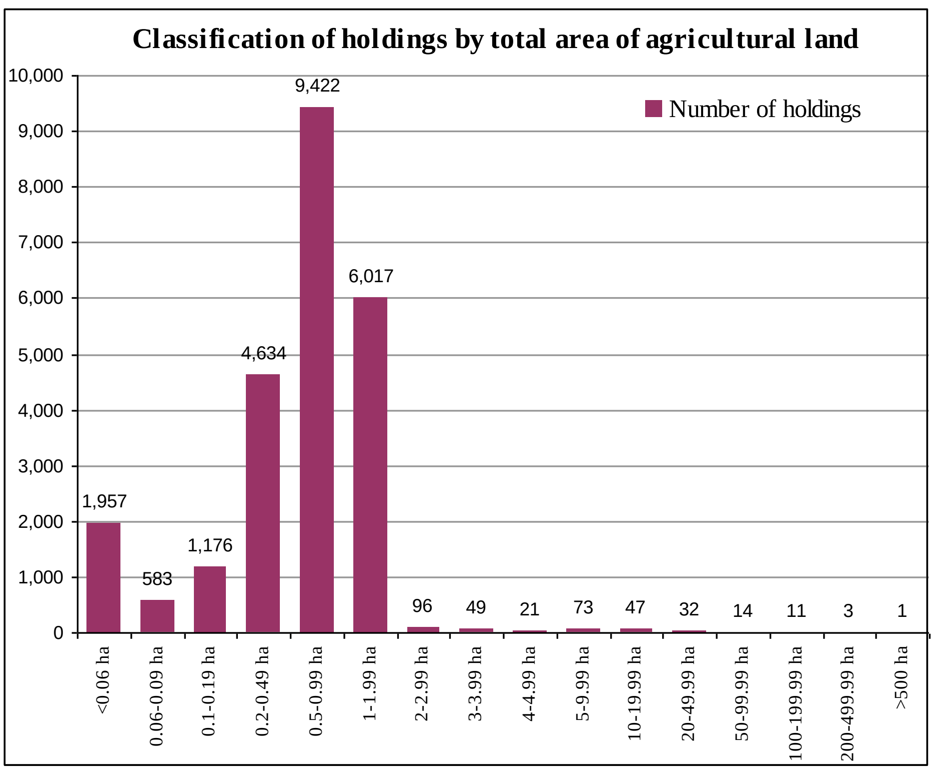
Table 2. Land Use Type in Senaki and Khobi municipalities (area in ha) Source: Geostat

Area	Total 1985	Total 2009	Khobi 1985	Khobi 2009	Senaki 1985	Senaki 2009
Municipality area	119,670		67,600		52,070	
Agriculture land	49,410	51,691.3	29,338	29,160.1	20,072	22,531.2
Arable land	20,045	26,564.1	11,549	14,755.8	8,496	11,808.3
Permanent crops	9,033	8,780.2	5,128	5,322.6	3,905	3,457.6
Cultivated lands	29,183	35,344.3	16,677	20,078.4	12,506	15,265.9
Fallow land	0	168.0	0	0	0	168.0
Household land plots	5,417		2,885		2,532	
Pasture/hay	20,227	16,179.0	12,661	9,081.7	7,566	7,097.3

Table 3. Land Use Type of Rioni River Watershed Area within the Khobi Municipality[5]

Land Use Type	km^2
In total	27.00
Arable land	4
Forest	1.29
Forest wetland	0.1
Shrub land	0.8
Shrub wetlands	1.5
Meadow (pasture)	3.5
Marshlands	2.1
Beach	0.4
Hydro	10.5
Roads	0.3
Build-up area	0.15
Settlements	2.4

Diagram 1. Classification of Holdings by Total Area of Agricultural Land[6]



[5] Calculation done based on the GIS mapping data, which may include a slight error with comparison of the cadastral data
[6] Source: The first national agricultural census data, 2004 GEOSTAT

Diagram 2. Total Area of Agricultural Land Operated by Holdings and its Structure by Land Use

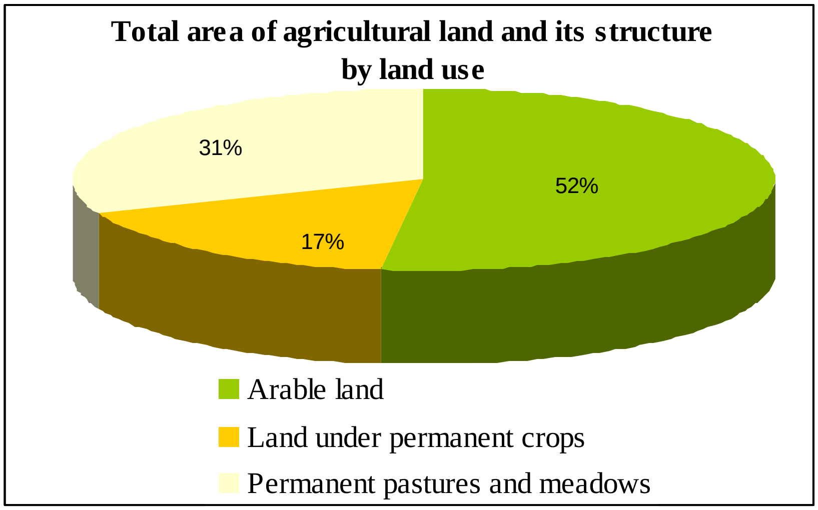
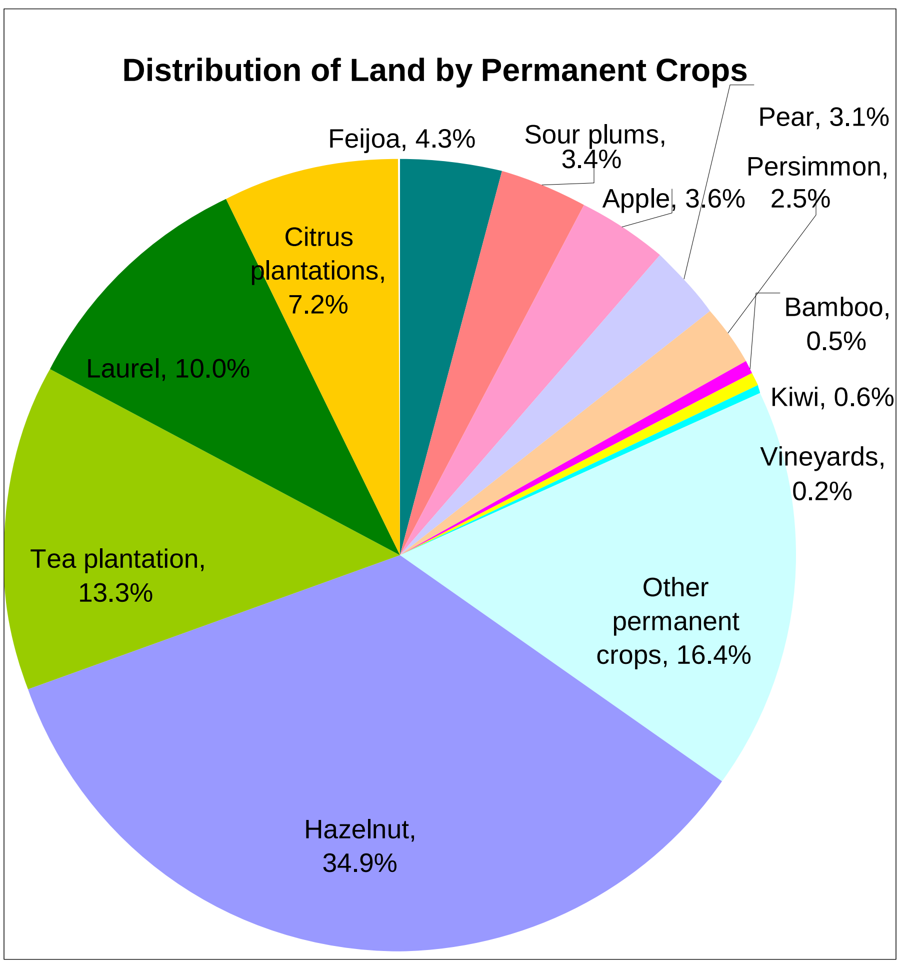


Diagram 3.



Annex 6. Geomorphology

Picture 1: Rioni bed and Floodplain to the South of the Issula Village

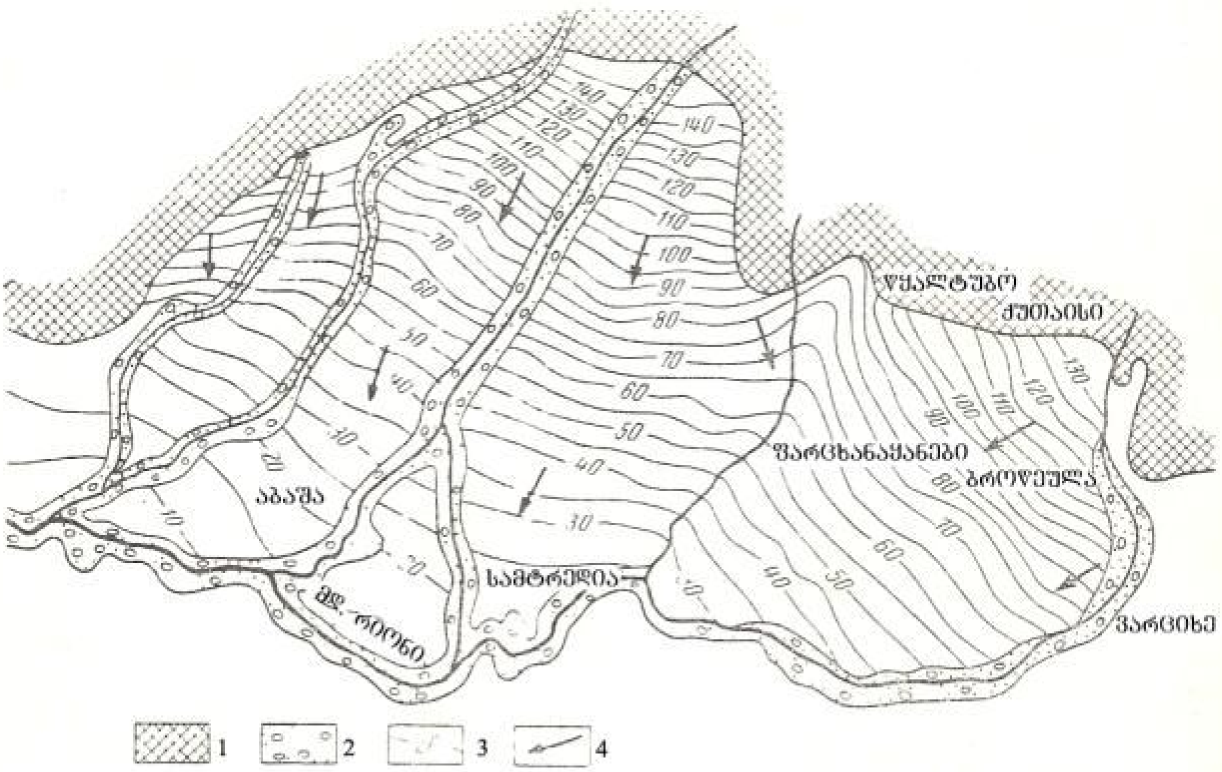
Picture 2: Fine Particles Accumulated in the River Bed

Pictures 3, 4: Right Bank Lower Clay Stair Case

Picture 5: Dry Cracks of the Clayey Sediments on the Right Bank of the River

Pictures 6 and 7: Flat, Left and Right Side First Terraces

Scheme 1: Hydroisolines of the Water-bearing Horizons of the Lower Quaternary Sediments



Source: L. Kharatishvili

1 – Quaternary sediments; 2 – Recent alluvial sediments; 3 – Hydroisolines with absolute values (m) 4 – Groundwater flow direction

Scheme 2: Points of Field Observations

Table 1: GPS Coordinates of Field Observation Points (July, 2012)

##	Geographic Location of the Observation Point	Altitude (m)	GPS Coordinates		Picture of the Location
			Latitude (E)	Lognitude (N)	
1	Right bank of the Tekhuri River, near the entrance of Kolkheti PA.	4	0258413	4676417	
2	Right bank of the Tekhuri River.	10	0255735	4675028	
3	Section at 0.5 km from the mouth of the Tekhuri River.	10	0254604	4674390	

4	Section at 200 m from the mouth of the Tekhuri River.	18	0254800	4674594	
5	Artesian well in the village of Akhalsopheili.	28	0259158	4677645	
6	Sabajo Village.	2	0733690	466030	
7	Right bank of the Rioni River.	5	0731584	4676721	
8	Oil bore hole in the village of Sabajo.	3	0731170	4677250	

Given below is a brief description of observation points

Observation point 1. The relief of the first terrace above the river bed is flat and smooth, and they are covered with grass and other types of vegetation of low density. River flows in wide less steep river bed. Flow velocity is low. Slopes are slightly inclined towards river beds and outcropped with fine clays ad clayey sediments.

Observation point 2. Upstream Tekhuri River bed is deep and slightly inclined. First terraces are elevated at 2 meters and scarce in vegetation grown on loams and clayey sediments. On the right bank, the shoreline has dry cracks on clay and clayey soils (Please refer picture 5).

Observation point 3. The observation point is located on the right bank of the Rioni River, 05 km from the confluence of Tekhuri and Rioni rivers. Here, the river bed is wide and covered with silty islands. There are 4-m high terraces composed of fine sands and covered with alnus and acacia, ferns and elder shrubs. The terraces are unshaped and slightly inclined.

Observation point 4. This point is located on the right bank of the Tekhuri River, at a distance of 200 m from the river mouth. The morphological structure is similar to previous observation sites.

Observation point 5. This point represents artesian well in the village of Akhalsopheli. Presumably, it is 150 m deep and reaches pressured horizons of Kolkheti artesian basin. According to the local people, water has flowed to the surface continuously for around 40 years. The taste of the water is slightly hydrosulfidic and the temperature roughly 10^0C. The well capacity is around 0.3 l/sec.

Observation point 6. This site is located 7 km from the Sabajo Village, upstream of the Rioni River mouth, to the east of the village. It is on the right bank of the river represented as 3-m high vertical terrace above the river bed. Walls of the terraces are outcropped with fine clay and clayey sediments. Flow velocity is very low. Both banks are terraced and covered with vegetation.

Observation point 7. This point is located towards the flow direction and 2.2 km from the mouth of the Rioni River. In this area, the river bed is extremely wide and measures over 700 m. There is a vividly shaped terraced stair on the left bank of the river. There are households and large farm lands on the river terraces. The right bank is composed of weak sediments that are slightly banded and eroded. There are boulders scattered along the river banks in order to protect the bank from wash out.

Observation point 8. This point is in Sabajo Village, on the location of an old oil drill. The depth of the bore hole is 4,500 m. In the past, oil was extracted from this field. Currently, oil extraction operations are suspended and the oil is well conserved.

Annex 7. Forest Resources and Its Use in the Lower Rioni Pilot Watershed Area

Table 1. Composition of the Forests Fund by Forest and Land Categories (Area, ha)

Municipality (The Rioni river watershed area)	Total Area of the Forest Fund	Forests		Lands of the Forest Fund																					
				Forest lands						Agricultural lands					Lands with Special Function					Unused lands					Total forest fund lands
		Total	Including man-made forests	Forests without dense crowns (canopy)	Nurseries	Burnt and dead tree stands	Clearcut areas	Meadows and unforested areas	Total	Arable lands	Hay fields	Pastures	Perennial crop lands	Total	Water bodies	Pipeline and other linear infrastructure right of ways	Roads and trails to logging areas	Household farmlands	Total	Wetlands	Dunes	Glaciers	Ravines and cliffs	Total	
Senaki	10277	10163	770	–	–	6	–	86	92	–	–	15	2	17	–	–	–	2	2	–	–	–	3	3	114
Khobi	129	129	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total	10406	10292	770	–	–	6	–	86	92	–	–	15	2	17	–	–	–	2	2	–	–	–	3	3	114

Table 2. Species Composition and Timber Reserves/Stock of Forests in the Rioni river watershed area)

N	Species	Senaki Municipality				Khobi Municipality				Total			
		Area		Reserve/stock		Area		Reserve/stock		Area		Reserve/stock	
		Ha	%	Thousand m^3	%	Ha	%	Thousand m^3	%	Ha	%	Thousand m^3	%
1.	Oak	68	0.7	5.1	0.6					68	0.7	5.1	0.6
2.	Beach	562	5.5	70.0	8.4					562	5.5	70.0	8.3
3.	Caucasian/European Hornbeam	3524	34.6	314.6	37.9					3524	34.6	314.6	37.6
4.	Oriental Hornbeam	279	2.6	18.9	2.5					279	2.6	18.9	2.3
5.	Acacia	540	5.2	27.0	3.3					540	5.2	27.0	3.2
6.	Alder	4914	49.0	363.6	43.8	129	100	9.0	100	5043	49.0	372.6	44.4
7.	Poplar	13	0.1	1.7	0.2					13	0.1	1.7	0.2
8.	Cottonwood Poplar	3	_	0.3	_					3	_	0.3	_
9.	Black Poplar	122	1.0	15.3	1.8					122	1.0	15.3	1.8
10.	Walnut	5	_	0.1	_					5	_	0.1	_
11.	Chestnut	46	0.5	4.6	0.5					46	0.5	4.6	0.6
12.	Cypress	3	_	0.3	_					3	_	0.3	_
13.	Japanese Cedar (Cryptomeria)	30	0.3	3.6	0.4					30	0.3	3.6	0.4
14.	Plaintree (Platanus)	51	0.5	5.1	0.6					51	0.5	5.1	0.6
15.	Gum tree (Eucalyptus)	3	_	0.3	_					3	_	0.3	_
	Total	***10163***	***100***	***830.5***	***100***					***10292***	***100***	***839.5***	***100***

Table 3. Distribution of Forests by Densities (Area, %)

Geographic Area	Density										Total	Average Density
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0		
Senaki Municipality	_	**0.4**	**8.9**	**8.6**	**10.2**	**49.5**	**16.3**	**6.1**	_	_	**100**	**0.59**
Khobi Municipality	_	_	_	_	**20.0**	**60.0**	**20.0**	_	_	_	**100**	**0.60**
Total		**0.4**	**8.9**	**8.6**	**10.2**	**49.5**	**16.3**	**6.1**	_	_	**100**	**0.59**

Annex 4. Average Forest Structure Indicators

Geographic location	Year of Forest Inventory	Indices									
		Average age	Average bonitet (productivity class)	Average density	Total stock		Stocks of mature and old/aged trees		Average increment		Area of mature and oldest tree groves
					Thousand m^3	m^3/ha	Thousand m^3	m^3/ha	Thousand m^3	m^3/ha	
Senaki Municipality	1990	34	II_1	0.59	830.5	81.7	166.9	166.9	29.7	2.9	1735
Khobi Municipality	1984	15	II_0	0.60	9.0	69.8	_	_	0.5	4.6	_
Total		***34***	***II_1***	***0.59***	***839.5***	***81.6***	***166.9***	***166.9***	***30.2***	***2.9***	_

Table 5. Vertical Distribution of Forests (Area, %)

Geographic Location	Altitude (Above Sea Level)										Total
	0-250	251-500	501-750	751-1000	1001-1250	1251-1500	1501-1750	1751-2000	2001-2250	2251 <	
Senaki Municipality	**89.0**	**11.0**	_	_	_	_	_	_	_	_	**100**
Khobi Municipality	**100**	_	_	_	_	_	_	_	_	_	**100**
Total	**89.5**	**10.5**	_	_	_	_	_	_	_	_	**100**

Table 6. Forest Distribution by Slope (Area, %)

Geographic Location	Slope (^{0})					Total
	0-10	11-20	21-30	31-35	36 <	
Senaki Municipality	49.2	30.8	10.2	5.0	4.8	**100**
Khobi Municipality	100	_	_	_	_	**100**
Total	**50.0**	**30.0**	**10.2**	**5.0**	**4.8**	**100**

Annex 8. Water Use

Table 1. Water Abstractions and Consumption in Lower Rioni Pilot Watershed Area (Senaki Municipality) in 2002-2011 (Thousand m^3/year)

Year	Number of Water Use Reports Submitted to the Ministry of Envrionment	Abstractions from Natural Water Bodies		Water Usage/Consumption			
		Total	Including groundwaters	Total	Including		
					Drinking water	Industrial	Other
2002	1	780	780	614	614	-	-
2003	2	704	704	564	530	34	-
2004	2	814	814	594	555	39	-
2005	2	724	724	724	720	4	-
2006	3	2211	2211	1770	1700	70	-
2007	3	7.5	7.5	7.5	-	7.5	-
2008	4	9	9	9	-	9	-
2009	5	5052	5052	4043	3904	139	-
2010	7	3035.7	3035.7	2531.7	2451	80.7	-
2011	7	2529	2523	1773.7	1763.5	10.2	-

Table 2. Water Abstractions and Uses by Senaki Centralized Drinking Water Supply System (2001-2011) (Thousand m^3/year)

Year	Water Abstractions from Natural Water Bodies		Water Uses			
	Total	Including groundwater	Total	Including		
				Drinking Water Supply	Industrial	Other
2001	-	-	-	-	-	-
2002	780	780	614	614	-	-
2003	700	700	560	530	30	-
2004	810	810	590	555	35	-
2005	720	720	720	720	-	-
2006	2206	2206	1765	1700	65	-
2007	-	-	-	-	-	-
2008	-	-	-	-	-	-
2009	5045	5045	4036	3904	132	-
2010	3024	3024	2520	2450	70	-
2011	2517	2517	1762	1762	-	-

Table 3. Sewage Discharges from the Senaki Sewerage System into the Tekhuri River (Thousand m^3/year)

Year	Total Wastewater Discharges	Including Untreated Wastewater Discharges
2002	520	520
2003	520	520
2004	540	540
2005	280	280
2006	1000	1000
2007		
2008		
2009	1975	1975
2010	1500	1500
2011	1410	1410

Table 4. Wastewater Discharges from Sources Other than Senaki Sewerage System into the Tekhuri River

Year	Number of Statistical Reports	Total Wastewater Discharges	Untreated Wastewater Discharges
2002	0	0	0
2003	1	0	0
2004	1	2.8	2.8
2005	1	2.8	2.8
2006	2	3.2	3.2
2007	2	4.4	4.4
2008	3	4.9	4.9
2009	4	3.9	3.9
2010	6	5.4	5.4
2011	8	5.4	5.4

Annex 9. Existing Water Supply and Sanitation Systems

Table 1. Current State of Rural Water Supply Systems of Selected Communities of Khobi Municipality

#	Community/ Village	Headworks		Water Distribution Network		Water Supply	Drinking Water Quality	On-going or Planned Activities
		Number of Intakes	Technical Condition	Length	Technical Condition			
1	**Patara Poti: supplied from Poti Water Supply System**							
	Patara Poti	-	-	Network covers the entire village.	Satisfactory; 1 section (district) needs major renovation; 1,500 m section needs replacement	24 hours	Satisfactory	-
2	**Chaladidi: supplied from Poti Water Supply System**							
	Sachochuo	-	-	Network covers the entire village.	The system needs major renovations; losses from corroded fittings and joints totals 25%.	24 hours	Satisfactory	It is planned to partially rehabilitate the network; the United Water Company of Georgia has initiated installation of water meters at individual consumer level from August, 2012.
	Sabajo	-	-	Network covers the entire village.	Internal network needs major renovations; 2.5 km section has to be repaired/replaced.	24 hours	Satisfactory	It is planned to partially rehabilitate the network; the United Water Company of Georgia has initiated installation of water meters at individual consumer level from August, 2012.
	Sagvamichao	Around 35% of village population abstracts water from individual wells.	-	Internal network covers only 65% of village population	Water main (D=250mm) requires major renovations.	24 hours	Satisfactory	It is planned to partially rehabilitate the network; the United Water Company of Georgia has initiated installation of water meters at individual consumer level from August, 2012.

3	**Sagvichio: supplied from Poti Water Supply System**							
	Sagvichio	-	-	Network covers the entire village.	Satisfactory; internal network requires partial rehabilitation and expansion.	Over 12 hours of scheduled supply.	Satisfactory	It is planned to partially rehabilitate the system; implementation of erosion control measures in the area where water main is laid; replacement of internal network.
4	**Shavgele: supplied from Poti Water Supply System**							
	Shavgele	Part of the population is supplied from individual wells and the remaining in a centralized manner from 1 reservoir.	System does not work currently.	7 km water main and 6 km internal network; It covers the absolute majority of the village population.	Internal network requires major renovation; 2 km section needs replacement.	No water supply.	Unsatisfactory; water is contaminated with sediments.	It is planned to install an electric pump (costing 27,000 GEL) near Poti and install 150 mm diameter branch pipe from 700 mm water main of the city of Poti.

Table 2. Current State of Rural Water Supply Systems of Selected Communities of Senaki Municipality

#	Community/ Village	Headworks		Water Distribution Network		Water Supply	Drinking Water Quality	On-going or Planned Activities
		Number of Intakes	Technical Condition	Length	Technical Condition			
1	**Teklati: supplied from Poti Water Supply System**							
	Sagvaramio	-	-	Network covers the entire village.	Satisfactory	24 hours	Satisfactory	-
	Teklati	-	-	Network covers the entire village.	Internal network needs major renovations; 4 km section needs replacement.	24 hours	Satisfactory	-
	Golaskuri	-	-	Network covers the entire village.	Internal network needs major renovations. 5 km section needs replacement.	12 hours, with intermittent supply.	Satisfactory	-
	Tkiri	1 drilled well About 20% of local population abstracts drinking water from individual wells.	-	Network covers 80% of the village population.	Internal network needs major renovations. 4 km section needs replacement.	12 hours, with intermittent supply.	Satisfactory	-
	Reka	-	-	Network covers the entire village.	Satisfactory	12 hours, with intermittent supply.	Satisfactory	-
2	**Akhalsopheli: supplied from Senaki Water Supply System**							

	Akhalsopheli	7 drilled wells supply around 20% of the village population and the remaining abstracts water from individual dug wells.	Well capacity is not enough and the structures need major repair; 4 wells need cleaning; 3 wells are out of order and need to be decommissioned and replaced.	Internal network covers only 20% of the local population.	Water main is damaged and there are high water leakages; internal network needs replacement (5 km).	Less than 12 hours	-	-
	Isula	6 drilled wells which supply about 20% of village population. The rest abstracts water from individual dug wells.	Well capacity is not enough and the structures need major repair: 5 wells need cleaning; 1 well is out of order and needs to be decommissioned and replaced.	Internal network covers only 20% of the local population.	Water main requires replacement;	Less than 12 hours.	-	-
3	**Zemo Chaladidi - is supplied from Poti water supply system**							
	Mukhuri, Siriachkhoni	Poti water main and 50 m^3 reservoir. 30% of village population abstracts drinking water from individual dug wells.	Reservoir needs cleaning and water main rehabilitation.	Internal network covers 70% of local population.	Internal network needs major renovation. Water main has improper design;at the 2 km section 63 mm diameter pipes were replaced with 100 mm diameter pipes and therefore, population does not receive	No drinking water is provided to local population.	Unsatisfactory	Senaki municipality plans to carry out partial rehabilitation works for the system.

					enough water due to low water pressures.			
4	**Nosiri - partially supplied from Senaki drinking water supply system**							
	Nosiri	Headworks of Senaki drinking water supply system. About 40% of local population abstracts drinking water from individual wells.	Satisfactory	Internal network covers 60% of local population.	Satisfactory	Over 12 hours; intermittent supply	-	-
5	**Menji: partially supplied from Senaki Drinking Water Supply System and partially from its own sources**							
	Bataria	Headworks of Senaki drinking water supply system and local water company ”Menji“,; 60% of the local population is supplied with drinking water from individual wells.	Satisfactory	Internal network covers 60% of the local population.	3 km section of the internal network requires replacement.	Less than 12 hours.	Unsatisfactory ; highly turbid water.	Rehabilitation works are not planned.

	Sakharbedio	Headworks of Senaki drinking water supply system and local water company ”Menji“; Around 70% of the local population abstracts drinking water from individual wells.	-	Internal network covers only 30% of the local population.	Internal network is dilapidated and needs replacement (4 km); 4 km section of water main requires replacement.	Over 12 hours; intermittent supply.	Unsatisfactory; highly turbid water.	Rehabilitation works are not planned.
	Satsuleiskiro	1drilled well owned by local water company ”Menji“, Ltd; 160 m^3 reservoir; 70% of the local population abstracts drinking water from individual wells.	Satisfactory	Internal network covers only 30% of the local population.	Internal networks need major renovations; 2 km section of the water main needs rehabilitation.	24 hours	Unsatisfactory, highly turbid water.	Rehabilitation works are not planned.

Table 3: Drinking Water Supply Problems of Selected Villages of the Lower Rioni Pilot Watershed Areas that Indentified Drinking Water Supply among its Top Priority Issues

#	Village	Water Source	Issue/Problem
		Khobi Municipality	
1	**Patara Poti Village and Patara Poti community.**	Poti Water Supply System	*Drinking water shortage and poor quality:* 1) Drinking water is not disinfected; 2) Water main and internal network are dilapidated and need replacement. Therefore, there are high losses in the system and the risk of water contamination is high.
2	**Villages of Sagvamichao, Sachochuo and Sabajo.**	Poti Water Supply System	*Drinking water shortage and poor quality:* 1) Drinking water is not disinfected; 2) Internal network are dilapidated and need replacement. Therefore, there are high losses in the system and the risk of water contamination is high.
3	**Village Sagvichio and Sagvichio community.**	Poti Water Supply System; individual wells.	*Drinking water shortage and poor quality:* 1) Drinking water is not disinfected; 2) Meters are not installed; 3) Internal network is damaged at many points.
4	**Village Shavgele and Shavgele community.**	Poti Water Supply System; drilled village well(s): individual wells.	*Drinking water shortage and poor quality:* 1) #1 headwork is unfenced; 2) Water is not treated technologically and disinfected; 3) Water main delivering water from the headworks, internal network and regulating valves are dilapidated and need renovation/replacement, and therefore water is not currently supplied to the population through village system.
		Senaki Municipality	
1	**Villages Golaskuri, Tkvili and Teklati community.**	Poti Water Supply System; drilled village well; individual wells.	*Drinking water shortage and poor quality:* 1) Drinking water is not disinfected; 2) Internal network is damaged and needs renovations.
2	**Villages of Akhalsopheli and Isula and Akhalsopheli community.**	Poti Water Supply System; drilled village wells; individual household wells.	*Drinking water shortage and poor quality* 1) #1 headwork is not fenced; 2) headwork is dilapidated and can't supply enough amounts of water to villages; 3) Drinking water is not disinfected; 4) Water main and internal network are dilapidated and need replacement. Therefore, there are high losses in the system and water contamination risk is high.
3	**Villages of Mukhuti**	Poti Water Supply System;	*Drinking water shortage and poor quality:*

	and Siriachkhoni, and Chaladidi community.	storage reservoir; individual household wells.	1) Storage reservoir is in disrepair and needs renovation/replacement; 2) Drinking water is not disinfected; 3) Internal network is deteriorated and outdated, system design is poor and therefore, villages do not receive water in a centralized way.
4	**Villagges of Bataria, Sakharbedio and Satsuleiskiro, and Menji community.**	Senaki Drinking Water Supply System; drilled village wells; individual household wells.	*Drinking water shortage and poor quality:* 1) Water is not treated technologically and disinfected; 2) Water main delivering water from the headworks, internal network and regulating valves are dilapidated and need renovation/replacement, and thus water is supplied to local population in limited quantities and intermittently. Therefore, villages mostly use individual wells.

Annex 10. Priority Environmental Problems Identified by Selected Communities

Table 1. Priority Problems Identified by Selected Communities of Khobi Municipality

Community	Village	Priority Issue
1. Patara Poti		
	Patara Poti	• Availability of safe drinking water (drinking water shortage and poor quality); • High risk of natural disasters–floods and flash floods; • Secondary bogging of agricultural lands due to poor drainage; • Wind induced soil erosion of agricultural lands.
2. Chaladidi		
	Sagvamichao	• Availability of safe drinking water (drinking water shortage and poor quality); • High risk of natural disasters – floods and flash floods; • Reduction of crops and green cover due to introduction of invasive species (American butterfly).
	Sachochuo	• Reduction of crops and green cover due to introduction of invasive species (American butterfly); • High risk of natural disasters – floods and flash floods; • Bogging of agricultural lands due to poor drainage; • Availability of safe drinking water (drinking water shortage and poor quality).
	Sabajo	• Reduction of crops and green cover due to introduction of invasive species (American butterfly); • Bogging of agricultural lands due to poor drainage.
3. Sagvichio		
	Sagvichio	• Availability of safe drinking water (drinking water shortage and poor quality); • High risk of natural disasters – floods and flash floods; • Reduction of crops and green cover due to introduction of invasive species (American butterfly).
4. Shavgele		
	Shavgele	• Shortage of drinking water; • High risk of natural disasters – floods and flash floods; • Bogging of agricultural lands due to poor drainage.

Table 2. Priority Problems Identified by Selected Communities of Senaki Municipality

Community	Village	Priority Issue/Problem
1. Teklati		
	Sagvaramio	• High risk of natural disasters – floods and flash floods; • Bogging of agricultural lands due to poor drainage; • Pollution of the Tsivi River from untreated wastewater discharges.
	Teklati	• Reduction of crops and green cover due to introduction of invasive species (American butterfly).
	Golaskuri	• Deforestation.
	Tkhiri	• High risk of natural disasters – floods and flash floods; • Bogging of agricultural lands due to poor drainage.
	Reka	• Pollution of surface waters (solid waste and untreated wastewaters).
2. Akhalsopheli		
	Akhalsopheli	• High risk of natural disasters – floods and flash floods; • Reduction of green cover due to invasive species (American butterfly); • Bogging of agricultural lands due to poor drainage.
	Isula	• High risk of natural disasters – floods and flash floods (significant threats posed to the kindergarten) • Reduction of green cover due to introduction of invasive species (American butterfly); • Bogging of agricultural lands due to poor drainage.
3. Old Senaki		
	Kveda Sorda	• Wind-induced erosion of agricultural lands; • High risk of natural disasters – floods and flash floods; • Bogging of agricultural lands due to poor drainage; • Reduction of green cover due to introduction of invasive species (American butterfly).
	Meore Nosiri	• Poor drinking water quality in the centralized water supply system; • Wind-induced erosion of agricultural lands; • Bogging of agricultural lands due to poor drainage; • Reduction of green cover due to introduction of invasive species (American butterfly).

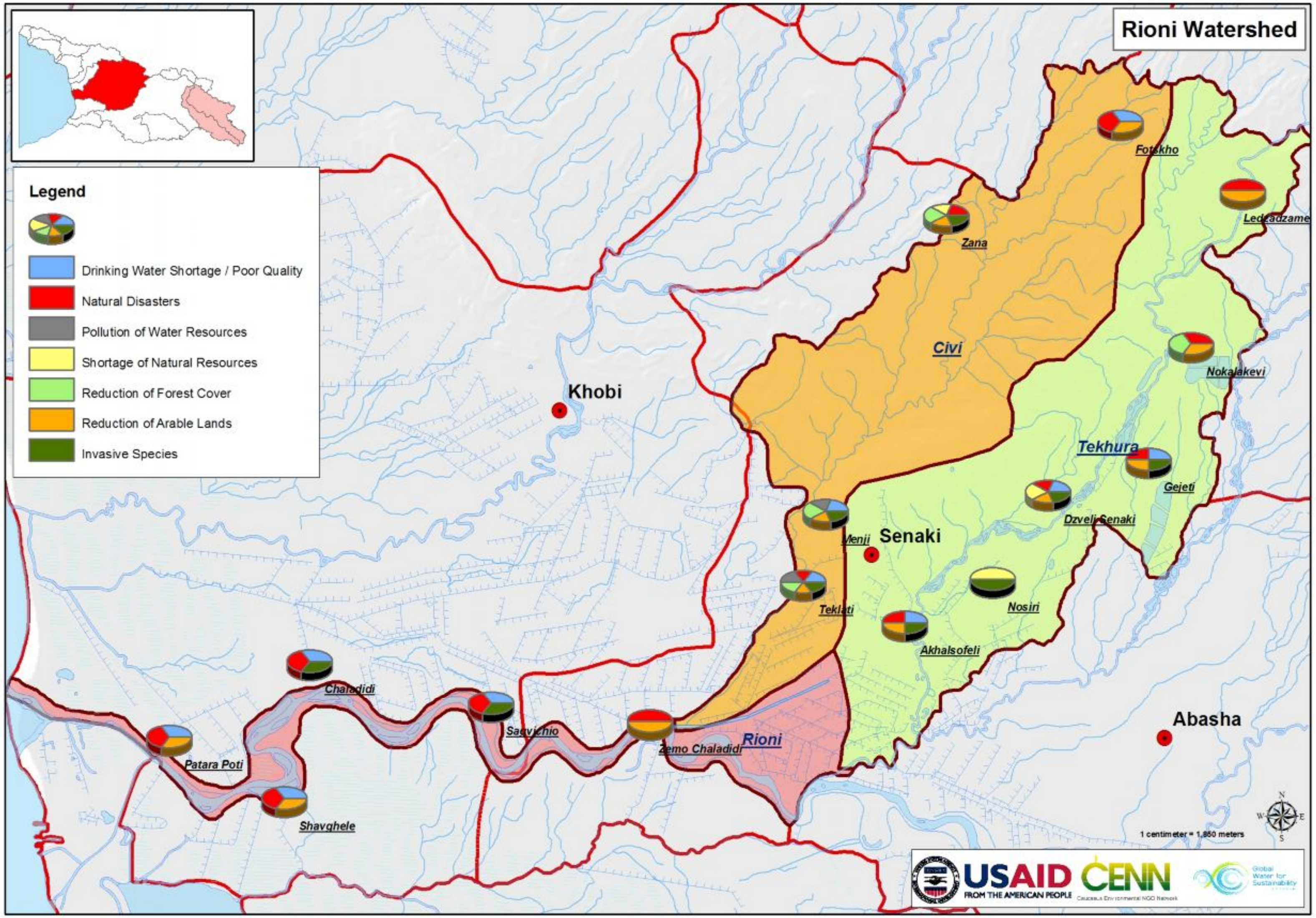
	Zeda Sorda	• Wind-induced erosion of agricultural lands; • High risk of natural disasters – floods and flash floods; • Bogging of agricultural lands due to poor drainage; • Reduction of green cover due to introduction of invasive species (American butterfly).
	Sachikobavo	• Natural disasters – landslides and floods; • Reduction of green cover due to introduction of invasive species (American butterfly).
	Kotianeti	• Reduction of drinking water resource in individual wells; • Bogging of agricultural lands due to poor drainage; • Reduction of agricultural lands due to weeding and transformation into shrublands and forests; • Reduction of green cover due to introduction of invasive species (American butterfly).
	Old Senaki	• Poor drinking water quality in centralized water supply system; • Wind-induced erosion of agricultural lands; • Bogging of agricultural lands due to poor drainage; • Reduction of green cover due to introduction of invasive species (American butterfly).
4.Nosiri		
	Saodishario	• Reduction of drinking water resource in individual wells; • Reduction of green cover due to introduction of invasive species (American butterfly).
	Sakilasonio	• Reduction of drinking water resource in individual wells.
	Sabeselio	• Reduction of drinking water resource in individual wells; • Reduction of green cover due to introduction of invasive species (American butterfly).
	Shua Nosiri	• Reduction of drinking water resource in individual wells.
	Nosiri	• Reduction of drinking water resource in individual wells.
5. Gejeti		
	Gejeti	• Availability of safe drinking water (absence of centralized water supply system); • Reduction of crops and green cover due to introduction of invasive species (American butterfly); • Wind-induced soil erosion due to destruction of windbreaks; • High risk of natural disasters – floods and flash floods.
6.Nokalakevi		

	Zemo Nokalakevi	• Deforestation; • Disaster risk – landslides, floods and flashfloods.
	Jikha	• Disaster risk – floods and flashfloods; • Flooding and bogging of agricultural lands; • River bank erosion.
	Lebaghaturie	• Disaster risk – floods and flashfloods; • Bogging of agricultural lands due to poor drainage; • River bank erosion; • Deforestation.
	Gakhomila	• Disaster risk – floods and flashfloods; • Bogging of agricultural lands due to poor drainage; • River bank erosion; • Deforestation.
	Dzigideri	• Wind-induced soil erosion of agricultural lands due to destruction of windbreaks; • Bogging of agricultural lands due to poor drainage; • Disaster risk – floods and flashfloods.
7. Menji		
	Bataria	• Poor availability of safe drinking water (water shortage and poor quality); • Pollution of soil and ground waters from untreated wastewater discharges and dumping/disposal of solid household wastes; • Deforestation; • Reduction of crops and green cover due to introduction of invasive species (American butterfly).
	Sakharbedio	• Reduction of crops and green cover due to introduction of invasive species (American butterfly); • Wind-induced soil erosion of agricultural lands due to destruction of windbreaks; • Shortage of drinking water supplied through centralized water supply system due to poor condition of the network.
	Satsuleiskiro	• Poor availability of safe drinking water (water shortage and poor quality); • Reduction of crops and green cover due to introduction of invasive species (American butterfly); • Wind-induced soil erosion of agricultural lands due to destruction of windbreaks.
9. Ledzadzame		
	Ledzadzame	• Reduction of crops and green cover due to introduction of invasive species (American butterfly);

		• Pollution of soil and groundwaters from untreated wastewater discharges and dumping/disposal of solid household wastes; • Bogging of village territory and agricultural lands due to poor drainage.
	Betlemi	• Wind-induced soil erosion of agricultural lands due to destruction of windbreaks; • Pollution of soil and groundwaters from untreated wastewater discharges and dumping/disposal of solid household wastes; • Bogging of village territory and agricultural lands due to poor drainage.
	Lesajaie	• Reduction of crops and green cover due to introduction of invasive species (American butterfly); • Wind-induced soil erosion of agricultural lands due to destruction of windbreaks; • Bogging of agricultural lands due to poor drainage.
	Legogie	• Reduction of crops and green cover due to introduction of invasive species (American butterfly); • Wind-induced soil erosion of agricultural lands due to destruction of windbreaks; • Bogging of agricultural lands due to poor drainage.
	Jolevi	• Bogging of village territory and agricultural lands due to poor drainage; • Reduction of crops and green cover due to introduction of invasive species (American butterfly).
10. Zana		
	Zana	• Reduction of source water in individual wells; • Reduction of crops and green cover due to introduction of invasive species (American butterfly).
	Satkebuchao	• High risk of natural disasters – floods, flashfloods and landslides.
	Saesebuo	• High risk of natural disasters – floods and flash floods.
	Etseri	• Wind-induced soil erosion due to destruction of windbreaks; • Deforestation.
	Sashurgaio	• Deforestation; • Bogging of lands; • High risk of natural disasters – floods, flashfloods and landslides.

11. Potskho		
	Pirveli Mokhashi	• Shortage of safe drinking water (quantity and quality); • Wind-induced soil erosion due to destruction of windbreaks; • High risk of natural disasters – floods and flashfloods.
	Meore Mokhashi	• Shortage of safe drinking water (quantity and quality); • Wind-induced soil erosion due to destruction of windbreaks; • High risk of natural disasters – floods and flashfloods.
	Legogie-Nasaju	• Wind-induced soil erosion due to destruction of windbreaks.
	Potskho	• Shortage of safe drinking water (quantity and quality); • Wind-induced soil erosion due to destruction of windbreaks; • High risk of natural disasters – floods and flashfloods.

Map 1. Priority Environmental and Natural Resources Management Issues of Pilot Communities



Annex 11. Matrix of Priority Watershed Issues of the Lower Rioni Pilot Watershed Area Identified by INRMW Experts

Topic: Forest Resources

#	Priority Issue	Criteria: Negative Impact	Maximum Attainable Score	Scoring Result	Causal-Chain Analysis		
					Causes	Negative Impacts/Impacts on Other Resources	Scale of the Impact
1.	Deterioration in general condition of high conservation value forest areas (Total score:17)	On the health of population	10	6	Absence of proper legal-regulatory, policy and institutional framework for sustainable forest management; absence of data on the current state of the forests and volumes of timber harvesting; underutilization of alternative (renewable) energy resources such as solar energy, wind energy, geothermal energy and biogas; lack of technical, financial and human resources for sustainable forest management.	Deterioration of water balance and shortening of water resources Degradation of ecosystems; Degradation of soil cover; Decreased biodiversity and extinction of rare species; Degradation on natural habitats within the protected areas and its buffer zones.	Whole watershed area
		Watershed ecology.	8	7			
		Social-economic conditions: housing, infrastructure, and agriculture.	5	4			
2	Deterioration in general condition of forests; decrease of forest stand frequency below the allowable level (Total score:18)	On the health of population	10	6	Failure to implement inventory and functional zoning of forests; Absence of optimal norms (rules) for resources use; Lack of data on demand for resources; Uncontrolled cutting of trees for firewood; Absence of reliable information on forest resources and conditions. Lack of measures on restoration of degraded forest.	Deterioration of water balance and shortening of water resources; Degradation of ecosystems and soil cover; Decreasing of biodiversity and extinction of rare species; Degradation on natural habitats.	Whole watershed area
		Watershed ecology.	8	8			
		Social-economic conditions: housing, infrastructure and agriculture.	5	4			

3.	Reduction of timber resources **(Total score: 18)**	On the health of population.	10	6	Unsustainable use of timber resources; Uncontrolled cutting of trees for firewood; Failure to implementation of a monitoring system; underutilization of alternative (renewable) energy resources such as solar energy, wind energy and biogas; There is no set up optimal quota for timber use, that does not exceed the annual increment of timber; Absence of forest maintenance and restoration measures;	Degradation of forests and soil of adjacent territories; sharp decrease of climate and water regulatory functions; Deterioration of water balance and shortening of water resources; Decreasing of biodiversity and extinction of rare species; Ecosystem degradation.	**Whole watershed**
		On the ecological condition of the whole water catchment area.	8	8			
		On socio-economic conditions: dwellings, infrastructure, agriculture.	5	4			

Topic:: Land Resources

#	Priority Issue	Criteria: Negative Impact	Maximum Attainable Score	Scoring Result	Causal-Chain Analysis		
					Causes	Negative Impacts/Impacts on Other Resources	Scale of the Impact
1.	Soil degradation (Total score: 16)	On the health of population	10	7	secondary bogging of soils; Overgrazing and uncontrolled grazing; unsustainable pasture management (absence of pasture vertical zoning and rotation, absence of optimum grazing loads, etc).	Reduction of soil stability (thickness of the soil); stream/lake sedimentation. degradation of ecosystems within the KNP and its buffer zones. Pasture erosion and loss of its productivity;	**Entire watershed.**
		Watershed ecology.	8	6			
		Social-economic conditions: housing, infrastructure and agriculture.	5	3			
2.	Loss of high productivity	On the health of population	10	8	Improper land cultivation; destruction of	Loss of agricultural land	Entire

	agricultural lands and changes in land use Total score: (Total score: 17)	Watershed ecology.	8	6	windbreaks. Absence of land reclamation measures. Use of valuable agricultural land for non-agricultural purposes. Unsustainable agricultural practices; Damaged drainage systems.	productivity and total area of productive lands; generation of eroded sections;	watershed.
		Social-economic conditions: housing, infrastructure and agriculture.	5	3			
3.	Land pollution (Total score: 17)	On the health of population	10	8	Pollutants leaching from waste dumps, open-pit mines, and pit latrines; Urban storm water and agriculture runoff; Untreated wastewater discharge; Absence of regulatory and law enforcement mechanisms for soil quality; Absence of effective waste and wastewater control regulatory and/or economic mechanisms; Absence of financial, technical, and human resources for implementing effective waste management and water sanitation policies; Absence of soil quality monitoring system.	Loss of land productivity; Pollution of underground and surface waters; Decreased biodiversity.	Entire watershed.
		Watershed ecology.	8	5			
		Social-economic conditions: housing, infrastructure and agriculture.	5	4			

Topic:: Waste Management

#	Priority Issue	Criteria: Negative Impact	Maximum Attainable Score	Scoring Result	Causal-Chain Analysis		
					Causes	Negative Impacts/Impacts on Other Resources	Scale of the Impact
1	Unsanitary (which are not in compliance with environmental norms) legal	On the health of population	10	8	Landfills constructed during the Soviet period without any projection of environmental protection measures;	Polluted water, soil, and air in recreational and other	Watershed level.

	and illegal landfills in the pilot municipalities (Total score: 19)	Watershed ecology.	8	7	Absence of waste collecting and transportation services in the villages; Low level of awareness in the local population; Limited financial and personnel capabilities in the municipalities. Lack of technical equipment (e.g., containers, garbage trucks, etc.); Weak legislation on waste management.	territories; Impedes development of tourism.	
		Social-economic conditions: housing, infrastructure and agriculture	5	4			
2.	Absence of waste re-use and recycling capacities and practices. (Total score: 11)	On the health of population	10	4	Absence of relevant infrastructure to process waste, including collection stations for recyclable materials; Low level of awareness in the local population; Weak legislation on waste management.	Large quantity of waste, including nondegradable waste in landfills; Loss of land resources for landfills.	Watershed level.
		Watershed ecology.	8	4			
		Social-economic conditions: housing, infrastructure and agriculture.	5	3			

Topic: Water Resources

#	Priority Issue	Criteria: Negative Impact	Maximum Attainable Score	Scoring Result	Causal-Chain Analysis		
					Causes	Negative Impacts/impacts on Other resources	Scale of the Impact
1.	Increased floods and flash floods.	On the health of population	10	10	Unequal river runoff distribution among various seasons; Increased precipitation due to climate	Secondary bogging of large territories;	Entire watershed.

	(Total score: 22)	Watershed ecology.	8	7	change; Poor infrastructure: drainage systems and flood control structures.	Distribution of insects and algae; negative impacts on aquatic biota; increase in evapotranspiration, change in ground water table and negative impacts on soil cover and local climate; reduction of productive agricultural lands and agricultural output; damage to houses and local infrastructure.	
		Social-economic conditions: housing, infrastructure and agriculture.	5	5			
2.	Water pollution (surface and underground). (Total score: 13)	On the health of population	10	7	Poor infrastructure of legal and illegal landfills; Amortized centralized sewage systems in the cities and absence of waste water treatment plants; Absence of sewage networks in villages; Agriculture and urban runoff; Wastewaters drained from Chiatura manganese mine and enrichment plant; Poor monitoring systems for ambient water quality (underground and surface); Absence of effective regulations, including standards for wastewater discharges; Absence of a common effective policy on waste management; Poor law enforcement.	Deterioration of the water ecosystem. Decreased biodiversity in surface waters;	Watershed level.
		Watershed ecology.	8	5			
		.	5	1			

Topic: Water supply systems

#	Priority Issue	Criteria: Negative Impact	Criteria: Negative Impact	Maximum Attainable Score	Causal-Chain Analysis: Causes	Causal-Chain Analysis: Negative Impacts/Impacts on Other Resources	Causal-Chain Analysis: Scale of the Impact
1.	Poor drinking water quality. (Total score: 10)	On the health of population	10	7	Water supply system headworks are not protected; Intakes of the headworks and pipes are depreciated; headworks are faulty: they do not have the capacity for even crude technological processing (purifying, filtering) and they are missing components such as filters, clean water reservoirs, and sediment traps; Absence/insufficient water disinfection; No state monitoring of water quality.	-	Selected communities.
		Watershed ecology.	8	1			
		Social-economic conditions: housing, infrastructure and agriculture.	5	2			
2.	Shortage/Poor availability of drinking water. (Total score: 9)	Community health.	10	7	Absence of centralized water supply systems in many villages and uncontrolled use of water through individual wells; Insufficient technical condition of intakes; Significant water loss due to depreciated/damaged main pipes and internal networks; Irrational water distribution due to absence of storage reservoirs and, in some cases, due to incorrect construction of the system; Inadequate funding to rehabilitate existing systems/build new efficient systems; Absence of effective water use tariffs and implementation systems (e.g., proper institutions, billing and bill collection systems, penalties).	Shortage of drinking water; high losses in the system; reduction of source water due uncontrolled abstraction of water from individual wells.	Selected communities.
		Watershed ecology.	8	1			
		Social-economic conditions: housing, infrastructure and agriculture.	5	1			

Topic: Biodiversity

#	Priority Issue	Criteria: Negative Impact	Maximum Attainable Score	Scoring Result	Causal-Chain Analysis		
					Causes	Negative Impacts/Impacts on Other Resources	Scale of the Impact
1.	Degradation of natural ecosystems and biomes through destruction, modification and/or transformation; Destruction of habitats. (Total score: 20)	On the health of population	10	7	Overgrazing, intensive forest cutting; Unsustainable harvesting of species; poaching; Introduction of invasive species and unsustainable tourism; peat extraction; Draining of wetlands; Burning of wetlands; Poor biodiversity-related legislation, policy, and planning; Weak enforcement of biodiversity and forest management laws and regulations; Poor economic conditions of rural communities heavily dependent on local resources for their subsistence Low public awareness of environmental protection.	Degradation of wetland habitats; reduction of wetlands' water retention and purification capacities; intensification of coastal erosion; loss of species, particularly wetland species, including birds, reptiles, fish, relict, rare and endemic plant species; reduction of ecotourism potential of the region.	Watershed level
		Watershed ecology.	8	8			
		Social-economic conditions: housing, infrastructure and agriculture.	5	5			

Topic: Agriculture

#	Priority Issue	Criteria: Negative Impact	Maximum Attainable Score	Scoring Result	Causal-Chain Analysis		
					Causes	Negative Impacts/Impacts on Other Resources	Scale of the Impact
1	Loss of traditional, endemic species (e.g., lentil, chickpea, flax, wheat) and wide use of GMOs. Total score: 16	On the health of population	10	8	Lack of control of gene-manipulated materials and products; Wide use of mass-production crops; Loss of local knowledge of traditional agriculture.	Agricultural genetic erosion.	National
		On the ecological condition of the whole water catchment area	8	5			
		On socioeconomic conditions: dwellings, infrastructure, and agricultural fields.	5	3			

Annex 12. Summary of priority problems of the Lower Rioni pilot Watershed Area

#	Area	Priority Issue	Watershed/Ecosystem Value/Function/Service Impacted	Max. Score	Scoring
1.	**Forest Resources**	**1. Deterioration of overall quality of high conservation value forests;** **2. Reduction of timber resources.** Immediate/underlying causes – problem 1 and 2: unsustainable use of timber resources, including uncontrolled cutting of trees for firewood; overgrazing in forest ecosystems; cutting of forests for implementation of land development projects; absence of forest maintenance and/or restoration measures. Root causes – problem 1 and 2: application of unsustainable silviculture methods, e.g. clearcutting; lack of financial, technical and financial resources to carry out afforestation/reforestation measures; underutilization of alternative energy sources; poor economic sense of local population that limits access to secure energy sources (gas, electricity, etc.); local population's lack of awareness on energy saving and efficiency measures; absence of a common forest management policy, effective legislation and regulations; absence of forest inventory and monitoring systems; absence of effective law-enforcement system.	Human health	40	**40**
			Drinking water supply	40	**20**
			Ecosystem integrity/conservation value	40	**40**
			Disaster risk reduction	40	**30**
			Energy resources	30	**10**
			Forest resources used as fuel	30	**30**
			Agricultural production	30	**10**
			Provision of reserves of mineral resources.	30	**20**
			Cultural value	20	**10**
			Ecotourism	20	**20**
			Recreation	20	**20**
Total score					***250***

#	Area	Priority Issue	Watershed/Ecosystem Value/Function/Service Impacted	Max. Score	Scoring
2.	Water Quantity	**1. Poor access to drinking water and reduction of water sources;** **2. Increase in the frequency and intensity of floods and flash floods.** Immediate/underlying causes - problem 1: existence of inefficient and outdated centralized water supply systems in urban areas and few villages; absence of centralized rural water systems in the absolute majority of villages; extraction of drinking water from individual/common wells; Root causes – problem 1: lack of financial, technical and human resources for rehabilitating existing systems and/or building new efficient systems; absence of effective water use tariffs and implementation systems (appropriate institutions, billing and bill collection systems and penalties). Immediate/underlying causes – problem 2: deterioration of existing drainage systems and flood control structures and/or absence of such systems; river bank and bed erosion, riverbed sedimentation/silting, coastline erosion and loss, naturally occurring tectonic and geodynamic process including, eustasy, intensification of sea surges and storms, etc. Root causes – problem 2: lack of technical, human and financial resources to properly design, construct, operate and maintain drainage systems and flood control structures; climate change and change in seasonal river runoff due to: a) forest degradation/decline as a result of unsustainable timber harvesting and absence of proper legal-regulatory, policy and institutional frameworks; b) extensive extraction of sand and gravel from riverbanks and beds without any environmental consideration, river bed diversion, construction and operations HPPs in the upstream areas of the river basin, etc.	Human health	40	**40**
			Drinking water supply	40	**40**
			Ecosystem integrity/conservation value	40	**40**
			Disaster risk reduction.	40	**40**
			Energy resources	30	**10**
			Forest resources used as fuel	30	**0**
			Agricultural production.	30	**15**
			Provision of reserves of mineral resources.	30	**20**
			Cultural value	20	**20**
			Ecotourism	20	**20**
			Recreation	20	**20**
Total score					***265***

#	Area	Priority Issue	Watershed/Ecosystem Value/Function/Service Impacted	Max. Score	Scoring
3.	Water Quality	**1. Pollution of surface and ground waters;** **2. Contamination of tap water** Immediate/underlying causes – problem 1: discharge of untreated wastewaters from point sources of pollution (sewerage systems, upstream and local industries, etc.) into surface waters; agriculture and urban runoff; drainage of storm waters and seepage of leachates from controlled and uncontrolled waste disposal sites, open pit mines, dry pit latrines; Root causes – problem 1: deteriorated or absent sewerage systems; absence of wastewater treatment facilities; absence of standard-based sanitary landfills and poor condition of existing landfills; non-proper agricultural practice; lack of state finances to rehabilitate/build centralized sewerage systems and construct WWTPs and standard-based landfills; poor ambient water quality and soil monitoring; absence of effective regulations, including standard for wastewater discharges; absence of a common effective policy on waste and water management; weak law enforcement; low environmental consciousness of local communities. Immediate/underlying causes - problem 2: deteriorated drinking water supply infrastructure or absent infrastructure in the majority of the villages; absence of sanitary zones/lack of protection of zones around existing water sources; absence of tap water treatment in virtually all communities with centralized water supply systems; Root causes – problem 2: shortage of funds to rehabilitate existing centralized systems or to build new systems; absence of effective regulations, weak law enforcement and monitoring mechanisms; low local capacity for tap water quality and environmental pollution control; low environmental consciousness of local communities	Human health	40	**40**
			Drinking water supply	40	**40**
			Ecosystem integrity/conservation value	40	**40**
			Disaster risk reduction	40	**0**
			Energy resources	30	**0**
			Forest resources used as fuel	30	**0**
			Agricultural production	30	**25**
			Provision of reserves of mineral resources.	30	**0**
			Cultural value	20	**20**
			Ecotourism	20	**20**
			Recreation	20	**20**
Total score					***205***

#	Area	Priority Issue	Watershed/Ecosystem Value/Function/Service Impacted	Max. score	Scoring
4.	Waste Management	**1. Poor sanitary-hygienic conditions in urban and rural settlements;** **2. Pollution of streams, rivers, groundwater and soil from waste dumped in dry ravines, drainage canals and riverbeds, as well as from seepage of pollutants from controlled and uncontrolled waste disposal sites.** Immediate/underlying causes - problem 1: substandard waste collection, transportation and disposal systems in the urban areas and nonexistence of these systems in the vast majority of villages; existence of illegal and uncontrolled dumpsites Root causes – problem 1: lack of financial, technical and human resources/capacity to organize effective waste collection, transportation and disposal systems; absence of effective waste collection and disposal tariffs; poor enforcement of tariff collections. Immediate/underlying causes - problem 2: unsanitary and poor ecological conditions of existing legal landfills, proximity of waste disposal sites to streams and settlements; improper operation and maintenance of existing waste disposal sites. Root causes problem 2: lack of financial, technical and human resources to build standard-based sanitary landfills and/or properly operate and maintain existing facilities; absence of waste recycling and processing practices and amenities; absence of common standard-based legal-regulatory, policy and institutional frameworks in the area of waste management; weak environmental monitoring and law enforcement; low environmental consciousness of local communities.	Human health	40	**40**
			Drinking water supply	40	**30**
			Ecosystem integrity/conservation value	40	**40**
			Disaster risk reduction	40	**0**
			Energy resources	30	**0**
			Forest resources used as fuel	30	**0**
			Agricultural production	30	**20**
			Provision of reserves of mineral resources.	30	**0**
			Cultural value	20	**20**
			Ecotourism	20	**20**
			Recreation	20	**20**
Total score					***190***

#	Area	Priority Issue	Watershed/Ecosystem Value/Function/Service Impacted	Max. Score	Scoring
5.	Land Resources	**1.Soil bogging, wind and water induced soil erosion, river bank and coastal erosion;** **2. Loss of productive agricultural lands and high conservation value natural ecosystems, including floodplain forests, wetlands, etc.;** **3. Soil contamination.** Immediate/underlying causes - problem 1: poor land reclamation caused by improper drainage of agricultural lands or absence of such mechanisms; lack of flood control structures on river banks, river bed diversion or other changes in river hydromorphology as a result of various instream manipulations; eustasy and tectonic subduction of land; uncontrolled and excessive grazing, uncontrolled land cultivation, unrestrained forest cutting; Root causes – problem 1: lack of financial, technical and human resources to rehabilitate existing drainage and flood control systems, design and build new and more efficient systems as well as to implement erosion control/land reclamation measures; absence of policy/plan for sustainable land management; absence of effective land use tariffs and implementation mechanisms; low awareness of local farmers on sustainable water and land use and good agriculture practices; lack of the scientific knowledge on human and climate change impacts on coastal erosion, etc. Immediate/underlying causes - problem 2: application of unsustainable agricultural practices; destruction/elimination of windbreaks; overgrazing and uncontrolled timber harvesting; infrastructure development activities without considering and mitigating expected environmental impacts; uncontrolled peat extraction; Root causes – problem 2: absence of effective agricultural land management policy, including land use planning and its implementation mechanisms (e.g., land use zoning, land inventory and monitoring, land use fees, land allocation, etc.); absence of proper zoning or other regulatory or economic mechanisms for sustainable pasture management; absence of sustainable forest management laws, policies and effective mechanisms for law enforcement; lack of local knowledge on good agriculture	Human health	40	**30**
			Drinking water supply	40	**25**
			Ecosystem integrity/conservation value	40	**40**
			Disaster risk reduction	40	**40**
			Energy resources	30	**0**
			Forest resources used as fuel	30	**0**
			Agricultural production	30	**30**
			Provision of reserves of mineral resources.	30	**0**
			Cultural value	20	**10**
			Ecotourism	20	**15**
			Recreation	20	**15**

		practices; absence of common effective policy and its implementation mechanisms for forest management. Immediate/underlying causes - problem 3: leaching of pollutants from waste dumps or waste burial sites, open-pit mines and pit latrines; pollution from urban and agriculture runoff; discharge of untreated wastewaters into the earth's surface. Root causes – problem 3: improper use of agrochemicals; poor knowledge on the optimum agrochemical inputs; absence of regulatory and law enforcement mechanisms for soil quality; absence of effective environmental pollution control regulatory and/or economic mechanisms; absence of financial and technical resources for implementing effective environmental control policies, including policies for waste and wastewater management.			
Total score					***205***

#	Area	Priority Issue	Watershed/ecosystem Value/Function/Service Impacted	Max. Score	Scoring
6.	**Biodiversity**	**1. Degradation (destruction, modification/transformation) of natural ecosystems and biomes (e.g., wetlands, floodplain forests, sand dunes, etc.);** **2. Species loss and decrease in wildlife populations;** **3. Loss of traditional and endemic species (e.g. lentil, chickpea, flax, wheat etc.);** **4. Widespread use of GMOs** Immediate/underlying causes - problem 1: overgrazing; intensive forest cutting; introduction of invasive species; poaching and unsustainable tourism; uncontrolled peat extraction; instream operations, including extraction of sand and gravels from river beds and terraces; artificial fires; land clearing for infrastructure and other economic development activities in protected wetlands and its buffer zones.	Human health	40	**25**
			Drinking water supply	40	**0**
			Ecosystem integrity/conservation value	40	**40**
			Disaster risk reduction	40	**0**
			Energy resources	30	**0**
			Forest resources used as fuel	30	**0**
			Agricultural production	30	**30**

		Immediate/underlying causes - problem 2: poaching; overfishing; distribution of invasive species; implementation of infrastructural projects in areas rich in biodiversity without conducting environmental impact assessment and mitigation measures; unsustainable tourism. Root causes – problem 1 and 2: inadequate legal-regulatory, policy and institutional frameworks for biodiversity conservation and sustainable utilization; poor biodiversity monitoring and law enforcement capacities, including the lack of technical and financial resources and qualified staff; high local poverty level and low environmental awareness of the local population. Immediate/underlying causes – problem 3: widespread use of mass-production crops. Root causes – problem 3: absence of state policy and its implementation mechanisms on Georgian agrobiodiversity, and the decline of local knowledge on traditional agriculture. Underlying cause – problem 4: wide availability and low cost of GMO seeds and products compared to ecological seeds and products. Root causes – problem 4: low public awareness and absence of legal, policy and institutional frameworks for regulating the use of GMO raw materials and products.	Provision of reserves of mineral resources.	30	**0**
			Cultural value	20	**20**
			Ecotourism	20	**20**
			Recreation	20	**20**
Total score					***155***

Annex 13. Waste Management

Table 1. Urban Waste Management Service Basic Data for Senaki Municipality[1]

Municipality	Annual Volume of Solid Wastes	Service Provider of Waste Management Services / Annaul budget	Number and Type of Waste Collection Containers	Number of Vehicles and their Type	Service Coverage Area%	Characterization of Legal Landfill	Tarrif	Medical Wastes	Hazardous/ Industrial Wastes
Senaki	26.000-28.000 m^3	Cleaning and greening service of Senaki Municipality. 175,000 GEL	75 pieces of 0.25 m^3 capacity plastic containers; 100 pieces of 1.1 m^3 capacity metal containers.	2 close waste vehicles with automatic emptying system; 1 open waste truck with a capacity of 7 m^3	Only 30% of population of Senaki City is covered.	Neighboring the village of Teklati; 13 ha land; Only 4 ha is operational; landfill is not fenced; distance from Senaki – 15 km, from the nearest settlement – 3 km, and from the Rioni River – 1.5 km.	Households - 0.3 GEL; Organizations – depending on location, area and number of personnel.	Private company collects, transports and disposes wastes in Kutaisi.	Not registered

[1] The city of Khobi is not located in the Lower Rioni Pilot Watershed Area

Table 2. Tentative Cost of the Measures to be carried out in Khobi Municipality

Khobi municipality	
Construction of a new regional landfills	7,500,000 EURO
Decommissioning/conservation of existing landfills	200,000 EURO
Purchase of waste collection containers	150,000 EURO
Purchase of waste collection and transportation vehicles	300,000 EURO
Development of municipal waste management plan	20,000 EURO
Staff capacity building and public awareness raising	60,000 EURO
Total	**8,230,000 EURO**

Table 3. Tentative Cost of the Measures to be carried out in Khobi Municipality

Senaki municipality	
Setting-up one waste transit (temporary storage)station	400,000 EURO
Decommissioning/conservation of existing landfills	200,000 EURO
Purchase of waste collection containers	120,000 EURO
Purchase of waste collection and transportation vehicles	300,000 EURO
Development of municipal waste management plan	20,000 EURO
Staff capacity building and public awareness raising	60,000 EURO
Total	**1,100,000 EURO**

Annex 14. Socio-economic Indicators

Table 1. Percentage Share of Households by Various Agriculture Produce, 2011

Product	Households (%)
Potato	44.1
Legumes (kidney beans)	60.2
Corn grain/flour	92.0
Wheat grain/flour	1.8
Vegetable	59.9
Beef	45.0
Pork	37.4
Mutton (lamb)	0.6
Poultry	64.1
Fish	5.9
Sunflower	0.7
Egg	76.5
Milk	51.1
Cheese/butter	63.2
Grapes	43.9
Honey	14.9
Fruit	52.8
Other products	1.3

Household survey

March 2012

This survey aims to describe the socio-economic conditions of households in your region and their relation with the environment. Your answers will greatly assist us in successful implementation of the project.

The data will be processed by summarizing the information provided by the respondents. The data received from this survey will only be used in a generalized form.

We are kindly asking you to answer the questions sincerely and check the answer that best describes your household. You can check more than one answer only where the survey states, "***you can provide more than one answer.***"

Should you have any questions related to the questionnaire, please call 5 71 00 36 76.

R1. Municipality

1. Oni
2. Ambrolauri
3. Telavi
4. Akhmeta

R2. Name of the settlement: ___________________________

R3. How long has your household been living in the settlement? _______________

By household we refer to the people residing with you in one house and/or have shared income and expenses whether they are relatives or not.

H1. How many people (including you) live in your household presently?

Total number of household members	

E1. What is the **average** current monthly income of your household?

Note: By current expenses we refer to daily expenses such as food, soap, detergents, toilet paper, shampoo, cigarettes, journals/newspapers, matches, candles, bulbs, cleaning items, fuel, bus, mini-vans, etc.

Current expenses in GEL		We did not have any expenses – 0

E2. What are the **average** monthly long-term expenses of your household?

Note: By long-term expenses we refer to expenses such as: clothes, shoes, furniture, sheets, towels, books, paper, stationery, education expenses, transport maintenance (excluding fuel), weddings, dowries, other celebrations, funerals, renovations, agricultural expenses, etc.

Long-term expenses in GEL		We did not have any expenses – 0

E3. What is the **average** amount of household communal fees?

Note: By communal fees we refer to monthly expenses such as: electricity, gas, kerosene, firewood, water, telephone, etc.

Communal fees in GEL		We did not have any expenses – 0

E4. What was the total monetary income of your household during the last month?

Total amount in GEL	

E5. What share (percent) of your household's income was generated from selling natural resources (hay, fish, firewood, construction materials, berries, mushrooms, healing/vegetable dyes, etc?

___________ % ***Note the share in percentage***

E6. Are you and/or your household members involved in any kind of economic activities?

1. Yes ***Continue***
2. No ***Go to E9***

E7. What is the sphere you are involved in? **You can provide more than one answer**

1. Selling agricultural products
2. Trade
3. Tourism related activities
4. Other ***(identify)*** ____

E8. What is the percentage of the income from economic activities in your total household income?

_________ % ***note the share in percentage***

E9. Compared to other households of your village which category would you attribute your household to? ***Check a single answer***

1. Very poor
2. Poor
3. Medium income
4. A little more than medium income
5. High (rich)

P1. What size of land do you and/or your household members own?
We refer to the total land space in the village as well as in other territories. Please note the size of your land in m^2. 1ha = 10,000 m^2.

_____________ ***m^2***

P2. How many square meters of your land do your household use for agriculture?

_____________ ***m^2***

A1. Approximately how many kilograms of each of these products did your household produce/grow last year?

		Amount
A1.1	Potatoes	kg.
A1.2	Haricots	kg.
A1.3	Corn/corn flour	kg.
A1.4	Wheat/wheat flour	kg.
A1.5	Vegetables	kg.
A1.6	Beef	kg.
A1.7	Pork	kg.
A1.8	Mutton	kg.
A1.9	Poultry meat	kg.
A1.10	Fish	kg.
A1.11	Sunflower seeds	kg.
A1.12	Eggs	Units
A1.13	Milk	Liters
A1.14	Cheese/butter	kg.
A1.15	Grapes	kg.
A1.16	Honey	kg.
A1.17	Fruit	kg.
A1.x	Other (please define)	kg.

A2. Do you own poultry/cattle to provide food or generate income?

1. Yes
2. No

A3. How do you use the neighboring forest?

		Yes	No
A3.1	Collect firewood	1	2
A3.2	Collect mushroom, grass, berries for personal use	1	2
A3.3	Collect mushroom, grass, berries for selling	1	2
A3.4	Graze cattle or feed bees	1	2
A3.x	Other (please define)	1	2

Statistical Tables, Results of Survey

Community * Municipality Cross tabulation

		Municipality		Total
		Senaki	Khobi	
Community	Sagvichio		249	249
	Shavgele		300	300
	Chaladidi		1058	1058
	PataraPoti		426	426
	Teklati	870		870
	Akhalsopeli	632		632
	Gejeti	280		280
	Nokalakevi	476		476
	Nosiri	1053		1053
	Potskho	571		571
	Ledzadzamie	347		347
	Bataria	587		587
	Zana	401		401
Total		5217	2033	7250

Are you and/or your family members engaged in any economic activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	4749	65.5	66.4	66.4
	No	2403	33.1	33.6	100.0
	Total	7152	98.6	100.0	
Missing	System	98	1.4		
Total		7250	100.0		

$E7 Frequencies

		Responses		Percent of Cases
		N	Percent	
$E7[a]	Sale of agricultural products	3547	70.6%	73.9%
	Trade business	1450	28.9%	30.2%
	Tourism related business	25	0.5%	0.5%
Total		5022	100.0%	104.6%

What part of your income comes from these activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 25 %	424	5.9	9.4	9.4
	26 - 50 %	1161	16.0	25.8	35.2
	51 - 75 %	465	6.4	10.3	45.5
	More than 75 %	2458	33.9	54.5	100.0
	Total	4508	62.2	100.0	
Missing	System	2742	37.8		
Total		7250	100.0		

Total everyday expenses (GEL)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 50 GEL	1720	23.7	23.7	23.7
	51 - 150 GEL	3734	51.5	51.5	75.2
	151 - 300 GEL	1396	19.3	19.3	94.5
	301 - 500 GEL	246	3.4	3.4	97.9
	More than 500 GEL	154	2.1	2.1	100.0
	Total	7250	100.0	100.0	

Total long-term expenses (GEL)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 GEL	135	1.9	1.9	1.9
	Less than 50 GEL	677	9.3	9.4	11.3
	51 - 150 GEL	3797	52.4	52.7	64.0
	151 - 300 GEL	1538	21.2	21.3	85.3
	More than 300 GEL	1059	14.6	14.7	100.0
	Total	7205	99.4	100.0	
Missing	System	45	.6		
Total		7250	100.0		

Total utility bills (GEL)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 10 GEL	446	6.1	6.2	6.2
	11 - 25 GEL	3178	43.8	44.2	50.4
	26 - 50 GEL	1966	27.1	27.4	77.8
	51 - 100 GEL	959	13.2	13.3	91.2
	More than 100 GEL	635	8.8	8.8	100.0
	Total	7183	99.1	100.0	
Missing	System	67	.9		
Total		7250	100.0		

Total income for last month

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100 GEL	751	10.4	10.5	10.5
	101 - 250 GEL	3048	42.0	42.4	52.9
	251 - 500 GEL	2362	32.6	32.9	85.8
	501 - 1000 GEL	1023	14.1	14.2	100.0
	Total	7184	99.1	100.0	
Missing	System	66	.9		
Total		7250	100.0		

Compared to other families of the village, which group best describes your family?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very poor	204	2.8	2.9	2.9
	Poor	2259	31.2	31.8	34.7
	Medium income	4346	59.9	61.1	95.8
	More than medium	289	4.0	4.1	99.9
	High income (Rich)	9	.1	.1	100.0
	Total	7107	98.0	100.0	

Missing	System	142	2.0
Total		7250	100.0

Statistics

How many people currently live in this household?

N	Valid	7250
	Missing	0
Mean		4.77
Median		5.00
Std. Deviation		1.765
Minimum		1
Maximum		11

What part of your income comes from sale of natural resources?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No income	3573	49.3	65.4	65.4
	Less than 25 %	1562	21.6	28.6	94.1
	26 - 50 %	184	2.5	3.4	97.4
	More than 75 %	74	1.0	1.4	98.8
	100 %	66	.9	1.2	100.0
	Total	5460	75.3	100.0	
Missing	System	1790	24.7		
Total		7250	100.0		

$A3 Frequencies

		Responses		Percent of Cases
		N	Percent	
$A3[a]	We collect firewood in the forest	4716	42.6%	81.1%
	We collect mushrooms, herbs, berries for our own use	1477	13.4%	25.4%
	We collect mushrooms, herbs, berries for sale	399	3.6%	6.9%
	We graze our livestock/bees in the forest	4468	40.4%	76.8%
Total		11061	100.0%	190.1%

$A1 Frequencies

		Responses		Percent of Cases
		N	Percent	
$A1[a]	Potatoes	3156	6.2%	44.1%
	Haricot	4308	8.4%	60.2%
	Maize/maize flour	6586	12.9%	92.0%
	Wheat/wheat flour	126	0.2%	1.8%
	Vegetables	4285	8.4%	59.9%
	Beef	3222	6.3%	45.0%
	Pork	2675	5.2%	37.4%
	Mutton	46	0.1%	0.6%
	Bird meat	4586	9.0%	64.1%
	Fish	424	0.8%	5.9%
	Sunflower seeds	49	0.1%	0.7%
	Egg	5475	10.7%	76.5%
	Milk	3660	7.1%	51.1%
	Cheese/Butter	4526	8.8%	63.2%

	Grape	3142	6.1%	43.9%
	Honey	1065	2.1%	14.9%
	Fruit	3779	7.4%	52.8%
	Other	94	0.2%	1.3%
Total		51202	100.0%	715.4%

Do you have any livestock?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6332	87.3	94.1	94.1
	No	398	5.5	5.9	100.0
	Total	6731	92.8	100.0	
Missing	System	519	7.2		
Total		7250	100.0		

Statistics

What is the total size of plot owned by your household?

N	Valid	6686
	Missing	564
Mean		10510.69
Median		10000.00
Std. Deviation		6495.991

Statistics

What size of plot is used for agriculture?

N	Valid	6731
	Missing	519
Mean		7271.33
Median		7000.00
Std. Deviation		4167.149

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