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Rapid Assessment of the Rioni and Alazani-lori River Basins

Republic of Georgia

Technical Summary Report

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Integrated Natural Resources Management in the Republic of Georgia Program

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I. INTRODUCTION

1. Background

Georgia is a country rich in natural resources with many picturesque and pristine ecosystems, but in the presence of unclear environmental legislation and the weak law enforcement the condition of the country's environment has suffered for years. Many surface and ground waters are severely polluted due to waste dumping and untreated wastewater discharges, large areas of forests are cleared due to illegal logging that was very intensive after the break-up of the Soviet Union, populations of a number of valuable and unique fish and wildlife species are reduced due to poaching, and many 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 adverse impacts of natural disasters and climate change undermine the natural resource base and ecosystem services that Georgia depends upon for sustainable development.

In order to address 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 the "Global Water for Sustainability" (GLOWS) Program by a consortium of international and national organizations under leadership of Florida International University (FIU) in a partnership with Care International, Winrock International, UNESCO-IHE and Caucasus Environmental NGO Network (CENN).

2. Objectives and Scope

The primary goal of the INRMW Program is to improve current and future lives of people in Georgia by utilizing and managing natural resources more sustainably, including water, soil, vegetation, and the ecosystems that encompass them. The project aims to introduce innovative approaches and practical models of participatory integrated natural resources management in targeted watersheds, by facilitating reforms to and harmonization of national policies, and 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 representative watersheds of Rioni and Alazani-Iori River Basins and efforts will be made to upscale and disseminate them across the country. The project goal will be achieved by implementing a number of sequential activities that include: baseline assessments of existing laws, policies, institutions and practices with regard to management of natural resources and related sectors; rapid assessments of the existing socio-economic and environmental situation in targeted river basins; selection of four representative upstream and downstream pilot areas for on-the-ground interventions; detailed assessments of pilot areas; development of resource management plans and; implementation of a number of priority interventions at community level through community small-grants program.

The Rapid River Basin Assessment is a second major deliverable under the project. Its general objective is to create a knowledge base around the targeted Alazani-Iori and Rioni river basins to lead to selection of four smaller representative pilot areas for on-the-ground interventions based on a number of physico-geographic, environmental, social-economic, governance and other criteria. To this end, specific objectives of the study are: to collect, synthesize and analyze the baseline situation existing in Alazani, Iori and Rioni River Basins in terms of ecological status and the use of natural resources there; to identify linkages among the use of natural resources and ecosystem functions and; to define resource use opportunities, where sustainable and integrated management of these resources can bring immediate health, environment,

ecological, and economic benefits. Information and analysis contained in this report will help the project identify and select those four pilot areas within the larger geographic areas that might be the most appropriate for demonstration of integrated natural resources management in a watershed context and as well, the most promising to bring tangible results easily replicable in other areas.

The current document is a technical summary of a full version of the Rapid Basin Assessment and contains only major highlights of baselines information, brief analysis of environmental pressures and impacts and, major findings together with recommendations. It does not include annexes and sources of information, for which one has to refer to the full version.

3. Methodology, Limitations

The study has been developed through collection, compilation and analysis of available information as well as through face to face interviews with project partners and representatives of the Ministry of Environment, Ministry of Energy and Natural Resources, United Water Company, various environmental NGOs, etc. Opinions expressed in this report are those of individual experts and may not coincide with the official positions of the government of Georgia or USAID Caucasus. For this assessment we have relied on available data and studies. During the assessment limitations were noted for selected historical and current socio-economic and environmental data. While there is abundant information on the Alazani River Basin, given the past and current donor efforts, there are very limited studies on the Rioni and Iori River Basins. Furthermore, various studies differ in terms of the completeness of data and inconsistencies between reports are common. Consequently, we can take no responsibility for those data and information we have extracted from existing studies and our assessment could not be conducted at the same level of detail for all the basins and sectors of interest.

II. PHYSICAL-GEOGRAPHIC AND ENVIRONMENTAL CONTEXT

1. Alazani-Iori River Basins

Geography, Geomorphology, Geology. The Alazani and Iori Rivers flow parallel to one another and are one of the major trans-boundary rivers of the Kura-Aras River basin. They originate in the Main Caucasus Range at an elevation of about 2,600-2,800m above sea level (a.s.l.), flow through an inter-mountainous depression, cross the Georgian-Azerbaijan border and join the Mingachavir Reservoir in Azerbaijan. The total length of the rivers is 351 and 320 km, respectively, and their total catchment areas are 11,800 km^2 and 4,650 km^2, respectively. The average annual precipitation in the Alazani basin varies from 400 (Dedoplistskaro municipality) to 993 mm (Lagodekhi municipality). The average annual air temperature is between +9°C and +14°C. The minimum temperature rarely drops below minus 18°C – 23°C and the maximum temperature does not exceed plus 37°C – 39°C. In the Iori Basin annual average sum of precipitation is 1,300-1,400 in highlands and 400-500 mm in lowlands. Average annual temperature is from 0°C to +8°C in highlands and from +10°C to +11°C in lowlands. January temperature in mountainous areas varies from -10°C to -2°C and in lowlands – from -1°C to -3°C and, July temperature – from +8°C - +19°C in upper courses and – from 22-27^0C in middle to low courses. Absolute minimum is within the range of -28 and -40°C and absolute maximum – +20+22°C and +35 –-+36°C in upstream areas, while the absolute maximum value reaches 39°C and the minimum -26°C –- -33°C in the lower course of the Basin.

The Alazani basin is located within two tectonic zones: the east slope of the Caucasian folded-fractured mountain zone and the Alazani plain (valley). There are two distinctive orographic structures in the basin: the Mountain Areas of the Greater Caucasus and the Kura-Aras or Iberian lowland. The Mountainous areas of the Greater Caucasus are represented by the Central and the Eastern Caucasus. The Central Caucasus encompasses the upper reaches of the Alazani River, including the river source. The Eastern Caucasus almost entirely coincides with the southern slopes of the Kakhetian Caucasus and is represented by the ridges of several mountains as well as by the basins of the left tributaries of the r. Alazani. Kura-Aras or Iberian lowland is represented Alazani-Gishitskali and Iori-Ajinauri sub-regions consisting of the Alazani plain (valley), the Gombori range (a chain of various ridges), the Iori or Gare Kakheti Plateau and the part of the Gombori range. Geological composition of the mountainous parts is sandstone and clay shale, limestone and marls and. are spread on the right bank. Rocks are covered with clay and sandstones. Terraces of the Alazani Valley are covered by marl and sandy conglomerates. Floodplains are mostly built of alluvial, alluvial-proluvial and partly – delluvial sediments of the Quaternary period. The TsivGombori Range is mostly composed of conglomerates of Neocene age and loams (sandstone, clays). The Gare Kakheti Plateau is composed of conglomerates and pebbles. Flat surfaces are covered by alluvial sediments and the slopes of the ranges – alluvial-talus surfaces. The Plateau is mainly covered by loam.

The Iori River Basin is stretched on the southern slopes of the Greater Caucasus (Central Caucasus) and between the Kakheti and Kartli ridges. Mountainous areas of the Iori Basin belong to the Mestia-Tianeti tectonic zone of Late Jurassic and Cretaceous Carbonate Flysch of the Fold-and-Thrust Structure of the Southern Slopes of the Greater Caucasus, more specifically, to the Djinvali-Gombori tectonic sub-zone. The flysch is mostly composed of sandstones, marls, limestone, breccias (sedimentary rocks) mixed with porphyries and conglomerates. Tianeti and Ertso depressions are formed by Quaternary sands, clays and pebbles. Downstream of Sioni reservoir in the middle reaches of the Basin, Mestia-Tianeti tectonic zone turns into Eastern zone of molassic deposits of the Iverian Intermountainous Depression, more specifically, into Mukhrano-Tiriphoni sub-zone. Very small part of the basin in the middle to lower reaches is located in the southern zone of the depression, namely in Sartichala Sub-zone. Sartichala sub-zone is composed of Quaternary alluvial-delluvial-prolluvial deposits of sedimentary rocks). Mukhrani-Tiriphoni sub-zone is represented by Alazani sediments composed of thin layers of conglomerates and clays and Dusheti formations. It downstream Sagarejo transforms into Gare-Kakheti sub-zone represented by low thickness Shiraki molassic formations of clays and allegorites with conglomerate and sandstone interbeds; medium-thickness Eldar deposits of clays with sandstone and conglomerate mid-layers and; medium thickness Agchagil-Apsheron marine deposits of clays, sandstones and conglomerates. Quaternary deposits are found on Taribana valley, mid and late cretaceous – in v. Khirsa, Late Eocene - in Udabno and quaternary alluvial-prolluvial sediments - in flood plains.

Landscapes. Following landscapes are met in the Alazani river basin: ***alpine and sub-alpine landscapes*** spread at an altitude of 2,000-2,500 m above sea level transforming into broad-leafed forests of oak, ash, elm, etc. at an altitude between 600-800m and 1,800-1,900m; ***Desert, semi-desert, steppes, arid light woodland, Shibliak, phryganoid vegetation, rock xerophytes and halophyte communities*** dominate on the right bank of the River Alazani and, ***floodplain forests*** on the left bank on the Alazani river. In the basin, forests occupy slopes and foothills of the Greater Caucasus, Tsivgombori range and the banks of the Alazani Basin. There are following protected areas within the Basin: Tusheti Protected Areas, Batsara-Babaneuli Strict Nature Reserve, Ilto Managed Reserve, Lagodekhi Protected Areas and Vashlovani Protected Areas.

In the Iori Basin, ***High Mountain Meadow Landscapes*** dominating at river source transform into ***Middle mountain, Low mountain and foot-hill landscapes*** with broad-leafed forests. In the middle and lower parts of the basin along both riversides small fragments of the ***Riparian (Tugay groves) forests,*** with *Pistacea mutica* and *Celtis caucasica* are found. They are rich in rare and endemic, as well as relic species from cretaceous period and onward. On the right-bank side of the basin closer to the river valley *lays* ***a semi-prairie***, covered with grain plants and big intermixture of xerophytes. The semi-prairies, as well as the semi-deserts on gristly-sandy soil bases are met on the left-bank side of the basin. ***Arid light woodlands*** composed of pistachio (*Pistacea mutica)* and juniper (*Juniperus foetidissima)* are found in Vashlovani Reserve, mount Nazarlebi, Pantishara, Shiraki Plateau, Kotsakhura Ridge, Western slopes of Eldari Ridge, etc. ***North Sub-Tropical Semi-Arid Landscapes*** occupy significant part of the Iori upland (plateau). Shiblyaks and steppes are spread on chernozems, while brown and grey-brown soils are met in areas with significant humidity. Dry steppes on ash-brown soils with semi-desert vegetation are also met here. Natural landscapes and agriculture lands with orchards and gardens are concentrated on irrigated lands. Lands unsuitable for irrigation are used for winter pasturing. ***North Sub-Tropical Arid Landscapes*** are mostly distributed in the Eldar lowland. Natural landscapes with fragrant-absinthe, saltine desert and semi-desert vegetation on grey and grey-brown soils dominate here. ***Semi-deserts with formation of*** *Artemisia fragrans* are met only on the Eldar Lowland in Dedoplistskaro municipality. Following protected areas are located within the Iori River Basin: part of the Vashlovani Protected Areas, Chachuna Managed Nature Reserve, Korugi Managed Nature Reserve and Mariamjvari Strict Nature Reserve. Overall, in Iori river basin, forests occupy slopes and foothills of the Greater Caucasus, Tsivgombori range and the banks of the Iori Basins.

Land Resources. Due to the complex oro-climatic and biological conditions of the Alazani-Iori river basins, soils in the targeted areas are diverse and are represented by 15 types of soils varying from primitive soils to chernozems, marshy and saline soils.

Mineral Resources. Alazani and Iori River Basins are rich in mineral resources especially, the Kakheti region shared by both river basins. Various construction and facing materials are extracted in almost all municipalities, with large quantities of limestone extracted in Dedoplistskaro. Oil and gas deposits exist in Sagarejo, Gurjaani, Dedoplistskaro and Signagi, the majority of which is extracted in the amount of 260 tons of oil per day. Experts think that the Taribana valley in Dedoplistskaro districts may contain billion of tons of oil reserves. Copper deposit is discovered in Telavi district. Mineral water is extracted in Ujarma, Sagarejo district. Tianeti municipality belonging to the Mtskheta-Mtianeti region and located in the upper course of the Iori Basin is relatively poor in mineral resources. Deposits of limestone and brick clay are found here. There is also an extraction of sand and gravel for construction materials as well as extraction of peat. In Iori section of the Gardabani municipality belonging to the Kvemo Kartli region oil and gas deposits are found on Iori plateau, which are extracted by company Ioris Valley. There are also limestone and clay deposits in Sartichala.

Renewable Energy Resources. In general, the Alazani river basin is poorer in renewable energy resources, except for solar energy compared with the Rioni River Basin, due to its oro-climatic and hydrological peculiarities. According to estimates, total theoretical technical hydropotential of the basin equals to 414.2 MW of installed capacity and 2,420.2 mln Kwh electricity output. Wind power potential at the height of 50m above the ground level is mostly less than 100 watt per square meter on the majority of the territory. With regards to the solar energy, one of the highest values of annual average duration of sunny periods nationwide is recorded in Telavi and Akhmeta districts. The longest sunny periods occur in summer time amounting to over 340 hours in Kakheti. Total annual solar radiation, including direct and indirect radiation

varies from 125 to 140 kcal/sm^2 in the Alazani river basin. In terms of biomass resources, the Alazani river basin is rich in forest resources, with Akhmeta, Kvareli, Lagodekhi and Telavi municipalities having the large forested areas. There are very few geothermal hot water sources in the Alazani river basin.

Similar to the Alazani river basin, the Iori River Basin is poorer in renewable energy resources except for solar energy, than the Rioni River Basin. Moreover, it is poorer in renewable energies than the Alazani Basin. Hydropotential of the Iori river basin equals to 41.5 MW of installed capacity and 237.3 mln kWh of power output. As for the wind power potential, it varies from 100 to 1,200 w/m^2 (the Shiraki Plateau) with the lowest values below 100 w/m^2 recorded at river source. Total annual solar radiation varies from 125 to 140 kcal/sm^2. This is one of the highest values across the country. In terms of biomass and in particular, wood resources potential, it is lower than that of the Alazani basin. The majority of wood resources are concentrated in the Tianeti. The Iori river basin is scarce in geothermal resources, with only 1 well of 0.04 MW thermal capacity located in v. Ujarma, Sagarejo municipality.

Water Resources. Seasonal fluctuation of the river run-off is characteristic of the Alazani River Basin. Floods happen in spring, flash floods – in summer and fall and, low waters – in winter and summer. Most of the rivers of the basin are fed by multiple sources, e.g. ground water accounts for 40% of the water flow of the Alazani River, rain water – 31% and snow melting – 29%. Overall, the surface waters of the Alazani basin fall under the category of rivers with 25-50% spring runoff. The annual discharge of the Alazani, measured at the confluence of the Alazani and the Mingechavir is about 2.5 billion cubic meters. Total water resources of the Alazani River in Georgia are estimated at 3.10 km3 (570mm). The long term average discharge recorded for the Shakriani Bridge is 45 m3/sec and for the village of Chiauri – 71.4 m3/sec. The maximum discharge of Alazani recorded at the Shakriani Bridge is 1,160 m3/sec (5/6/1948). Maximum value, recorded for the village of Chiauri - Lagodekhi district amounts to 685 m3/sec (21/5/1936). Multi-year average discharge is 479 m3/s. Following major tributaries flow into the River Alazani: Ilto, Stori, Kabali, Avaniskhevi, Bursa, Duruji.

The Aquifer of Late Jurassic period is found on the southern slopes of the Greater Caucasus, stretched up to the upper course of the river Alazani. The water-bearing horizon is formed here with marl slate, sandstones and limestone. It is characterized with high yield, counting tens of liters a second. The regime of the springs depends on atmospheric precipitation. The water mainly is of hydrocarbonate calcium type. The Alazani artesian basin covering the majority of the Alazani River Basin belongs to sub-mountainous and inter-mountainous confined aquifers. It is enclosed between impermeable strata of Quaternary alluvial-proluvial sediments and is very rich in fresh subsurface pore and stratal water, located at the depth from 10 to 60m. Well-spring flow rates range from 0.2 to 165 L/sec, transmissibility coefficient is 500-1500 m2/day. The waters are mainly free-flowing, with flow rates of 1.5 to 8.5 L/sec. Their filtration coefficient is 3.9 m/day on average. The total groundwater resource in the major part of the Alazani-Ayrichay Valley (6,000 km2) is estimated at 39.3 m3/sec, with a reserve of 20.4 m3/sec in Georgia. While the minimum flow measured at the most downstream gauging site on the Alazani-Ayrichay basin is 63.7 m3/sec, the exploitation of 39 m3/sec appears to be safe. On the territory of Georgia old quaternary sediments contain hydro carbonate calcium-sodium waters, with mineralization not exceeding 0.7 g/L and total hardness of 1.8-6.5 mg-equiv. However, waters at the Georgian borders are mineralized to 1.5-2.7 g/L.

The river Iori is fed by snow melting, rainfalls and groundwater, with following contribution by these sources: ground waters – 39%, rainfall – 33%, snow melting – 28%. Flow regime of the river is characterized by uneven annual distribution of the run-off, with spring floods, summer-fall high waters and flash floods and, winter steady low waters. Over 40% of annual flow occurs in spring, 27-33% – in summer, 16-17% – in fall

and 8-14% – in winter. However, in the wintertime the flow regime is characterized by instability year by year and in some years equals to the summer flow. The minimum flow is observed in winter (December-February). The highest sediment discharge and concentration is observed during the spring floods and the minimal sediment load – in winter (January-February). During low-water level the water in the river is clean, transparent and good for drinking. Annual flow of Iori River is 341 mln m3. According to series of hydrological observations (1934-1993), multi-year average run-off of the river is 15.1 m3/s. Recent hydrological data on Iori are absent. Major tributaries of the Iori River are: Lakbe, Ole, Adzezi, Kharshula, Sagome, Keno, Adedi, Gombori, Lapiankhevi, and Ragolantskali.

Ground waters of the Iori Basin are represented by Mestia-Tianeti basin of pore and fracture water, Iori-Shirak basin of pore and stratal water and at a lesser extent, by Marneuli-Gardabani basin of pore and stratal water and Kartli Plain artesian basin (Kartli-Tiriphoni-Mukhrani artesian basin). Aquifers of the Greater Caucasus fold zone represented by Mestia-Tianeti basin of pore and fracture water are found in the upper reaches of the Iori Basin. These are mostly composed of terrigenous and carbonaceous flysch of the Early and Late Cretaceous and Late Jurassic ages as well as of Middle and Early Jurassic shale stratum. Due to numerous fractures and karsts, limestone and sandstones are highly permeable and saturated with water. Outcrops of the terrigenous flysch are mostly met in the upper weathered zone (to 20-25m), and have low flow rates, up to 0.2 L/sec in shale formations and up to 6 L/sec in sandstone inter-beds. Flow rates of the springs occurring in the limestone mainly exceed 1 L/sec; in rare cases reaching 25 L/sec. Carbonaceous flysch aquifer of Late Jurassic period is built with 1500m-thick limestone, dolomite and marl. Water in this aquifer has high flow rate of up to 70 L/sec. Shale strata aquifer of the Middle and Early Jurassic age is mainly represented by thick mass of clayey shale sediments of dislocated and fractured structure. It includes zones of intensive and restricted water circulation. Unconfined fracture groundwater circulates in the former zone, with spring outputs ranging within 0, 02-0.1 L/sec. In large faults, where the crystalline rocks thrusts the shale mass, spring flow rates are much higher reaching 5 L/sec. Sub-mountain and intermountain aquifers are represented by ground waters of Iori-Shirak and Marneuli-Gardabani pore and stratal water basins, built with merged river debris cones. Ground waters occur at the tops of the cones forming a single unconfined aquifer. In the center and periphery, where clays or clayey matrix occur, these divide the single aquifer into the unconfined aquifer and several confined ones. Aquifer of the Quaternary alluvial-proluvial sediments of 10-500 thickness is widespread within Tiriponi-Mukhrani, Marneuli-Gardabani, and the Iori tableland. In the Iori-Shirak artesian basin, the aquifer thickness ranges within 37-72m in the debris cones of the Iori tributaries. The waters are mainly free-flowing, with flow rates of 1.5 to 8.5 L/sec. Their filtration coefficient is 3.9 m/day on average. In the central sunken part of the Marneuli-Gardabani plain, strong groundwater streams circulate at the depth of 20m. The total thickness of the strata reaches as much as 3000 m. Well-spring flow rates ranges within 0.10-5.7 L/sec. Most wells have piezometric levels to 42 meters below the ground level. In Mukhrovani-Ujarma segment ground water mineral content is up to 20-35 g/l, represented by hydrocarbonate and Na+ type waters. The aquifer of the recent alluvial sediments built of cobble with sandy and sand-salty matrix and inter-beds and lenses of sand, sandy loam, loam and clay, is found in floodplains and above-floodplain river terraces. The aquifer thickness mostly ranges within 3- 15 meters, occasionally reaching 30-40 meters. The filtration coefficient is 10-30 m2/day, occasionally 100-200 m2/day.

2. Rioni River Basin

Geography, Geomorphology, Geology. Rioni is the largest water body in western Georgia. Its length is 327 km, total catchment area - up to 13,400 km^2 that is approximately 20% of the whole Georgian territory and, total fall - 2,960 m, average fall of the river is 8 m per one kilometer, average elevation - 1,084m and average

inclination – 7.2 %. The river originates from two sources on a southern slope of the Main Caucasian range and runs into the Black Sea near the city of Poti. Through many sleeves the rives runs into the Black Sea, but the basic part of the drain passes through bypass channel constructed in 1939 for protection of Poti from flooding. The climate of the Rioni Basin is mostly mild subtropical and is more humid than that of Alazani and Iori River basins. Average annual temperature in lowlands is +9-+10^{0}C and in mountains – +4-+5^{0}C. In lowland, January mean temperature is +1.5-+4^{0}C and July mean temperature – +18-+24^{0}C. The annual sum of precipitation is 1,000-1,500 mm in lowlands and 1,600-1,800mm in highlands. The climate of the Rioni Delta, where it flows into the Black Sea is humid subtropical. According to multi-year hydrometeorological observations, until 1990s the mean annual air temperature in the coastal area varied in the range of +14.4-+14.5^{0}C and annual sums of precipitation from 1,400 mm to 2,600 mm (Batumi). In the last half-a-century, till the beginning of the 1990s, the air temperature in the coastal zone decreased by 0.2-0.3^{0}C, while for the last 16 years it increased by 0.2^{0}C.

The Rioni River basin is located on the southern slopes of the Greater Caucasus range and within the sub-mountainous immersion zone (depression). It is represented by the Mountain Areas of the Greater Caucasus, the Lesser Caucasus and the Kolkhida humid sub-tropical regions. In accordance with geotectonic zoning, upstream areas of the Rioni river basin are located within the lower zone of the Crystal Core of the Main Caucasus Anticline and, the Folded System of the Southern Slope of the Greater Caucasus (i.e. zones of the Mestia-Tianeti carbonaceous sediments of upper Jurassic and cretaceous periods represented by Shovi-Pasanauri sub-group and, the Gagra-Java represented by upper and lower Jurassic porphyries and Racha-Lechkhumi syncline) Lower Paleozoic, Mesozoic and Cenozoic formations are met here. The geological structure of foothills is represented by paleogenic and neogenic deposits. Imereti upland, located to the east of Kolkhida lowland (plain) within sub-mountainous immersion zone (depression), is represented by Meso-Cenozoic and Quaternary thick carbonaceous and effusive deposits. The Quaternary and Cenozoic sediments have the widest distribution. Recent Quaternary sediments are distributed in river valleys and represented by riverbed and floodplain facieses; Alluvial-Delluvial sediments are distributed in watersheds and hillock banks and clays and sandstones one to two meters deep. The Kolkhida lowland is the most submerged structure in Georgia, filled with thick Quaternary formations. Its fundament is parted with deep tectonic fractures.

Landscapes. ***Caucasian Sub-nival, High-Mountain Alpine Shrubbery-Meadow and Sub-alpine Landscapes*** are spread on the Main Caucasus Range, where the River Rioni originates in upper Racha. ***Colchic Middle-Mountain Forest Landscapes*** are spread in the mountainous areas and along with the Racha-Lechkhumi are met in Imereti region. ***Colchic Low-Mountain Forest Landscapes*** infringe the Colchic foot-hills as a relatively narrow (5-10km) strip, widening up to 10-12 km in Upper Imereti and Guria. ***Colchic Lowland landscapes*** are composed of Quaternary alluvial deposits with sphagnum-reed marshes and marshy alder-thickets on peat bog and mineral- bog soils are distributed. A comparatively low marshy part of the Colchic lowland with its depression-accumulative plain relief and sphagnum-reed marshes is of special mention. Swamp alder forests and unique lowland peat bogs are found here (in the lower reaches of the Rioni River in the Kolkhida Lowlands around Paliastomi Lake). The Kolkhida lowlands are considerably changed by human activities and natural-agrarian landscapes with maize crops, tea, and more rarely citrus occupy drained lands. Rioni River Basin is very rich in forest resources, especially its upper parts. Almost all types of forests specific to the ecosystems of Georgia are met in the Basin. There are following Protected Areas in the Rioni Basin: Borjomi-Kharagauli National Park, Ajameti Manager Reserve and Imereti Caves Protected Areas with Sataplia Strict Natural Reserve located in Imereti Region, Katsoburi Managed Natural Reserve and Kolkheti National Park

located in Samegrelo-Zemo Svaneti region. In addition, there is a planned Central Caucasus Protected Area to cover Racha-Lechkhumi and Kvemo Svaneti region.

Land Resources. In general, soils of the Rioni River basin belong to the West Georgia soil group region, which are represented by lowland-plain marsh and podzol, foothill-hill, mountain-forest and mountain-meadow soils.

Mineral Resources. Rioni River Basin is abundant with mineral resources. Upper courses of the Basin are rich in non-ferrous metal and non-metal mineral deposits. At a lesser extent, ferrous mineral resources are also found in the region. The region is extremely rich in mineral waters. In terms of precious stones, striped agate deposits are found in Tsageri municipality. Middle to Low courses of the Basin especially, Imereti region, are also characterized by richness and diversity of mineral resources, with more than 100 deposits registered there. Major mineral resources are as follows: manganese, coal, bentonite clays, marble, limestone, teschenit, basalt barites, liatonites, clay, etc. In addition, the region is rich in healing mineral waters. Samegrelo-Zemo Svaneti section of the Rioni Basin is very rich in hot thermal waters. There are also peat reserves in various municipalities.

Renewable Energy Resources. Rioni River basin is extremely rich in hydro resources as well as with biomass, in particular, with wood resources. Geothermal and wind resources are also significant. In terms of solar energy, its potential is far lower here than that in the Alazani-Iori river basins. More specifically, total theoretical technical hydropotential of the rivers of the Rioni basin within the Racha-Lechkhumi region is estimated at 428.8 MW of installed capacity and 2,390.0 mln kWh of power output. Wind power potential is mostly insignificant and is less than 100 w/m^2. It is high only on the Mamisoni pass varying from 500-800 w/m^2. Regarding the solar power potential it varies from 4.2 to 4.5 kwh/m^2 a day. The higher values are only recorded on the southern slopes of the West Caucasus. The Racha-Lechkhumi region is very rich in wood resources. Forests cover over 275,817 ha of land, with 263,093 ha of forested areas. Regarding the geothermal resources, there are no hot water sources found in the region. Total theoretical technical hydropower potential of the Rioni river Basin rivers flowing in Imereti region is estimated at 669.3 MW of installed capacity and 1,989 mln kWh of power output. With regard to wind resources, the majority of the region's territory has the 100-250 w/m^2 power potential density, with Kutaisi and its surrounding areas having from 500-800 w/m^2 to 800-1,200 w/m^2 values and the large areas on the Likhi range – more than 1,200 w/m^2 values. In terms of solar energy, solar power potential is 3.8 kwh/m^2 per 24 hours in the majority of the area of the Imereti region. The forest cover of the region makes up 286,332ha or nearly 44% of the region's total area (655,200ha). Imereti region is relatively rich in geothermal resources. Total thermal capacity of the existing groundwater sources are estimated at 28.3 MW. There are 24 geothermal hot water wells in the region, with water temperature varying from 300C to 61^0C. Total theoretical feasible hydropower potential of the Rioni Basin rivers flowing in Samegrelo region amounts to 64.9 MW of installed capacity and 363.7 mln kWh of annual power output. In terms of wind power potential, the wind power density is within the range of 100-250 w/m^2 in the absolute majority of the region, with Poti and its surrounding areas along the shore having the wind power capacity between 800 and 1,200 w/m^2. Regarding the solar energy potential, it is 3.8 kwh/m^2 a full day on the majority of the region's territory. With regards to the biomass, the region is rich in wood resources. The forest cover is over 40% of the total area of the region (744,100ha). In addition to forest wood resources, there are significant biomass resources in the form of agriculture wastes from hazelnut production.

Water Resources. Rioni is the most effluent water body in Georgia. The river water level increases in spring (April) and reaches its maximum in June. The flooding continues until the end of August. By the end of

September, flooding is caused by heavy rains and reaches its maximum in October – November. Minimum water level is observed during December-February. Overall, 38.8% of total run off occurs in spring, 28.5% - in summer, 18.4% in fall and 14.3% in winter. 34.7% of the run-off is created by groundwater, 32.5% - by rain water, 28.2% - by snow melting and 4.6% - by glaciers. The river annually brings 12.9 km^3 water and 6.9 mln tons of sediments to the Black Sea. The sediment amount increases from river head to mouth ranging from 96,000 to 6.9 mln 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. In upper reaches, average annual (long-term) water discharge of the Rioni river is 27.9 m3/sec (near the village of Glola), 30.6 m3/sec (near the village of Utsera), and 43.7m3/sec (near the village of Oni). The maximum water discharge of the river is 368m3/sec near Glola, with a corresponding minimum of 16.0m3/sec (75% probability). Average annual flow speed of the river is 31.8 m/sec near the village of Utsera, 45.3 m/sec (near the town of Oni), and 70.5 m/sec near Sori. Near Kutaisi average annual discharge is 134 m3/s and near Sakochakidze gauging station – 406 m3/s. Maximum flow rate is 345m3/s near Glola (1% probability), 1806 m3/s near Kutaisi and 3730m3/s – near Sakochakidze; Minimum discharge (75% probability) is 16 m3/s near v. Glola, 22.0 m3/s near Kutaisi and – 34.0 m3/s near v. Sakochakidze. After Kutaisi flowing over the Kolkhida lowland the river width grows up to 250 m., water depth is 0.8-5 m. and flow speed - 0.7-1.5 m/s. At a lower part of the basin, the river flows on a highly marsh-ridden area. Width of the river there varies from 100 to 150 m, depth: 1-5 m, flow speed: 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. This means that effect of waves of these deltas on the coast line is relatively strong. Main tributaries of the Rioni river are: Jejora; Lukhunistskali; Kvirila; Tskhenistskali; Khanistskali; Tekhuri; Sulori and; Gubistskali.

In upstream areas, groundwater of the Rioni Basin is represented by Racha-Lechkhumi artesian basin contained in Meso-Cenozoic sediments. Peripheral parts consist of Jurassic and lower cretaceous sediments and central parts – sediments of upper cretaceous and Cenozoic origin. Major aquifers are met in layers of mid-Jurassic volcanic, lower and upper cretaceous limestone, Neocene limestone and quaternary alluvial-delluvial sediments. Mid-Jurassic volcanic deposits mostly bear slightly mineralized hydro carbonate ground waters. Low discharge spring mineral waters are very abundant in the region. In tectonic folds and Jurassic deposits hydro carbonate and chloride waters are met, while in upper Jurassic deposits – sulphate rich waters. Lower cretaceous aquifers contain karst and karst-porous groundwater, which flow on the surface as strong springs and in many cases bring an origin to various rivers (e.g. Sharaula). In the submersed part of Racha-Lechkhumi Syncline lower cretaceous sediments create slightly mineralized artesian aquifers with a death of 2000 m. presumably; these layers consist of thermal hot waters. Upper cretaceous layers that are not widely spread consist of karst waters. Recharge areas are located in upper parts of the syncline and discharge areas – in lower parts. Discharge happens mostly in tectonic faults and Lajanuri anticline, where the vein of limestone is emerged on the surface. In the Middle-Miocene sandy and limestone formations there are karst waters of high mineralization. Quaternary alluvial-delluvial sediments spread in floodplain areas and terraces there are rich in hydro-carbonate and calcium waters. Old quaternary sediments found in upper terraces, consist insignificant volumes of groundwater of hydro carbonate-calcium type. Groundwaters in Imereti lowland (lower reaches or Rioni) belong mostly to Tskaltubo artesian basin of karst waters. Lower cretaceous layers here consist of fault-karst, pore-karst and karst artesian waters of high water discharge – 200-220 l/s. Upper cretaceous Paleocene limestone is not widely spread and contains low yield karst waters. Quaternary sandy layers are saturated with unconfined perforated ground waters which flow out to the as springs of high yield. To the north and from the north-east to west aquifers become confined. In few areas highly mineralized chloride-sodium or calcareous groundwater in Jurassic porphyries and sands and pebble containing layers are found. Overall, mineral composition of groundwater of Tskaltubo

artesian aquifer is of hydro-carbonate and calcium. The total resource is estimated at 15m3/s. Tskaltubo is well-known for its mineral waters, with 0.7-0.8 g/l mineralization level. Water discharge is 18-20 l/s and temperature +33-35^{0}C. Groundwater of Kolkheti lowlands (Lower reaches of Rioni), predominately in coastal zone, are represented by upper aquifers contained in recent coastal marine and alluvial, marshy and Rioni river recent alluvial sediments. Rioni river recent (quaternary) alluvial sediments are composed of sands, sandy gravels and clays and are found at 10-15m depth. 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 met at 5-10 m depth. The water is of bicarbonate, calcium and magnesium type. Recent marshy formations are represented by sands, clays and turf and peat at 5-30m depth. The groundwater is bicarbonate calcium-magnesium type. Groundwater 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 in width. The water is mostly found at 1-5 meter depth in sands and gravels in the coast line and 0.5-1 m in marshes. The water discharge here is 0.1-1 l/s. Overall, groundwater salinity is 0.3-0.5 g/l. Water recharge rate exceeds discharge rate.

III. SOCIO-ECONOMIC CONTEXT

1. Alazani-Iori River Basins

Population Size. Total population size of the Alazani River Basin is about 392,500, of which urban population makes up only about 20%. There are eight administrative districts within the Basin: Akhmeta, Telavi, Gurjaani, Kvareli, Signagi, Sagarejo, Lagodekhi and Dedoplistskaro that are located in Kakheti Administrative Region. Telavi is an administrative center of the region. The average population density is 38 individuals per square kilometer. Total population size of the Iori Basin is about 95,200. This figure is only estimate. It includes total population size of the Tianeti district of Mtskheta-Mtianeti region and the Sagarejo district of Kakheti region as well the population size of following communities: Sartichala (Sartichala and Muganlo villages) – Gardabani municipality; Kachreti, Naniani and Jimiti – Gurjaani municipality, Bodbe and Ulianovka – Signagi municipality and Mirzaani and Japharidze – Dedoplistskaro municipality.

Economy. Kakheti region shared by Alazani and Iori river basins is a leading agricultural region of Georgia. The most developed branches are viticulture, followed by cereal production and livestock rising. Food production sector is also developed due to the large share of agriculture in the region's economy. Wine production is the most important branches of this sector. Oil and gas extraction activities of limited scale are ongoing in Sagarejo and Dedoplistskaro districts. In addition, a number of mines operate there, extracting various construction materials. Commercial logging and wood processing activities are ongoing in Akhmeta district. Trade and services also play significant part in the region's economy. In recent years, construction sector became fast-growing sector due to the on-going and planned road and other infrastructure projects. In Tianeti district of the Mtskheta-Mtianeti region located within the Iori River Basin, agriculture is a major sector of economy with leading branch of live-stock rising. Industry is weakly developed. Tianeti and Sioni are resort areas of local importance. In Gardabani, Kvemo Kartli section of the Iori River Basin represented by Sartichala and Muganlo villages of the Gardabani municipality agriculture sector is mostly developed. Industrial activities are represented by oil and gas extraction activities in Sartichala as well as by extraction of lime stones and other construction materials.

Local Infrastructure. Road infrastructure is well-developed in Kakheti. The Length of the state importance roads equals to 580 km; presently, their condition is satisfactory, meeting average standards. Length of the

international importance highway is 125 km. The Railway transport operates in the region having a slight importance. In Tianeti section of the Iori River Basin, there are roads of national and local importance. The total length of roads is 204 km. Many of local roads are unpaved and are only ground cover. Recently rehabilitation of internal roads has been started. Gardabani section of the Iori river Basin is very close to Tbilisi and the road infrastructure is well-developed there.

As for the telecommunications system, an international trunk-line is available on the territory of Kakheti, while modern technologies are established in Telavi and Gurjaani (a digital trunk-line). The territory is fully under coverage area of existing cellular communications companies. Internet technologies are less developed in Kakheti region, although dial-up internet is available in every district. There is also a satellite internet accessible in Telavi Municipality. In Tianeti municipality, mobile service coverage good, covering entire region. Limited internet connection is possible in Tianeti and Sioni. TV coverage is weak in remote villages. In Gardabani section of the Iori River Basin there is also full mobile service coverage. Access to internet is offered also by mobile service operators. TV coverage is full.

Kakheti region is entirely electrified. Population is supplied with electricity round-the-clock. However, in high mountains, e.g. in Tusheti access to electricity grid is absent and some micro-size electricity and heat generation renewable energy technologies installed at household level are met. Six small to medium-size hydro power plants are functioning in Kakheti. There are several small HPP construction projects currently on-going. In Tianeti section of the Iori river basin there is 24-hour power supply to the population. The power is supplied through on-grid seasonal regulation Sioni 9.14 MW HPP It is built on the old river bed and utilizes the full river run-off. In Gardabani section of the Iori river basin, there is also a full power and gas supply to the population. There are four on-grid small to medium-size HPPs on Samgori Irrigation canal carrying water from Sioni reservoir: 14 MW installed capacities Satskhenisi HPP; Martkhophi 3.8 MW derivation SHPP with about 6 GWh average annual output and; Tetrakhevi SHPP of 12.4 MW installed capacity and Satskhenisi SHPP.

All municipal centers of Kakheti region are provided with central system of natural gas supply; 88% of town population is attached to the system, but only 60% of them are supplied, while 23% of village inhabitants have joined the system, and only 35% of them receive natural gas. The majority of rural population uses bottled gas, while others apply timber as a fuel. Similar situation exists in Tianeti and Gardabani sections of the Iori River Basin. Natural gas supply coverage rate is high, supplying the majority of population with the natural gas.

Most of municipal centers of the Kakheti region have central water supply systems, with some of the systems being already rehabilitated or being currently under rehabilitation. There are very few rural systems in the region. During the Soviet times, such systems existed in total of 35 villages of Kakheti region serving 164,850 people in rural areas. After the break-up of the Soviet Union, they stopped functioning. Only recently, the government has started rehabilitation of existing or development of new systems for rural areas. Most of the urban areas are covered with centralized sewerage systems. On average, network coverage rate does not exceed 50%. Only two municipal systems cover a maximum of 70-80% of the town. Existing sewerage systems are outdated and their designed capacity is much lower than is required. None of the systems has wastewater treatment plants, and sewage is directly discharged either on agricultural lands or into the River Alazani and tributary rivers. Rural areas are not covered by centralized sewerage systems at all. As for Tianeti section of the Iori River Basin, water supply systems have been rehabilitated in the town of Tianeti. In Gardabani section of the Iori River basin, water supply systems exist in all villages.

Wastes in all municipal areas of Kakheti region are disposed on specially arranged polygons that do not meet minimum health and environmental requirements. Some of the urban areas, for example, the town of Lagodekhi does not have legal landfill site at all. The majority of the existing landfill sites do not have defensive borders; therefore, the municipal waste is scattered all over the nearby territories and into riverbeds. Villagers chaotically dispose household solid wastes in the storm water channels and in the nearest riverbeds. Waste disposals are located mainly on the right side of Alazani River. Five waste disposal sites are close to Alazani Canal. Similar situation exists in Tianeti section of the Iori River Basin with regards to the waste disposal. More specifically, in Tianeti municipality there are no legal landfills operating currently. Wastes are dumped on illegal landfills and on river banks. In Gardabani section of the Iori river basin, villages of Sartichala and Muganlo are served by Rustavi landfill located near village Akhalisopheli.

There are six irrigation systems, located in all districts of the Kakheti region. The main canal of the Lower Alazani Irrigation System is derived from Alazani below the mouth of the River Chelti and receives 20 m^3/s of water. A number of small reservoirs designed for irrigating agriculture lands are located in the Alazani river basin. In the Iori River Basin, there is a large Sioni reservoir located in v. Sioni (Tianeti district) that provides water to Samgori Zemo (Upper) and Kvemo (Lower) main irrigation canals. Water discharge of 13 m3/sec is delivered through the water intake to the Upper Main Canal of Samgori Irrigation Scheme and 24 m3/sec flow is delivered through the Iori River channel to the Kvemo Samgori Irrigation Scheme in Gare (outer) Kakheti. Apart from Sioni reservoir, there are a number of reservoirs smaller than Sioni one, located mostly in Kakheti region. The largest one is Dalis Mtis reservoir of seasonal regulation with 180 mln m3 total and 140 mln m3 active volumes in Dedoplistskaro municipality, designed to irrigate Taribana valley. However, the irrigation system has never been put into operation.

2. Rioni River Basin

Population size. Total population size of the Rioni River basin is about 987,175. The region covers following municipalities: i) Oni, Ambrolauri, Tsageri, Lentekhi located within Racha-Lechkhumi and Lower Svaneti region; ii) Tkibuli, Samtredia, Terjola, Zestaponi, Sachkhere, Kharagauli, Bagdati, Vani, Chiatura and Khoni and the city of Kutaisi, Imereti regional center; iii) Abasha, Senaki, Martvili, about one third of the Khobi municipality, excluding town Khobi and, the city of Poti located within Samegrelo-Zemo Svaneti region; iv) very small area of Chokhatauri (Khokhnari and Zemo Kheti communities) and very small part of the Lanchkhuti municipalities located in Guria region and, part of the Java municipality located in a break-away region of South Othetia.

Economy. In Racha-Lechkhumi Region agriculture is the major economic sector with livestock rising contributing the largest share to the sector. In Imereti region, agriculture is also a leading branch of the economy. Industry slightly lags behind it. In Samegrelo-Zemo Svaneti section of the Rioni Basin, agriculture is the major sector of economy, followed by transport. In Guria section of the Rioni Basin, represented by very small unpopulated area of Lanchkhuti municipality and few northern villages of the Chokhatauri municipality, agriculture is the major economic activity, with leading branches of cattle rising and poultry production.

Local Infrastructure. In Racha-Lechkhumi, there is a road of national importance connecting Kutaisi with Ambrolauri and Oni. The total length of the road of national importance is 311 km. Local roads were rehabilitated recently. As for the Imereti section of the River Basin, the region is one of the important transportation hubs in Georgia located in TRACECA corridor. The road connecting Tbilisi to Poti port is being rehabilitated currently with a purpose to develop a highway. There are two airports in Kutaisi, of which one

Kopitnari airport offers international flight services. Roads of local importance have also been rehabilitated in municipalities. However, some roads are still in poor condition, especially those to villages. At the very lower course of the Rioni River Basin, in delta area, location of the city of Poti sea port *in Samegrel-Zemo Svaneti* gives a strategic importance to the region. Poti is a major harbor at the eastern Black Sea coast at the mouth of the Rioni River. It is a cross point of the Trans-Caucasian Corridor/TRACECA. Regarding the ground transport, there are roads of international, national and local importance as well as the railway in Samegrelo. The length of the latter is 150km and the length of the roads is 1,888km. Completion and operationalization of on-going East-West high way will increase the transit importance and capacity of the region.

Regarding the telecommunications infrastructure, the Rioni River Basin is well-covered with such systems. Mobile service coverage of the Racha-Lechkhumi region is satisfactory. Satellite and wireless internet connection is available in cities. The major problem in remote villages is TV coverage. Communication system of Imereti is also very good. Major mobile companies and a land line are also operational in cities. Internet access is widely available in Kutaisi and at limited level in municipal centers. In those areas, where there is no internet coverage, people can still have it, since mobile operators offer services in all areas under their coverage. The coverage rate of mobile services is almost 100%. Tele-communications system is well developed in the districts of Samegrelo-Zemo Svaneti region. All mobile operators are presented in the region, offering various services, fixed (land-lines), wireless phones and wireless access to the Wi-Fi. In addition, a number TV and internet providers operate there. Postage services are also presented in all municipalities.

Racha-Lechkhumi population is supplied with electricity round-the-clock. There are electricity grid and power distribution companies there. Two HPPs Ritseula (6MW designed capacity) of river run-off type and Ladjanuri regulating HPP (112.5 MW designed capacity) operate in the region. Actual capacity of Ritseula SHPP is 3.5 MW. Currently, rehabilitation works are on-going at Ritseula to increase a power capacity to 6.5 MW with 34-36 GWh annual output. Ladjanuri HPP works only at 12% of its installed capacity generating about 125 million kWh power annually. There is on-going project for 30.3 MW hydropower cascade in Lukhumiskhevi, Ambrolauri district. Furthermore, It is planned to build large-scale Namakhvani (450 MW) and Oni cascades (282 MW). Recently, a MoU has been signed between EnergoPro Georgia and the Government of Georgia on the development of the river run-off (derivate type) Alpana HPP with 70.6 MW installed capacity, 356.82 GWh average annual output. Middle to lower courses of the Basin where Imereti region is located is also very rich in energy resources especially, with hydro resources and, the power generation and the distribution are the largest economic sectors in the region contributing over 21-23% to the total industrial output. Here Access to 24-hour power supply is almost 100% for the entire population. There are following medium to large size privately-owned HPPs: Rioni river run-off HPP with 48 MW designed capacity and 325 mln kwh annual output; Gumati regulating HPP cascade, with 48 MW designed capacity and 249 mln kwh annual output HPP 1 and 22.8 MW designed capacity and 127 mln kwh annual output HPP2, Dzevrula HPP with 80 MW designed capacity and 140 mln kwh annual output, Shaori-Tkibuli annual regulation HPP Cascade with 38.4 MW designed capacity and 138kwh annual output and, Vartsikhe HPP Cascade with 4 HPPs of 46MW designed capacity each and 1,050 mln kwh total annual output. All HPPs are located at river Rioni except for Dzevrula HPP, located on river Dzevrula, Rioni tributary. In addition to medium to large-scale HPPs, there is a couple of small hydropower plants currently operational or under rehabilitation. In the nearest future a new project for construction of 300 MW coal-fired thermo power plant will be commenced. In addition to this, 13.2 MW capacity thermopower plant will be constructed to use part of the electricity generated for own consumption (1.2MW) and the rest – to sell to the power grid. As for Samegrelo section of the Basin, local population is almost entirely supplied with electricity generated through large-size Enguri HPP on river

Enguri that supplies almost half of the Georgia and entire Abkhazia with the power. There are no hydropower plants on the rivers of Rioni Basin, except for 1 small hydropower plant of 2 MW installed capacity on the river of Abashistskali in Martvili municipality. Guria section of the Rioni Basin is fully electrified. Energopro Georgia is a regional distribution company, operating in west Georgia and supplying electricity to the consumers. The majority of the population still has communal metering systems.

Major cities and towns as well as some lowland communities of the Racha-Lechkhumi and Lower Svaneti region are provided with gas. In addition, liquefied gas and oil products are distributed by several private companies. However, the majority of remote areas use wood for fuel. As for Imereti region, the cities and nearby villages of Imereti region are well-covered by network of natural gas pipes of Zestaphoni-Kutaisi-Sukhumi main pipeline, which is connected with passes through Imereti region. However, for remote areas wood fuel is used for heating and cooking. As for Samegrelo section of the Basin, there is existing gas pipeline Saguramo-Zestaphoni-Sukhumi that goes through Senaki to Abkhazia. It supplies various western regions of Georgia including Imereti and Samegrelo with natural gas. In 2009 Azeri Company SOCAR, limited started gasification of municipalities of Abasha, Senaki, Martvili and Poti. In addition to this, construction of a new 30-km 700 mm diameter section of Senaki-Poti main gas pipeline has been started aimed at providing gas to populations of the cities of Poti, Senaki, Khobi and adjustment rural areas as well as supporting the development of Poti Free Industrial Zone. In Guria section of the Rioni Basin, the company Socar implements the region's gasification program.

There are no irrigation systems in Racha-Lechkhumi, since the agriculture lands do not require irrigation as well as due to the pastures and hayfields representing the largest agriculture areas. In Imereti there are a number of irrigation systems of small capacity on Rioni, Tskenistskali and other rivers. In Samegrelo and Guria sections of the Rioni River Basin, amelioration systems represent drainage schemes. Samegrelo and Guria drainage systems are the part of the Kolkheti Plain Drainage system.

There are two water regulating reservoirs in Racha-Lechkhumi: Shaori and Ladjanuri. Shaori reservoir has a total volume of 90 mln m^3 active volume of 87 mln m^3. It is designed to regulate the water for Shaori HPP located in the city of Tkibuli and is of seasonal regulation. Lajanuri reservoir is built downstream of river Lajanuri by arch-type dam in Tsageri municipality. Total water volume is 20m^3 with 17mln m^3 active volume. The reservoir is of weekly regulating type and provides water to Lajanuri HPP. In addition, Lajanuri is used for fisheries. Given the river brings high sediments to the lake as well given the erosive banks of the river the lake is highly silted with more than 10m thickness sediments. In Imereti region there are a number of dams and reservoirs designed for a regulation of water for hydropower generation and irrigation. These are: Tkibuli seasonal regulation reservoir on river Tkibula with 84 mln m^3 total volume and 62 mln m^3 active volume, used for hydropower generation; Gumati daily regulation reservoir on river Rioni with 39 mln m3 total volume and 13 mln m3 active volume, used for power generation; Vartsikhe daily regulation reservoir on River Rioni with 14.6 mln m3 total volume and 2.4 mln m3 active volume, used for power generation and irrigation; Kukhi reservoir with 1.9 mln m3 total volume and 1.85 mln m3 active volume on river Rioni. The Gumati reservoir is heavily silted, because of high sedimentation by river Rioni. That's why the useful volume of the reservoir is only 33% of the total volume. Similarly, the river brings high volume of sediments at inflow area in Vartsikhe reservoir. Therefore, the useful volume of the reservoir is only 17% of total volume.

A number of water supply system rehabilitation works have been recently implemented or are currently on-going ***in Racha-Lechkhumi*** region. In Imereti region, during the Soviet period centralized water supply systems existed and properly operated in the majority of the cities that was common for entire Georgia. The network coverage was significant with over 79% average coverage rate. Rural areas on the contrary, were

not covered by centralized systems and the local population used wells for drinking water. The water cleaning plant served 70 % of total population. Wastewater system coverage in urban areas was much lower than that of water supply systems and amounted to about 40% on average. Wastewater treatment plants designed for both mechanical and biological treatment carried out only mechanical treatment of wastewaters even during the Soviet times. Such facilities existed for a number of cities. Currently, none of the wastewater treatment plants are operational. In Samegrelo section of the Rioni Basin, centralized water supply systems exist in all the municipal centers, including Poti, Martvili, Senaki and Abasha. These systems have been built during the Soviet period. Other urban areas of the region were not covered by sanitation network. Currently, large-scale water supply and sanitation system rehabilitation works are carried out in a number of cities of Samegrelo region, including Poti. With regards to rural water supply systems, in majority of villages of the River Basin they do not exist. Rural system development projects have recently been implemented in a number of villages. With regards to waste disposal there are legal waste disposal and illegal waste dumps sites in all cities that do not meet minimum health and environmental standards.

IV. INSTITUTIONAL CONTEXT

1. Alazani-Iori River Basins

Regional Governments. Kakheti regional administration is located in the city of Telavi and headed by the Kakheti Governor. The governor, in accordance with the current legislation is responsible for ensuring law and order in the region, coordinating development of regional and municipal development programs and supervising their implementation, overseeing the activities of local authorities and compliance of these activities with national laws and regulations, supervising spending of state transfers to the regions; ensuring protection of human rights, etc. Kakheti regional governor has one first deputy and two deputies. The administration itself is composed of a number of specialized offices. Kakheti region has its regional development strategy for 2009-2014. ***Mtskheta-Mtianeti regional administration*** is located in the city of Mtskheta, Mtskheta Municipality. The administration is represented by the regional governor and three deputies with one first deputy governor and consists of a number of functional departments. Mtskheta-Mtianeti region does not have a regional development strategy. ***Kvemo Kartli Regional Administration*** that among others is responsible for Gardabani municipality is located in the city of Rustavi It is represented by the regional governor, one first deputy and two deputies and various departments, including departments of administration, finance, culture, sports and youth, state supervision, and executive (Gambeoga).

Municipal Governments. There are eight municipalities in the Alazani river Basin that belong to the Kakheti regional administration. These are: Akhmeta, Telavi, Gurjaani, Kvareli, Sagarejo, Signagi, Lagodekhi and Dedoplistskaro municipalities. Each of the municipality is composed of the elected municipal council (Sakrebulo) and executive Gamgeoba, the members of which are appointed. Each of the municipality has its own local budget approved by the municipal council. With regards to the Iori River Basin, it fully covers Tianeti municipality of the Mtskheta-Mtianeti region, fully or partially covers the following municipalities of the Kakheti region: Sagarejo, Gurjaani, Signagi and Dedoplistskaro and, slightly covers the Gardabani municipality of the Kvemo Kartli region.

2. Rioni River Basin

Regional Governments. Rioni River Basin fully or partially covers four regional administrations: Racha-Lechkhumi and Kvemo Svaneti, Imereti, Samegrelo-Zemo Svaneti and Guria. ***Racha-Lechkhumi and Kvemo Svaneti Administration*** is located in the city of Ambrolauri, represented by the regional governor, its

deputies and various departments. The region does not have its own short-to-medium term development strategy. ***Imereti Regional Administration*** is located in the city of Kutaisi. The office is represented by the Governor, first deputy governor, two deputy governors and a number of local offices. The region does not have its short-to-medium-term strategy and it defines its priorities on an annual basis. ***Samegrelo-Zemo Svaneti Regional Administration*** is located in the city of Zugdidi and is composed of the regional governor and two deputies of which one is the first deputy as well as by a number of specialized departments (services) .The region does not have a short-to-medium-term strategy and the regional priorities are set on an annual basis ***Guria Regional Administration*** is located in the city of Ozurgeti and is represented by the Governor, first deputy governor and two deputy governors. The office consists of a number of specialized offices providing various services. Guria regional administration does not have a short-to-medium terms development strategy and the priorities are compiled on an annual basis.

Municipal Governments. Rioni Basin fully covers Ambrolauri, Oni, Lentekhi and Tsageri municipalities of the Racha-Lechkhumi region; fully covers Tkibuli, Sachkhere, Khoni, Vani, Badgati, Kharagauli, Tskaltubo, Samtredia, Zestaphoni municipalities and the city of Kutaisi of the Imereti region, fully or partially covers Abasha, Senaki, Martvili, Khobi municipalities and the city of Poti of the Samegrelo-Zemo Svaneti region and, only slightly covers Chokhatauri and Lanchkhuti municipalities of the Guria region.

V. PRESSURES AND IMPACTS ON WATERSHED RESOURCES

1. Pressures on Watershed Resources of the Alazani-Iori River Basins

Pressures on Water Resources of the Alazani River Basin. In the Alazani River Basin, water resources are used for domestic, irrigation, power generation and industrial purposes. In accordance with 2009 data of the Ministry of Environmental Protection and Natural Resources, in total 724.81 mln m^3 water was abstracted from water bodies of the basin, of which 12.36 mln m^3 (~1.7%) was groundwater abstraction and 712.45(~98.3%) mln m^3 – surface water abstraction. Of abstracted amounts, 629.24 mln m^3 was used for power generation, 9.94 9mln m^3 – for domestic water supply and 5.87 mln m^3 – for irrigation. By analyzing current water use information it can be concluded that the highest pressure on the waters of the Alazani basin are in the upstream areas. The waters of the r. Alazani are the most utilized, followed by the waters of the r. Samkuristskali. Rivers Bursa and Lopota are also highly utilized. The hydropower sector is the largest water user that receives water from own abstractions as well as through the transfer from irrigation systems.

In total, 646 mln m3 wastewater was discharged into the water bodies of the Alazani river basin in 2009, of which 629.21 mln m3 was clean water discharged by the hydropower sector and 11.58 mln m3 – untreated wastewater. The major point sources of pollution within the Alazani basin are domestic sewerage systems. Industrial wastewater discharges are significantly reduced at present compared with those of the Soviet period due much lower number of currently operating enterprises and much lower capacities of these facilities. However, the absence or the obsolescence of wastewater treatment technologies might offset the situation. Among diffused sources of pollution, the most significant ones are agriculture and urban run-off and leachates from waste disposal sites. Abandoned ware houses of obsolete pesticide stock-piles were one of the significant non-point sources of pollution until recently. In many places the substances were scattered all around the store houses and mixed with soils. Although all obsolete pesticides were collected and moved to temporary storage facility outside Kakheti region, nearby territories of former store houses might be still

contaminated with PoPs. In addition to above, open-pit mining operations for extraction of non-metal mineral resources also pose a threat to the waters and ecosystems of the basin.

Pressures on Water Resources of the Iori River Basin. In the Iori Basin, in accordance with 2009 official data of the Ministry of Environment, water withdrawals were made from the R. Iori and Sioni reservoir. In total, 260.95 mln m3 water was abstracted from natural water bodies, of which 179.68 mln. m3 water was taken from the R. Iori, 2.1 mln. m3 – from Iori filtrates and 78.85 mln. m3 – from the Sioni reservoir. Surface water was abstracted by Upper and Lower Samgori main irrigation canals. Out of total amount, only 1.92 mln m3 was consumed for irrigation purposes and the rest was transferred to the HPPs. Water taken from the Sioni reservoir was used by the Sioni SHPP.

By analyzing current water use information it can be concluded that in the Iori Basin, the major pressure was on the Iori River and the water was mostly used by upstream SHPP, followed by downstream HPPs and irrigation systems irrigating lands of the downstream areas.

In accordance with 2009 MoE data, total of 65.74 mln m3 wastewater was discharged, of which 65.57 mln m3 was discharged into the surface waters and 0.17 mln m3 – to the surface relief. 64.77 mln m3 waste water was discharged by the Irrigation company "Sioni -M" in both R. Iori and in Tbilisi reservoir without any consumption through a transit. Total amount of untreated sewage discharged from centralized sewerage systems amounted to 0.9 mln m3 and that of industrial wastewaters – 0.08 mln m3. Of this amount only 0.004 mln m3 was mechanically treated. Wastewater discharges occurred mostly in Tianeti and Sagarejo districts. Regarding the quality of wastewaters there is no effluent monitoring in the country. In accordance with the MoE estimates, the river's ecological and chemical status is assessed as "good". Azerbaijan confirms that there is little human impact on the river.

Pressures on Land Resources of the Alazani Basin. Traditionally, in Kakheti region, pressures on the land resources were inserted from intensive use of chemicals, application of unsustainable land management practices, including soil compaction by heavy machinery, intensive irrigation and, overgrazing. The post-Soviet drastic economic turn-down caused the decline in all economic activities, including agriculture activities. Farmers didn't have resources to buy agrochemicals and the central system for import and distribution for these chemicals has also diminished. Currently, among agrochemicals the most widely used are less toxic nitrogenous fertilizers and the manure. However, their overuse can cause soil salinization and acidification. The amount of manure used is still significant and soils might be polluted by various substances, including salts of heavy metals as well as by microorganisms. Regarding the irrigation, many systems stopped functioning due to the electricity shortage or obsolescence of the systems. Those that are currently operational work at lower capacities due to the reduced irrigation water demand. Therefore, the pressures from the use of agrochemicals and irrigation have declined. However, they have already damaged vast areas of agriculture lands in the Alazani valley. Meanwhile, the state due to the lack of finances was unable to implement land reclamation activities, including erosion prevention and mitigation measures. Hence, decrease in total area of cultivated agriculture lands and increase in low productivity and eroded lands have happened. This trend is maintained nowadays. Regarding the livestock rising, there is a growing trend of sheep breeding in a number of municipalities of the region. Intensive grazing on sub-alpine and alpine meadows is a common practice. There are frequent cases of illegal grazing of livestock in sub-alpine and alpine zones of the Tusheti National park and a conflict between the villagers and the park administration about this issue arise from time to time. At present, the pressure on land resources among others is imposed by the forest cutting. Currently, illegal cutting for export is completely eliminated.

However, local population still extensively uses wood for fuel. In particular, former collective farm forests designated as forests of local importance are under the high pressure.

Along with above pressures, the quality of land resources is affected by leachates and drainage waters from waste disposal and dump sites, open pit mining operations and urban surface run-off as well as by sewage and industrial wastewater discharges on the surface relief. Until recently, obsolete pesticide store houses created significant threats to the waters and soils of the region. Over 230 tons of old pesticides with more than 65% of PoPs content were stored there or mixed with soil. Recently, the government has moved these pesticides together with a part of contaminated soils to the temporary storage facility.

Active geodynamic processes as well as unfavorable hydrometeorological events, including landslides, mudflows, droughts, hail, floods that are frequent phenomena in the Alazani river basin affect significantly the state of the land resources within the targeted territory. In general, the east and the south-east part of the Alazani river basin (Southern Slopes of the Greater Caucasus), where Kvareli and Lagodekhi districts are located, is classified as high risk and hazard zone for flash floods. The r. Alazani itself does not directly threaten settlements but the tributaries do. Both left and right banks of the Alazani river basin are classified as high mud-flow prone areas. Catastrophic landslides are characteristic to Kvareli, Sagarejo, Signagi and Lagodekhi districts. Floods and mud or stone flows are specific to the left-side tributaries, with sources from the North on the Caucasus slopes; Mud and stone flows - to the right side tributaries, where river beds are dry most of the time, take their sources on the slopes of Tsiv-Gombori Mountains as a result of rainstorms. Since 2004, geodynamic processes have become much more active relative to the background levels. One of the major causes for these processes was heavy rains.

Pressures on Land Resources of the Iori River Basin. In the Iori river basin, the largest pressures on land resources are put from unsustainable pasture management, improper irrigation practices, cutting of windshields and riparian forests, etc. as well as from natural disasters (e.g. landslides, wind and water-induced erosion, etc.) and climate change. Among anthropogenic pressures, apart from unsustainable agriculture practices, significant threats stem from densely populated urban areas of Gurjaani, Sagarejo, Signagi and Dedoplistskaro that pollute the soil by run off from urban areas, waste disposal sites and open mining operations. There are a number of oil and gas fields in Sagarejo and Dedoplistskaro districts that also impose pressures on the land resources. Furthermore, sewage and wastewaters from a number of industries and sanitation systems are discharged either in storm water canals or directly on the surface relief.

Mudflows, landslides, gully erosion are widespread phenomena in the Basin. Along with debris flow processes, on the Iori Plateau gully erosion is widespread. Lateral erosion generally occurs along the foothills and accumulation plains, and along the rivers of Iori, Chailuri and other small rivers. High flood plains, as well as the first upper terraces of flood plains are eroded. Similar to Alazani river basin, climate change is a significant natural factor greatly affecting land resources and ecosystems of the Iori River Basin leading to desertification of the area.

Pressures on Landscapes and Biodiversity of the Alazani River Basin. In the Alazani river basin, pressures on ecosystems and biodiversity are put by both anthropogenic and natural factors. Among anthropogenic factors, unsustainable pasture management, extensive harvesting of plants and animals (illegal hunting, fishing, intensive logging, including illegal logging etc.) as well as tourism and infrastructure development activities put large pressures on the basin's ecosystems and biological resources. At a lesser extent, industrial activities also pose the threat to the biodiversity. Various mining operations extracting predominantly, construction materials also pose pressures on local landscapes and biodiversity. Unsustainable pasturing,

including overgrazing is a significant problem in almost all municipalities. Local population graze their livestock everywhere, including floodplain forests, state forests of national importance and even in Vashlovani protected areas. Night fires and shepherd dogs also impose negative pressures on the PAs' ecosystems. Regardless of this, sheep grazing has some positive impact on the landscapes and the vegetation cover and contributes to the wider diversity of biological resources there.

Among the natural pressures of the basin, natural disasters and climate change are the major ones causing landscape and biodiversity degradation. Climate change impacts are very high in venerable arid and semi-arid areas, especially in Dedoplistskaro district the pressures and impacts of which are discussed in detail in previous chapters.

Pressures on Landscapes and Biodiversity of the Iori River Basin. Similar to the Alazani river basin, human interventions as well as natural factors impose high pressures on landscapes and biodiversity of the Iori River Basin. While in the upstream and extreme downstream areas natural factors such as natural disasters and climate change pose the largest pressures on the ecosystems, in the middle to lower reaches were densely populated areas are located higher pressures come from land cultivation, urban infrastructure, industrial activities, etc. More specifically, in upstream areas where Tianeti district the large pressures of natural ecosystems and species are from naturally occurring landslides, mudflows, floods. However, human pressures are not insignificant as well. Illegal logging, hunting, fishing as well as overgrazing and unsustainable commercial harvesting of timber resources pose high threats to the landscapes and species. Illegal logging for fire wood is sizable in Tianeti municipality. The region is underdeveloped and poor and therefore, local population does not have enough resources to meet its cooking and heating demands especially, in remote mountainous areas. In the middle reaches of the Basin pressures on natural landscapes and biodiversity from densely populated urban and rural areas increase and become the major factors determining degradation of biological resources. Urban run-off, wastewater discharges from both sanitation systems and industries, agriculture run-off and land cultivation activities impose significant threats to the biodiversity. Recent intensive road construction activities have also posed pressures to the ecosystems during the construction phase. Unsustainable harvesting of biological resources, including illegal logging in the state forest fund of local and national importance as well as in floodplain forests together with poaching are also significant threats to the basin's ecosystems. There are minor oil and gas extraction activities in Sagarejo and Signagi municipalities that have a localized impact on surrounding landscapes and ecosystems. Overgrazing is the greatest problem in downstream areas of the Basin particularly, in Dedoplistskaro district. In winter times, large numbers of sheep are moved to the winter pastures from north-east and central parts of the country. Sheep migration to the zone begins in September and the sheep stay there until April of the next year. Before the Soviet regime, communities had followed a sustainable system of pasture rotation. Over the time the use of winter pastures changed in terms of both grazing methods and intensity. After Georgia's independence, adoption of a market economy and the subsequent recognition of private and communal property rights have not resulted in reintroduction of old pasture rotation system. In addition, the total number of sheep in the area has increased as certain number of livestock is brought from the neighboring territories of Azerbaijan and as well, as Georgian shepherds can no longer use Kizlar pastures in the North Caucasus. Apart from unsustainable grazing and pasture management practices, during Soviet times, pressures on ecosystems of pasturelands were imposed by intensive irrigation without taking consideration of local soil conditions, leading to soil salinization and bogging. In the past, even hilly areas of the pastures were irrigated intensively that imposed threats to the top soil of hills and foothill as well as to the plain vegetation through washing down dissolved gypsum and making it accumulate in the lowland areas. This posed threats to the plain vegetation. In 1970-80s, the use of new plots of land for agriculture

was very intensive. For this purpose, the Iori River was dammed and mechanical irrigation systems based on electrical pumps were constructed. Incorrect irrigation intensified the process of salinization. The construction of the Dali Reservoir on the river Iori, significantly affected the natural water regime of the river. This may be one of the reasons for the decline in floodplain forests downstream the reservoir. At present the irrigation infrastructure is paralyzed and considering current electricity shortage its reconstruction and operation are unlikely to be economical. Illegal logging is also a serious problem in middle-to lower reaches of the Iori Basin. This happens in state and protected areas forests and, in flood plain areas. Various mining industries, including gas and oil exploration and extraction activities concentrated in Sagarejo and Dedoplistskaro districts impose threats to arid and semi-arid ecosystems, though at smaller-scale due to low levels of extraction. Moreover, it is planned to increase oil production rates in the future if prospective reserves prove to exist that will further enhance the pressures on the ecosystems. Furthermore, there are several quarries that extract construction materials. During operations phase, these quarries pose pressures on the ecosystems in terms of destruction of relief, original ecosystems, species habitats, air, soil and ground water pollution by dust, silt and oil and, soil erosion. In addition, ground water table can be reduced. Likely high pressures on the natural ecosystems in the future could be imposed by increase oil production activities. As it was discussed in previous chapters, oil producing companies in Iori river basin are going to increase their productions that will significantly increase the pressures on surrounding ecosystems.

2. Pressures on Watershed Resources of the Rioni River Basin

Pressures on Water Resources. In the Rioni Basin, water resources are used for domestic, power generation and industrial uses. In accordance with official statistics of the Ministry of Environment, in 2009 total of 16,275.79 mln m^3 water was abstracted in the basin, of which 74.03 mln m^3 water was abstracted from groundwater sources and 16,201.94 mln m^3 – from surface waters. The largest abstractions happened from the R. Rioni amounting to 8,997.34mln m^3, of which 8,950.85 mln m^3 was the amount abstracted from the river Rioni and 46.49 mln m^3 – abstracted from its filtrates. Of total water abstracted, the energy sector used 8,950.13mln m^3 and the industry – only 950,000 m^3 of technical water. By analyzing the 2009 MoE data on water abstractions and uses, it can be concluded that the largest pressures on the waters of the Rioni river Basin have happened in the upper-middle reaches of the basin with water abstractions amounting to 14826.75 mln m3 in Imereti region and 1,335.09 mln m3 in Racha-Lechkhumi and Kvemo Svaneti regions. Surface waters of the R. Rioni were utilized the most, followed by waters of the R. Abasha. The largest water users, similar to other pilot basins, were the medium to large HPPs and potable water supply systems, followed by the industrial facilities concentrated in Imereti region.

In terms of pressures on water quality, major threats to the Basin's waters are from point sources of pollution, including municipal and industrial wastewater discharges especially, in the middle to low reaches of the basin where agglomeration of Kutaisi and Zestaphoni and the city of Poti are located with high urban population density and concentration of industries there. In addition, pollution from non-point sources, including that from drainage waters and leachates from waste disposal sites, open-pit mining operations and old industrial sites (brown fields) is pretty significant. In accordance with the MoE 2009 wastewater discharge statistics, total discharges into the Rioni river basin amounted to 16,242.95 mln m3, of which 16,228.91 mln m3 wastewaters were discharged into surface water bodies and 13.03 mln m3 – on the surface relief. Out of the total wastewaters discharged into the surface waters only 2.19 mln m3 was treated through primary (mechanical) treatment, 0.21 mln m3 – partially treated through primary treatment and 38.28 mln m3 untreated. In total, 52.3 mln m3 untreated wastewater was discharged in both surface waters

and the surface relief of the basin in 2009. The largest portion of wastewater (16,188.23mln m3) discharged into the surface water was the clean water used primarily by hydropower sector. The largest amount of the wastewater was discharged into the Rioni, followed by the amount discharged into the Tkibuli and Abasha. The highest discharges of untreated or partially treated wastewaters happened in Rioni, followed by discharges into Kvirila, Tskhenistskali, Budja and Tskaltubostskali. In terms of non-point sources of pollution, the situation is similar in the upper, middle and lower reaches of the basin. Legal and illegal waste disposal and dump sites pose high threats to the waters and land resources of the basin. Another significant diffused source of pollution is old industrial and mining sites (e.g. old arsenic and barite mines in Racha region). On-going mining operations of ferrous and non-ferrous metal are also significant threats to the natural resources of the Rioni basin, including water resources. For instance, there are about 20 manganese mines in Chiatura district of the Imereti region. Abandoned storage facilities with stock piles of obsolete pesticides in the Rioni Basin, which in accordance with PoPs inventories conducted in 2004-2005 consisted of about 65% PoPs, were sources of water and land pollution in the past. There were more than 20 small store houses in the basin, with 9 of them located in Imereti region containing obsolete pesticides in the amount of 10 tons. With regards to agriculture run-off and river pollution from it, it is considerably low compared with that of Soviet period, due to lower rates of the use of agrochemicals attributed to increased prices of fertilizers and pesticides as well as reduced agriculture activities. It is noteworthy to mention, that for last several years in Georgia and especially in Samegrelo region, agriculture suffers considerably from the parasite insect – American Butterfly. So-called wet fog method is used to control the pest. Various toxic propellants are used for this pest control and, the scale and the intensity of the use of these substances are so high that it will indubitably affect the state of the water in the River Rioni.

Pressures on Land Resources. In the Rioni basin, the largest anthropogenic pressures on land resources are posed from agriculture, industrial and urban development as well as from man-induced catchment and river flow alteration activities. Geodynamic processes, including landslides and mudflows are determining natural factors for soil erosion and land degradation in the upper reaches of the basin and, the floods and climate change – in the lower reaches of the basin.

In terms of geodynamic processes, landslides and mudflows are widespread phenomena in Racha-Lechkhumi and Lower Svaneti as well as on Upper Imereti Plateau (Imereti upland). In accordance with the Ministry of Environment these processes have become more frequent and intense since 2000. They impose high threats to the environment and the economy of the region both Racha-lechkhumi and upper Imereti regions. The surrounding areas of the Okriba settlement in Imereti between the river basins of Rioni and Tskenistskali are highly affected by landslides. Kolketi foothills located to the north of the Kolkheti Plain between the rivers of Enguri and Tskenistskali are also significantly affected by landslides, though at lesser extent than Okriba area. Landslides here develop as lateral spreads. Moderately affected area is the northern slope of Adjara-Imereti range. Climate change induced sea level rise and tectonic sinking of the land as well as man-induced river and sediment flow alteration put high pressures on the Rioni delta and coastal area of the Black Sea.

Similar to other pilot basins, current pressures on the land resources of the Rioni Baisn are imposed from the use of agriculture chemicals and extensive cultivation of arable lands are reduced due to the overall decrease in agriculture activities. Nowadays, nitrogenous mineral fertilizers are common widely used, which are much less toxic than organochlorine pesticides used in the past. However, due to the widespread phenomena of American butterfly in Samegrelo and parts of the Imereti regions, the pesticides are extensively used there through air spraying.

There are high pressures on land resources from densely populated Kutaisi-Zestaphoni agglomeration and the sea port Poti where major industries and urban infrastructure are concentrated. Hence, surface run-off from urban areas, drainage waters from waste disposal sites as well as wastewater discharges from sewerage systems and industries on the surface relief impose pressures on the condition of land resources. Furthermore, a numerous small to medium scale open-pit mining operations on-going almost everywhere of the basin, pose threats to the surrounding land resources. The highest pressures are imposed to the land resources from manganese open-pit extraction in Chiatura and nearby settlements. Hazardous wastes generated by Zestaphoni ferro-alloy plant, Chiatura manganese enrichment plant, many small-size smelters operating in various settlements of Imereti also are the sources of soil pollution by heavy metals and unintentional PoPs (dioxines/furanes). Many of Soviet-made transformers and capacitors, still in use in power distribution systems contain PCBs that are another group of PoPs. PCBs were used as lubricants or conductors in electricity transmission and distribution systems. Total amount of PCB containing and PCB contaminated oil is estimated at 152 tons by the Ministry of Environment. Abandoned arsenic mines in Racha-Lechkhumi through the surface run-off and leachates contaminate soils and groundwaters of nearby territories with highly toxic substances. Furthermore, construction of large-scale Namakhvani, Oni and Alpana HPPs will impose significant pressures on land resources of the project area and low reaches of the Rioni basin, with significant areas of agriculture and forest lands to be covered by the waters.

Pressures on Landscapes and Biodiversity. Similar to upstream areas of the Alazani and the Iori river basins, in the upper course of the Rioni river basin major pressures on natural landscapes and biodiversity are put from natural disasters including landslides, mudflows, floods, forest fires, etc. The area is less populated, urbanized and industrialized and therefore, anthropogenic pressures on ecosystems and biological resources are imposed from such activities, poaching, commercial and illegal logging and fishing.

Currently, both illegal and legal logging put pressures not only on forest ecosystems and their inhabitants, but also on the species populating sub-alpine and alpine belts. For instance, in Svaneti the Western tur lives in un-forested areas. Degradation of the forest belt causes damages to the upper belts and as a result, vertical zonality of vegetation changes ultimately affecting the tur populations. Illegal and unsustainable hunting targets large mammals. The most targeted species currently are the brown bear, chamois *(Rupicapra Rupicapra)* and roe deer. Due to the reduced population size of the tur, hunting on this species has also decreased. As it was discussed in previous parts, mining industries, both operational and abandoned ones and their wastes pose high pressures on the ecosystems of the Racha-Lechkhumi and Lower Svaneti region. The region is rich in non-ferrous metals and their extraction will increase pressures on the natural resource base and the ecosystems of the Rioni basin. Construction and operations of large HPP cascades in the Rioni during the last century has already impacted negatively spawning areas of trout in upstream areas and the Black Sea Salmon in downstream areas as well as many terrestrial fauna species through destruction and fragmentation of habitats, breeding and sheltering areas of mammals. Large areas of unique ecosystems and cultural landscapes have been flooded due to the damming and reservoir construction. In the coming years, high pressures on terrestrial and aquatic species and ecosystems will be imposed by new large-scale HPP schemes (e.g. Namakhvani cascade, Alpana HPP) that will cover all upper, middle and lower reaches of r. Rioni in Tsageri, Tskaltubo and Tkibuli municipalities. In addition to all above activities, tourism poses the pressures on the ecosystems of the upper reaches of the River Basin. Moreover, it is planned to build large tourism and recreational infrastructure around the Shaori reservoir that will enhance the anthropogenic pressures on the ecosystems of the region. There is also a plan to build a new road from Khashuri to Racha that will also impose pressures on biodiversity and landscapes during the construction phase. In the middle to low reaches of the basin (Imereti, Samegrelo) the major pressures on ecosystems and biodiversity are

imposed by urban and rural settlements, infrastructure development, various industries especially, mining industries and, from damming and storing of stream water. Threats of the poaching and intensive logging are also significant. Current on-going large infrastructure projects, including Black Sea high voltage transmission line, Kutaisi-Senaki-Poti section of East-West main pipeline main gas pipeline also impose pressures on natural landscapes and ecosystems. In terms of pressures from industrial activities, middle to low reaches of the Rioni basin are traditionally highly industrialized regions, with intensive mining operations and ferrous and non-ferrous industries, including manganese processing, ferro-alloy, chemical, textile, food, electro-mechanical, etc. facilities. Among on-going mining activities, extraction of ferrous metals, coal, non-ferrous metals, and various types of construction materials occurs in the region. In addition, there is pit extraction in Samegrelo region. Most of existing mines are open pit quarries posing threats to natural resource base, including land, water and biota, both aquatic and terrestrial. Abandoned mines also pose high threats to the terrestrial and aquatic species and entire ecosystems through toxic substance leaching, surface run-off, etc. It is noteworthy to mention that currently construction of 13 MW installed capacity coal-fired thermal-power plant is on-going and the next step is the construction and commission 300 MW installed capacity thermal plant in Tkibuli area. This plant might impose significant pressures on the ecosystems of the area through depositing acid loads, in the form of dust and acid rains. Moreover, sulfur dioxide can be transported to long distances by the prevailing air masses and deposited in a high distance from Tkibuli as acid rain. Regarding the pressures from agriculture activities, similar to other regions of Georgia, these pressures are also significant in the middle to low reaches of the basin, although less relative to 80s in terms of agrochemicals loads and the level of land cultivation. Overgrazing in mountainous areas and forests is also a problem. As for unsustainable harvesting of forest resources, illegal fishing and hunting all these are the problems in middle to low reaches of the basin. In the Rioni estuary and the coastal zone, where Kolkheti National Park is located there are unique wetland ecosystems with peat bog, mire and marsh over centuries natural landscapes have undergone significant anthropogenic pressures of land use and land use change especially, during the last century when the large-scale wetland drainage and peatbog reclamation for agriculture use has occurred together with massive deforestation in place of which tea and citrus have been planted. Peat has been extracted and used as fertilizer. Post-Soviet decline in all economic activities although has resulted in reduced pressures from economic sectors, including agriculture, this sector though, together with fishery still plays a leading part in the region's economy. The largest problem here is illegal fishing, in particular, on sturgeon. From local population, pressures on unique ecosystems within and outside the Kolkheti National Park are imposed by illegal wood cutting and fishing and, overgrazing. Within the Kolkheti National Park (KNP), people graze cattle and water buffalo during the entire year in wet forests, secondary shrub forests and meadows on peat, and on the edges of bogs. In addition, in mires local people harvest reeds for roofing, cut alder trees for construction timber and firewood and collect medicinal plants. Settlements, including the city of Poti pose pressures on the estuary and the coastal zone, through domestic waste disposal, agriculture and urban surface run-off, effluent discharges from industrial facilities and sewerage systems.

Regarding the natural pressures on the estuary and coastal zone ecosystems, floods, sea level rise, climate change, decrease in river sedimentation, etc. occurring as a result of both natural phenomena and man-induced ecosystem changes impose high pressures on these fragile areas.

3. Impacts on Watershed Resources of the Alazani-Iori River Basins

Impacts on Water Quantity and Quality. Impacts on the water quantity of Alazani-Iori River Baisns from current water uses are less than they were during the Soviet times. With the present level of economic development and the amount of available water resources, water demands by various sectors are more or less met and there is no conflict among them over water allocations, nor does among upstream and downstream users. At present, the hydropower sector is the largest water user and irrigation sector without any conflict transfers necessary amount of the water to it. Hydropower plants return clean water to the river bodies. It should be mentioned that river run-off in the lower reaches of the R. Alazani, during the period of 1996-2005 has increased from 104 to 111 m3/s compared with the period of 1955-1970. This corresponds to the average growth of the water discharge by 1-2% per decade. Thus, currently there is no significant water shortage in Alazani river basin to meet demand for water use. However, with the growth of economy, including agriculture and industrial sectors, 24-hour provision of potable water to the population, which is under the nearest plans of the government and as well, taking into consideration adverse impacts of the climate change the demand for various water uses, including irrigation, hydropower and industrial water use will increase that might be hardly met due to the decrease in available water resources. In addition, the conflicts between various water use sectors, as well as between upstream and downstream users might emerge, especially during the droughts, which are expected to become more frequent and severe. However, the Second National Communications of Georgia under the UNFCCC has not predicted a water shortage to hinder keeping the water supply-demand balance at least for irrigation water. The study forecasted 8% reduction of annual river run-off within 90-year time horizon till 2100, compared with the 30-year average river run-off of the second half of the 20th century (1951-1980). This, according to the SNC modeling results, won't have a serious impact on water availability, even with 50% increase in irrigation water demand and consumption levels. Regardless of this, decreased water resources, decreased annual precipitation (by 1.5%) and increased annual mean temperature (by 5^0C) will significantly raise an already existing water shortage for crops (e.g. winter wheat and sunflower) and pastures.

As for the impact of the man-induced catchment alteration and river regulation on water and sediment flow regimes, there are no significant river alteration schemes in the basin, therefore, there are no large impacts on water system of the basin.

It is very difficult to judge about the current water quality status of the Alazani river basin and the impacts of untreated wastewater discharges on it. Recent water quality data on the rivers of the basin are very scarce and are hardly representative due to diminished water quality monitoring network. Only two water quality sampling points exist on the river and only one (in the middle course) operates at present. Exceedances of maximum allowable concentrations (MACs) are the most observed for biogenic substances, e.g. ammonia, nitrite, phosphates. For instance, ammonia MAC (both Georgian MAC established for public health and EU limit value) exceedances were recorded each year during the period of 2005-2009. Similarly, Georgian fish water MAC and EU limit for nitrite were exceeded each year from 2005 through 2010. The EU phosphate value was also exceeded each year. Ammonia exceedances were 2-3 folds. High content of nutrients in surface waters of the Alazani basin is caused by untreated wastewater discharges as well as by agricultural run-off. At the lowest reaches of the river, on the Azerbaijan side, in the waters of the river Alazani (Ganykh), concentrations of phenols exceed norms 5-7 times, metals – 6-8 times and oil products – 2-3 times. These might me an impact of urban run-off from densely populated urban areas of Kakheti as well as from minor oil extraction activities.

Similar to the Alazani river basin, it is very difficult to judge about the impacts of current water uses on the water quantity of the Iori basin, given unavailability of relevant data and information. Regardless of above, based on the analysis of past and current water use data it can be said that the pressure and thus, the impact on the basin's resources is significantly reduced especially, from irrigation sector due to the reduced capacity of the systems as well as due to the reduced agriculture water demand. Therefore, at present supply-demand balance in the basin is maintained and water allocation among sectors is done without any water use sector experiencing the shortage in it. More specifically, the largest amount of water is used by SHPPs and the water is supplied to them through both own abstractions and transfer from irrigation systems. Waters used by HPPs are almost fully returned to the river. Traditionally, major pressures on the river system were put by downstream users: Upper and Lower Samgori irrigation system, which at present work with lower capacity. However, in the future with the rehabilitation of Samgori irrigation systems as well as with the growth of population and economy, including agriculture and industry in the areas of Kvemo Kartli region, negative impacts, including water shortage will increase in the basin. Water shortage, which is 30% of total annual flow during low waters, will be particularly acute in downstream semi-arid and arid areas of Dedoplistskaro district. In addition, conflict among various water users can arise. Furthermore, future adverse impacts of the climate change on water resources of the Iori River will deepen the water shortage. More specifically, in accordance with the SNC, annual mean temperature increase by 5.1^{0}C, annual precipitation increase by 1% and annual river run off decrease by 11% is expected within next 90-year horizon. With this river run-off decrease and major downstream water users' demand increase by 10%, there will be a serious water shortage from January through April (and from the second half of August through November. With the demand increase by 30% and 50% the shortage will exist during the entire period of the calendar year.

As for the alteration of the river and sediment flow through river regulation, it should be mentioned that the largest negative impact on water resources of the Iori Basin is posed by Dalis-Mta reservoir that was built for irrigating agricultural lands of Georgia and Azerbaijan. But the construction of relevant irrigational system in Georgia as well as in Azerbaijan was not carried out. As a result, the water reservoir has lost its function and at present only inactive storage capacity – 40 mln m3 is filled with water. Dali Reservoir has caused significant damage to riparian forests in the lower flow of the R. Iori, by restricting these territories from spring floods. That process is being aggravated by intensive use of water resources of the R. Iori, and the water discharge from its lower part does not now exceed 4-6 m3/s.

Regarding the surface water quality, for the Iori river basin, recent surface water quality data are absent. In 2009-2010, under the EIA for the Tbilisi landfill, irrigation water samples have been taken for a number of parameters (e.g. nutrients, heavy metals, and organics) from Zeda Samgori Irrigation Canal that is supplied with Iori water from upper reaches. The quality of water was in line with MACs. This indicates on lower anthropogenic pressures on the waters of the basin in upstream areas. However, on the middle to lower courses of the river there is an impact from densely populated urban areas of Gurjaani, Signagi, manifested by higher than MAC concentrations of phenols, metals (2-3 folds), oil products and sulfates (up to 2 folds) on Azerbaijan segment of the Basin that can be attributed to the urban run-off and some minor oil extraction and processing activities on Gare Kakheti Plateau.

Impacts on Land Resources. Land degradation in the forms of soil erosion, salinization, bogging, desertification and contamination is a large-scale problem in the Alazani river basin. Natural disasters, climate change and unsustainable agriculture and natural resources management practices are the major factors for land degradation here. Water erosion is widespread phenomena in the Alazani river basin,

followed by wind erosion dominating on the left bank of the river. On average, through water erosion about 60-70 tons of topsoil per hectare is lost in East Georgia. Nitrogen loss is about 23-24%. In the r. Alazani, about 8-9 mln tons of sediments are washed down annually. Another impact of intensive irrigation as well as of naturally occurring high groundwater table is soil salinization and bogging. The scale of this problem is significant, with 8,000 ha or 1/5th of total area (40,000 ha) of agriculture lands being affected by it. In particular, the right bank of the basin, which historically was under intensive irrigation, is affected by soil salinization. Similar problem of soil salinization and bogging exists on the Iori Plateau. Soil bogging is also significant problem in Lagodekhi and Dedoplistskaro districts. In the basin, several hundreds of ha of lands are facing desertification in the municipalities of Signagi, Sagarejo and Dedoplistskaro and thousands of ha are eroded in almost all municipalities.

In terms of soil contamination within the Alazani Basin, unfortunately currently there is no land quality monitoring in Georgia. Historical data are also practically absent. Only based on current pressures on the land resources, assumptions can be made about the potential pollutants. First of all, it should be noted that use of pesticides, including organochlorine and zinc and copper containing pesticides has been dramatically reduced in Georgia and therefore, we can assume that pollution of land resources by these chemicals is also reduced. At the same time, it should be mentioned that there were several store houses of obsolete pesticides in Telavi, Signagi and Dedoplistskaro municipalities where about 235 tons of pesticides were stored until last year. In 2003-2004 soil sampling was conducted in surroundings of Tsnori (v. Achinebuli) store house and the results of analysis showed soil contamination by heptachlor andα, γ-hexachlorobenzene. Although, currently almost all obsolete pesticides from Kakheti region are moved to Kvemo Kartli there is still need for site investigation and remediation. Furthermore, soils might be contaminated by PCB oils in areas where PCB oil containing or contaminated Soviet transformers and capacitors are located. But, this problem is of small-scale, since there are only 2 pieces of equipment identified as PCB containing with about 4.8 tons of PCB. Furthermore, surrounding lands of municipal waste disposal sites might be contaminated by various harmful substances including dioxins and furans, heavy metals as well as by various microorganisms, etc. Discharges of untreated municipal and industrial wastewater on the surface relief pollute the soils by nitrogen, organic matter, heavy metals, etc. Furthermore, urban surface run-off (storm and drainage water) pollutes soils with phenols, heavy metals, including lead.

Major impacts on land resources in the Iori basin are manifested as soil erosion, salinization, bogging, desertification and contamination. Semi-arid and arid areas widely spread in the Iori river basin are highly eroded and desertified due to both natural phenomena and man-made impacts. These areas are as follows: Shiraki, Eldari, Iori, Taribana, Naomari, Ole, Jeiran-Choli valleys, ridges and plateaus dividing them and the biggest part of southern slope of Kakheti Range. Desertification zone starts from an altitude of 300-400 m. In Dedoplistskaro district it has already affected 119,000 ha, in Signagi – 46,000 ha and in Sagarejo – 47,000 ha. Another significant problem of land degradation in the basin is a soil primary and secondary salinization and, bogging. This phenomenon is recorded in Sagarejo, Signagi and at a lesser extent, in Dedoplistskaro districts.

As for the pollution of land resources, similar to the Alazani river basin, land contamination by agrochemicals in the Iori Basin might be insignificant at present due to the application of low amounts relative to 80s. Soils of downstream areas of Iori basin might be polluted by phenols, heavy metals, surfactants, etc. due to the urban and storm water run-off from urban areas of Sagarejo, Signagi, Tsnori and Dedoplistskaro. Discharge of untreated sewage and wastewaters from mining and processing activities on the surface relief might be a source of soil pollution by nitrates, ammonia, heavy metals, bacteria and various parasites. Soil layers of

waste disposal sites and surrounding areas might be contaminated by various hazardous chemical substances, including salts of heavy metals, organics, dioxins and furans as well as by parasite microorganisms. Oil and gas extraction activities in Sagarejo, Dedoplistskaro and Gardabani districts cause pollution of lands by oil products. Soils around former pesticide store houses in Tsnori and Dedoplistskaro might also be polluted by pesticides, predominantly by heptachlor andα, γ-hexachlorobenzene that was detected during the 2003-2004 PoPs national inventory.

Impacts on Landscapes and Biodiversity. In upstream areas of the Alazani and Iori River Basins, alpine and sub-alpine meadows and mountainous forests are highly impacted by unsustainable logging and grazing. Fish populations are also affected by illegal fishing, although there are no data and studies on the ecological status of fish all over Georgia. Fish are impacted not only by illegal fishing, but also by instream, river banks and floodplain sand and gravel extraction by numerous companies. In Tusheti and Batsara-Babaneuli protected areas, especially in easily accessible parts large mammals are illegally hunted, included rare and endangered species, e.g. bezoar goat, tur, raw deer, etc. In middle reaches with densely populated urban and rural areas, natural landscapes are drastically reduced and transformed into cultural lands, including settlements and agricultural lands. Floodplain forests that are spread on Alazani and Iori river banks and are met in both middle and lower reaches are significantly declined, especially, on Iori River Banks, due to the artificial change of the river regime, tree felling, grazing and artificial fires. Therefore, habitats of a numerous species are degraded. Semi-deserts and steppes used as winter pastures in lower reaches of Iori and Alazani river basin are severely eroded due to overgrazing and unsustainable pasture management. There are also large areas salinated and bogged due to high ground water table and improper irrigation. Areas around oil fields and various quarries are severely degraded, although these activities are not voluminous and do not affect large areas. Regarding the individual species, wolves are heavily targeted by shepherds and locals in and around Vashlovani PAs, to avoid or reduce killing of sheep. Furthermore, such large mammals as red deer, raw deer, chamois are the most targeted species. In addition, there is a high disturbance by hunters of leopard and goittered gazelle. The major purpose of the Vashlovani National Park was to reintroduce goittered gazelle and recover leopard that is currently hindered by illegal hunting. The one of the largest environmental problems in Alazani-Iori river basins, as it was discussed above is climate change and human induced desertification affecting large landscapes in downstream areas particularly, semi-deserts and steppes. Such trends are observed in Chachuna steppe, southern foothills of Kotsakhura Ridge, Iori Steppe, Eldari plateau, Taribana valley, Natbeuri, Chatma depression, Terraces of the River Iori downstream of Dali Reservoir, etc. To a lesser extent from place to place desert communities are also found in pistachio light woodlands. All arid and semi-arid ecosystems of the Iori River Basin, including species inhabiting them are highly vulnerable.

4. Impacts on Watershed Resources of the Rioni River Basin

Impacts on Water Quantity and Quality of the Rioni River Basin. Current hydrometeorological monitoring is limited in the Rioni Basin. Regardless of the above, some conclusions on the water use pressures and impacts can be made by analyzing current and past water abstraction and consumption patterns. Namely, although, the total amount of water abstracted and consumed is much higher in the Rioni Basin than in the Alazani and Iori River Basins, this figure is by far below the water abstraction levels of the Soviet period, due overall economic decline and decrease in water demand by household, industrial and irrigation sectors across the country. To have a clear picture of the order of magnitude for water use decrease, one can compare water use figures of 80s and 2000s. For instance, total water withdrawal declined from 4,600 mln m^3 in 1985 to 1,621 million m^3 in 2005. Of this, Industrial water withdrawal for 2005 was estimated at 208

million m^3, while in 1985 this figure was 1,542 mln m3. Thus, it can be concluded the pressures and the negative impacts from water abstractions and consumption are reduced in the Rioni Basin. Rivers of the basin are characterized by high water flow and water resources are abundant there. Therefore, there is no water deficit in the region. Hence, the water budget of the Rioni Basin can accommodate much more water abstractions and consumption.

Regarding the impact of the climate change on the water and sedimentation flow of the basin, information is available for upper course of the river Tskhenistskali (Lower Svaneti), upper course of the R. Rioni and for the Rioni Delta and the Black Sea Coastal Zone. In the Lower Svaneti, located within the upper course of the r. Tskenistskali basin, last decade an increase in annual mean temperature by 0.6^0C has been observed compared with the data of 1955-1970s. This process is reflected in the glacier retreat, determining relevant changes in the river runoff. The projected rise in temperature by 2050 may result in the total disappearance of glaciers in Kvemo Svaneti that will have a significant impact on the river regime of the Tskenistskali basin. Furthermore, under the SNC project, a change in the river run-off of the Tskhenistskali upper course waters by 2100 has been estimated taking into consideration predicted values of annual temperature and precipitation. It was concluded that about 9% reduction of the Tskenistskali run-off in the whole upper course of the river might happen by the end of the current century (2070-2010), with the highest reduction (41%) to happen in summer time. However, the model used by the project didn't take into consideration glacier feeding parameter and with its inclusion in the model the results may be different. In the Rioni Delta there is a trend of an enhanced accumulation of sediments carried by glacier-fed rivers, caused by intensive enrichment of river sediment with moraine materials originated in the process of glacier retreat. Activation of sedimentation processes is clearly manifested in the coastal line, where the mouth of R. Rioni new branch is located. The branch (sleeve) has intruded into the sea by about 150 meters; this branch has developed its delta with islands similar to the old (historic) mouth, significantly exceeding the last one. The silting of the river bed by glacier sediment reduces the river bed carrying (discharge) capacity especially, during floods and, its inclination in an area affected by eustasy. This problem, first of all, is most urgent for settlements disposed around the upper part of this river section. A significant part of the lower portion of this segment is occupied by the Kolkheti National Park and other protected areas, which under the joint action of eustasy and river bed silting processes, have been flooded several times and seriously damaged. The impact of sedimentation on the river bed in this segment is very high. Lower reaches of the R. Rioni (HPP dam – Samtredia portion) includes riverine territory located in a zone of rare floods of the river (P<5%), which is spread upward along the river, from the water distributing unit to the upper limits of the eustatic blocking up. The river here flows into the bed, restricted by the earth dams, and its inclination does not exceed 1.0‰. One of the river branches joins the Lake Paliastomi by a canal cut through the left bank dam. Its level in the past rose to such an extent that it created a serious damage to Poti. At present, the destroyed dams have not been repaired at a sufficiently reliable level, so that even 5% probability floods could overflow them. Eustasy in this segment is the highest and its relative value has reached 0.7m by the end of the last century. This process seriously reduces the river bed carrying capacity, conductivity and conveyance, as the rise in sea level decreases the inclination of the river, and in this way accelerates the silting of the river bed by moraine sediment. Since 1925 an increase of R. Rioni backwater curve heights up to 0.9m during the spring floods has been recorded. During such events the sea level is higher by 0.20-0.25m, compared to the average value, and its length grows almost two folds. Accordingly, this drastically decreases the capacity of river bed and the reliability of earth dams along the river banks. This means that floods, which were not dangerous to Poti in 1920s, at present, seriously endanger the city. This phenomenon is especially dangerous for the city of Poti, as it is standing 1.5-2.0m below the level of the R. Rioni. Regarding the change in the water flow of the R. Rioni attributed to the climate change, its increase by 26% in the upper reaches is expected till 2050 and

decrease by 36% is expected by 2100 compared to the 2050 projected level. Predictions of the river run-off have been conducted through application of two models, which gave different results, one of them predicting the run-off growth by 2100 in contrary to its decrease by 2050. However, if we take into consideration anticipated decline in annual precipitation in western Georgia, decrease in water discharge seems to be more realistic. It should be mentioned that this forecast does not incorporate the variable of the glacier feeding of the runoff that might make corrections into the predictions.

As for the man-induced river alteration and its impact on the river and sediment flow of the Rioni Basin surface waters, water reservoirs built mostly for hydropower generation on the rivers of the Rioni Basin have significant impacts on river hydrodynamics and the river system as a whole, especially on downstream areas and deltas. For instance, Gumati water reservoir built in the lower reaches of the Rioni Basin on the River Gumati is highly silted and its active volume is decreased by 77%. Therefore, it has changed the river and sediment flow after regulation. This, itself, has an impact on delta formation that in the past was the most influenced by the river sediment run-off. Currently, the sea (sea waves, eustatic sea level rise, surges) impact is becoming stronger that accelerated the receding of the delta. The Lajanuri reservoir built in the upper course of the R. Tskenistkali Basin is also highly silted and its active volume has been decreased by 35% during 13 years of operation and in addition, landslides and mudslides periodically damage the adjacent settlements. Currently, there are preparatory works on-going for construction of Namakhvani HPP cascade that will be located between Ladjanuri and Gumati HPPs in Tsageri and Tskaltubo municipalities. In accordance with project pre-feasibility study and the ESIA, due to the high turbidity and sediment flow of the Rioni planned reservoirs will be filled in with significant amount of sediment over the time. The reservoir sedimentation will put pressures on river hydrology and hydraulics and will enhance river bank erosion, flooding of downstream areas and the loss of sea shores due to the shortage of sediment. Regarding the cumulative effects, Namakhvani HPP scheme together with existing Rioni cascade scheme and, the Greenfield Alpana HPP will significantly alter river hydrology by damming, river diversion and water storing. This will affect the seasonal water flow and prevent the river from floods. Coupled with the pressures of the climate change pressures put on the river system by above hydro projects will have significant impacts on the Rioni basin in the project site area and in the delta. The estuary of the river Rioni near the city of Poti will be threatened by the reduction of sediment load. The project pre-feasibility study has showed that there will be about 300-400 thousand m3 sediment shortage annually in case of 320m3/s water flow of the River in the Poti area (sediment load will be reduced to 1 million m3. However, river sediment carrying capacity will be enhanced from the river to the city). The delta area is already suffering from coastal erosion and loss due to the both anthropogenic interventions and eustasy coupled with sea level rise to the global warming. More specifically, there are two sleeves flowing into the Black Sea that form the island called “Bolshoi” where the part of the city is located. After the river diversion and Rioni’s confluence with the river Nabada the sediment and land formation has stopped in the old estuary, where the sea beaches are intensively washed out.

Regarding the surface water quality, recent water quality monitoring data (2005-2009) show lower than Georgian MACs for BOD_5 for every river and location. Values for this component are exceeded in Lake Paliastomi for 2008-2009, attributed mostly to the pollution of waters by the rivers flowing from Adjara and Guria. High concentrations of the nitrite were recorded for every year, 2-3 times exceeding the EU limit and Georgian MAC for fish, particularly in the downstream areas and the river mouth. The values for ammonia were also very high, exceeding Georgian MAC and the EU limit 2 folds and more every year in the lower reaches and the river mouth. High concentrations of ammonia and nitrites were attributed to the untreated wastewater discharges from sewerage systems and industrial facilities as well as to the agriculture run-off.

Concentration of manganese was high in the river Kvirila attributed to the discharges and runoff from industrial processes, which have led to considerable damage to the ecosystems of these rivers. An independent monitoring conducted under the Finish supported Rioni River Basin monitoring project in 2008, has shown high acidity of the river Rioni near Poti landfill and high concentration of manganese (3.09 mg/l) in r. Kvirila before Chiatura. Another independent study of environmental quality of the streams of the Rioni basin in the middle course was conducted jointly by the Georgian National Center for Disease Control and Public Health and the Science and Technology Center, Ukraine under the financial assistance of USEPA and USDoS in 2009-2010. The study has showed high concentrations of common manganese and iron along the entire reach of the Kvirila River. The 15-fold exceedance of the Mn MAC has been recorded below the manganese enrichment plant. Waters of Darkveti, Shukhruti and Darkveti rivers have been also contaminated with total manganese and total iron. Iron and manganese in the Kvirila River have been mostly represented as suspended particles. There have been very small amounts of dissolved metals of Mn and Fe in the waters. River bottom sediments have been also heavily polluted by manganese and associated to it the metals, particularly, nickel. Nickel concentrations exceeded the soil MAC in all sediment samples and have been high before and after manganese enrichment plant ranging from 290 ppm to 250 ppm. Regarding the drinking water quality, waters from Grudo Monastery and Ledjbani rural drinking water systems contained high e-coli counts and samples from Grudo and Ledjbani – high nitrate concentrations. Dissolved ferrous metals of Mn, Fe and Ni exceeded maximum allowable concentrations in some of the samples as well. As it was mentioned before, store houses of obsolete pesticides, where 10 tons of chemicals with about 65% of PoPs pesticides were stored in Imereti region, imposed threats to human health and environment. Although the chemicals have been collected, re-packed and stored in temporary disposal site outside Rioni Basin, surrounding soils and both ground and surface waters might be contaminated by these chemicals. During the inventory of POPs conducted in 2004-2005, samples were taken from ground and surface waters. In Rioni basin, three samples taken from the r. Rioni before Kutaisi, after Samtredia and at Sakochakidze gauging site showed water contamination by heptachlor and DDT and all five samples taken from the ground waters – contamination by heptachlor. 2 out of 15 samples taken from fish showed contents of heptachlor.

Impacts on Land Resources. Racha-Lechkhumi and Kvemo Svaneti as well as Upper Imereti Plateau are extremely affected by the landslides damaging entire settlements, agriculture lands and infrastructure. Low reaches of the Rioni River Basin, including areas below Kutaisi, Rioni Delta and coastal zone are high flood-prone areas and are extremely vulnerable to them. Floods there incur serious damages to local population, infrastructure and the resource base, including land resources (e.g. agriculture lands). For instance, in January 1987, over 200 km2 of the Kolkheti plain has been inundated due to high waters and floods that brought about death toll of 150 people, material damage in the amount of USD 700 mln, including destruction of 3,150 houses, 2,150 various infrastructure objects, 16 km railway lines, 1,300 km roads and 1,100 km power transmission lines. In the river mouth of Rioni, there is constant land erosion and the loss of the coastal area. This is caused by combination of sea level rise, tectonic sinking of the land and alteration of the river and the sediment flow. River bank protection structures built to protect the city against flooding and inundation by the r. Rioni and L. Paliastomi are no more effective means to protect the city of Poti. This is proved by the catastrophic floods of 1987 and 1997 on the r. Rioni. The Poti beach has been washed out. The sea receded by almost 0.9 km and took away almost 600 ha of the beach. This process is so intensive that poses high threat to the road built on Maltakhva-Supsa segment. Contrary to the land sinking, in the Rioni Delta there is a process of an enhanced accumulation of sediments carried by glacier-fed rivers, caused by intensive enrichment of river sediment with moraine materials originated in the process of glacier retreat. This causes the silting of the river bed by glacier sediment that reduces the river bed carrying capacity

especially, during floods and causes inundation of the area of Patara Poti, Chaladidi, Sabokuchao, Sagvamichao, Sakorkio, Sachochuo, etc. River bed silting process together with the eustasy causes frequent inundation of a significant portion of the Kokheti National park. Furthermore, construction of a number of regulating dams and reservoirs on the Rioni Basin has caused reduction of the river and the sedimentation flow at the river mouth that has affected formation of the delta. The latter in the past was the most influenced by the river run-off. Currently, the sea impacts through eustasy, surges, etc. became stronger, causing the retreat of the delta and the loss of the land area. The large-scale dam-based regulating Namakhvani HPP cascade that will be built within 4-year period starting from 2011 will have significant impacts on land resources of the project area as well as on low reaches and the delta of the Rioni River.

In terms of land contamination, there is no soil quality monitoring carried out in Georgia at present. However, based on economic trends and levels of current pressures on land resources, it can be assumed that agriculture lands now are in better state than during the Soviet times, due to the decreased loads of agrochemicals. However, the use of organic fertilizers is still high and the land resources can suffer from salinization, acidification, and pollution by heavy metals and microorganisms. Furthermore, discharge of untreated wastewaters from sanitation systems and industrial facilities on the surface relief pollute land resources by heavy metals, biogenic substances, microorganisms, etc. Contamination of soils by PoPs, heavy metals, microorganisms, etc. occurs from urban surface run-off and draining of waters from waste disposal sites. The quality of soils around old and operational mining sites is presumably poor. For example, abandoned arsenic ore mines in Racha-Lechkhumi probably contaminate the soils with heavy metals. It has to be also assumed that the soils around manganese quarries concentrated in and around the city of Chiatura are in very poor state, polluted from. Surrounding soils of small ware houses of obsolete pesticides where about 10 tons of chemicals were stored in environmentally unsafe manner might be still polluted with PoPs. For instance, a number of samples that were taken from the soils nearby obsolete pesticide store houses in Imereti (Zestaphoni, Samtredia) showed soil contamination by heptachlor,α, γ-hexachlorobenzene and DDT. In addition, old Soviet transformers and capacitors with 152 tons of PCBs still in use in almost all districts of the Rioni basin are the pollution sources for PoPs PCBs. These chemicals need proper handling and disposal/elimination and the contaminated sites – remediation.

Impacts on Landscapes and Biodiversity. In the upper courses of the Rioni River Basin, similar to the upper courses of Alazani and Iori River Basins, the most affected ecosystems are forests and sub-alpine and alpine meadows due to illegal and commercial logging and, grazing. This affects not only local flora, but also animal species, e.g. Western tur that populates sub-alpine and alpine belts in Svaneti and cleaning the forested zone causes disturbance of the tur habitats. In terms of the animal species, bear and wild goat are the most targeted by illegal hunters. Traditionally, the most hunted animal was the western tur, but due to the over centuries pressures, its population has dramatically reduced. Fish are affected by illegal fishing and various mining operations, in particular by extraction of sand and gravel from Rioni and its tributaries. These operations are done without any environmental impact assessments and permits and, therefore, no impacts on fish are taken into consideration. The most affected from pollution of land and water resources by abandoned arsenic mines in Racha-Lechkhumi are the agro-biological resources of the region, including livestock and agriculture lands. Renewal of extraction operations will farther exasperate the existing environmental problems related to arsenic mining. Moreover, if the gold mining is started in Oni region this might incur serious health and environmental impacts, especially impacts on aquatic biota. Due to the planned and on-going or planned large-scale HPP development projects, significant areas of natural ecosystems as well as cultural landscapes will be lost and fish populations as well as floodplain ecosystems affected.

In the middle to lower reaches of the Rioni River Basin, natural ecosystems though less rarely met than in upstream areas due to the population and economic pressures, are affected by industrial activities, mining operations, particularly manganese mining operations, urban infrastructure development, etc. The impact of such activities is habitat loss, fragmentation, pollution, disturbance of breeding, bird nesting and fish spawning, etc. In addition, cultural landscapes and their agrobiological resources, including crops, pasture meadow, etc are significantly impacted by urban, population and industrial pressures that is manifested in land erosion, loss of soil fertility and productivity, pollution, etc. Aquatic biota is disturbed by various mining operations since their sheltering, breeding and feeding areas are disturbed. Low-mountains, foothill and plain forests met in the middle to low reaches are significantly affected by illegal and commercial logging and cattle grazing as well as fish – by illegal fishing.

The most vulnerable ecosystems given their complexity, richness, rareness, relicness, endemism as well as current and likely anthropogenic and natural pressures coming from all upstream, middle stream and downstream areas are the Rioni mouth, estuary and the coastal zone with their peat bogs, glacial relic sphagnum mires, marshes, duns, and pine groves. All the upstream pressures individually or in a synergy influence the area. The largest impacts are the ecosystem fragmentation and species loss due to coastal erosion, eustasy, sea surges, floods, river alteration due to the urban, industrial and agriculture development, pollution due to the discharge of pollutants loads from upstream areas, particularly nutrients and oil products. Peatbogs and mires that once occupied very large areas during the Soviet regime have been drained, deforested and turned into agriculture lands in the last century. Degraded peatbogs then have been invaded by alien species. The Rioni River together with other rivers of Kolkheti lowlands provide spawning areas for migratory fish and are particularly crucial for populations of sturgeon (Acipenseridae), including extremely rare species of Acipenser sturio, categorized as being "on the critical verge of extinction" in the IUCN list for rare and endangered species. Given the high commercial value of sturgeon, this fish is one of the most affected by illegal fishing. Moreover, on-going and planned HPP projects will significantly alter the river regime and sedimentation that will hinder the spawning areas of this fish. Overall, the wild fauna of the protected areas has been degrading at high rate, with many species being on the verge of extinction.

VI. LINKAGES BETWEEN RESOURCES USES AND ECOSYSTEM FUNCTIONS

1. Alazani-Iori Basins

In the Alazani and Iori river basin, ecosystems and their resources, including water and associated to it resources have the following functions: 1. Health protection - to provide drinking water, nutritional base, energy and clean environment to population; 2. Economic (commercial) – to provide water and other resources for agriculture, industries, fisheries and power generation; 3. Livelihood support – to provide resource base (wood for fire, timber and woodchips as construction materials, mushrooms, berries, medicianl plants, pastures, etc.) for local subsistence economies; 4. Ecological – to maintain the ecosystem integrity, richness and healthiness; 5. Disaster Risk Reduction – to prevent floods, landslides, mudflows and avalanches or reduce their impacts; and 6. Aesthetic – to provide recreational resources to the populations. The importance of these functions varies among upstream and downstream areas as well as between Alazani and Iori river basins.

Ecosystems of the upstream areas of both Alazani and Iori river basins have more value for supporting biodiversity, maintaining ecosystem integrity, providing high quality recreational resources and supporting

the subsistence economies of local communities in comparison with commercial value. More specifically, mountainous forests there mostly have water regulation, soil and avalanche protection functions and are the habitats for many terrestrial fauna and flora (thought due to significant reserves they are considered by the state of high commercial value). Therefore, degradation of these natural ecosystems will ultimately result in increased natural disasters, reduced water resources, loss of biodiversity and, reduced aesthetic value leading to decreased tourists flow. In addition, this will also affect the livelihood of local populations strongly depending on natural resources of the watershed (fire wood, drinking water, non-timber resources, pastures, etc.). Therefore, it is necessary to take into consideration precautions against degradation of these forests which may end-up in increased natural disasters and reduced water resources. In addition, reduced aesthetic value due to degradation of natural ecosystems will result in decline of tourist flows. Furthermore, it should be thought to utilize secondary forest products, e.g. wood chips and wood wastes (e.g. saw dust) to be used for heating and cooking. Alpine and sub-alpine meadows of the targeted basins are habitats for many endemic, rare and endangered species, e.g. east Caucasus tur, bezoar goat, etc. and unsustainable utilization of pastures and forest degradation may impact the populations of these species. Waters of the upstream areas also have high ecological and aesthetic-recreational value. They provide spawning areas for many river fish, including trout and, drinking water source for many terrestrial species. Furthermore, many of sources for drinking water are located in upstream areas. Water hydrology, including water flow and sediment regime starts forming in the upstream areas. Therefore, while utilizing or directly or indirectly affecting the river quantity and quality, the river morphology, hydrology and ecosystem integrity should be taken into consideration. For instance, there are copper deposits in upstream areas that are currently unutilized. There are plans to start extraction of these resources, which might have high impacts on water and soil quantity and might impose serious health and environments threats.

In terms of economic (commercial) value, given low population density of upstream areas of both Basins and thus, low economic activities, there is no much use of the rivers for various economic activities, except for hydropower generation and extraction of sand and gravel from river banks and floodplain terraces. However, currently, existing hydropotential is underutilized particularly, in the upper courses of the Alazani river basin. But, while considering the further development of the hydropotential the river regime as well as future climate change impacts should be taken into consideration, as well as the demand by various sectors. Furthermore, sand and gravel extraction that is done in numerous places in carried out without any prior environmental impact assessment and periodic checks. They might have significant impacts on river hydrology, although in mud-flow basins of the river Duruji and Kabali in Kvareli and Lagodekhi municipalities inert material extraction and river bed cleaning is might be needed. Currently, these operations are of limited scale.

Going down to the middle reaches of the basins, population density increases so does the resource use. Commercial value and thus, utilization of the watershed resources also increase due to higher degree of urbanization and industrialization and land cultivation. Waters of the Alazani and Iori river basins are mostly used for drinking water supply and irrigation; at a lesser extent, by industrial facilities and, in Alazani river basin – by small hydropower plants. Current irrigation systems are inefficient with high water losses and some of them requiring electric pumping. It has an impact on water and land resources of the basin, causing decrease in land fertility and productivity and increase in water pollution and turbidity. Although, current use of agrochemicals is reduced due to overall drop in agriculture activities, but farmers don't follow good agriculture practices and in case of growth of this sector these pressures will be increased, given the low awareness of local population. From densely populated urban and rural settlements pressures are high on water and land resources, given the absence of water treatment facilities and absence of proper landfills.

These pressures reduce the health, livelihood, economic, authentic-recreational and ecosystem support values of the basins. Furthermore, unsustainable logging, hunting and poaching are problems common to middle to low reaches of both Alazani and Iori river basins that impact forest ecosystems, accelerate geodynamic processes and reduce the biological diversity. The most vulnerable to forest cutting and poaching are the unique floodplain forests in both Alazani and Iori River Basins that are habitats for many rare and relic species, resting areas of migratory birds and migratory corridors for a number of species. In addition, they regulate water regime of the Alazani and Iori rivers and prevent surrounding areas from floods. In addition, local population together with seasonal pastoralists graze their livestock in these forests, even in those located within the boundaries of protected areas.

Low reaches of the Alazani and Iori Basin are less densely populated than middle to upper reaches due to harsh local oro-climatic conditions. The degree of urbanization is also less relative to middle to upper reaches. Here natural landscapes occupy wider areas than in middle reaches, though they are mostly represented by semi-arid and arid ecosystems and at a lesser extent by floodplain forests. Ecosystems of downstream areas have higher health protection, ecological and livelihood support values than commercial and aesthetic-recreational values. More specifically, waters of lower reaches of the Alazani and Iori river basins are predominately utilized for drinking water supply and irrigating of agriculture lands. Land resources are mostly utilized as agriculture lands. Cereal production and livestock rising are the major agriculture branches here. The large areas of agriculture lands are used as winter pastures where nomadic pastorals come from various regions. These lands suffer highly from overgrazing, unsustainable pasture management and irrigation (e.g. no application of pasture rotation, burning of pastures, no irrigation or improper irrigation of the lands). In addition, almost complete cleaning of wind breaks in Sagarejo, Signagi and Dedoplistskaro municipalities have resulted in severe wind erosion of agriculture lands. Therefore large areas here are eroded, salinated and bogged with some of them completely transformed in badlands. Water shortage together with desertification is a huge problem in downstream areas of Sagarejo, Signagi and Dedoplistskaro municipalities that is accelerated by the climate change. Droughts here have become more frequent, longer and intensive. Estimates of climate change impacts show that river flow of Iori will be significantly reduced within next 50-year horizon and that of Alazani – not much, but there will be crop water shortage. In general, arid and semi-arid areas shared by Alazani and Iori river basins are very fragile and at the same time, very significant ecosystems due to the oro-climatic and biological peculiarities. They represent the verge of the ranges for many endangered and rare species and are impacted by harsh climate conditions. Therefore, their resistance to additional stress is very low. Meanwhile, anthropogenic pressures on these resources are high, including poaching, grazing, illegal tree felling, and killing of predators, mining operations, including oil and gas extraction that overweigh the carrying capacity of the ecosystems. Building of Dali reservoir in downstream areas that was aimed at irrigating large areas in Georgia and Azerbaijan have significantly changed the river regime and prevented downstream floodplain forests from receiving waters that enhanced degradation of these forests and further aridization of the downstream areas.

Stemming from above, it can be concluded that the resources in Alazani and Iori river basin are not used in an integrated way and environmental considerations are paid no/little attention while utilizing these resources for both meeting essential needs and generating profits. However, there is an example of integrated water resources management in the Iori river basin. This is complex scheme of hydropower and irrigation in Tianeti and Gardabani municipalities. Sioni reservoir built for irrigation purposes is utilized for hydropower generation and recreation and downstream areas use irrigation water for additional hydropower generation. So far, there was no conflict among different water users. The scheme itself takes into consideration various water uses. However, in case of increase in irrigated areas and high droughts

conflicts among various water uses might be generated. Another good example of sustainable natural resource management is maintaining of sacred, holly forests in Tusheti which are preserved as virgin forests. There were also traditions of sustainable natural resource management in the past, including hunting among Tushetians and pasture management. Unfortunately, this knowledge is almost entirely lost.

2. Rioni River Basin

Similar to the Alazani and Iori River Basins, ecosystems of the Rioni River Basin have following functions: 1. Health protection - to provide drinking water, nutritional base, energy and clean environment to population; 2. Economic (commercial); 3. Livelihood support/support of subsistence economies; 4. Ecological; 5. Disaster Risk Reduction; and 6. Aesthetic. The degree of significance of these functions varies among upstream and downstream areas.

In general, it should be mentioned that the Rioni River Basin is more densely populated than the Alazani and Iori River Basins, especially in middle to lower reaches and has a higher degree of urbanization and industrialization in comparison with Alazani-Iori River Basin. Therefore, health protection and economic uses of these ecosystems overweigh utilization of their ecological, aesthetic, recreation services. Upstream areas of the Rioni river basin are not densely populated and thus, urban and technogenic pressures on natural ecosystems are lower here than in downstream areas. Local resources, including water, land and forest resources are mostly utilized by local populations to meet their essential needs (drinking water, heating and cooking, etc.) and support subsistence economies (small farm systems, livestock rising, beekeeping, etc.). The region is rich in natural forests of high ecological and aesthetic value that provide habitats and shelters for many terrestrial flora and fauna. However, there forests undergo pressures from illegal and commercial logging and poaching. As a result of intensive hunting, for instance, Western tur, once abundant, became endangered now. Unsustainable logging, for instance enhances landslides, mudflows and avalanches being naturally very active in the region. The region has a high potential for tourism, given its ecosystems and mineral waters. In addition, there is a planned protected area of the Central Caucasus, the establishment of which is suspended due to other conflicting economic interests from government side. If established, the PAs will create additional niche for PA-based tourism. Furthermore, the area is very rich in mineral resources, especially in heavy metals, which were intensively extracted during the Soviet times, but now are mostly abandoned. The government intends to renew and as well expand mineral resources extraction activities that might have significant negative impacts on water, lands and biological resources of the region and diminish high aesthetic and ecological value of the region. Currently, limestone, clay, sand and gravel and the mostly extracted mineral resources, in particular, sand and gravel. These resources are extracted from river banks and floodplain terraces without any consideration of river topography, hydrology and aquatic biota. As for the use of waters of the Rioni River Basin in upper courses, they are primarily used for drinking water, including production of bottled water and for hydropower generation. Still, hydropower potential is underutilized and the government intends to maximize the use of hydro-resources. Already existing regulating HPPs in addition to bringing economic benefits to the country and the region have created significant problems to the surrounding areas. For instance, Lajanuri reservoir is almost entirely silted and has dramatically changed the river regime. Its power generation due to the decline in the useful volume is significantly reduced. While there are a numerous mining operations on the rivers of Rioni extracting inert material from the rivers, huge reserves of such materials accumulated at the bottom of Lajanuri are not used at all. Shaori and Lajanuri damming have also affected spawning areas of trout. New HPP schemes that are to be built in Racha-Lechkhumi area will also affect the river regime, especially sediment flow that will ultimately lead to the accelerated coastal erosion and loss, if not properly managed.

In the middle reaches, with densely populated Kutaisi-Zestaponi agglomeration, the health protection and economic (commercial) functions of natural ecosystems become more important. Therefore, technogenic and agriculture pressures on ecosystems and natural resources increase relative to upstream areas. Waters of the middle course are consumed by household, agriculture, industrial and power sectors. There are numerous small to medium-size industries in the region releasing pollutants into all environmental media. Particular threats are imposed by manganese extraction and processing activities in Chiatura and Terjola municipalities, which pollute surrounding environment with highly toxic metals. There is also coal extraction in Tkibuli area that also poses pressures on natural environment. It is planned to build a 300 MW coal-fired power plant that will utilize high sulfur-content coal that might lead in high acid loads on land and water resources. Although the large areas in the middle reaches are transformed into cultural landscapes and settlements, there are significant areas of Colchic middle-low mountain, hill and foothill and plain forests in the region, which are affected by illegal tree felling and commercial logging (Vani, Sachkhere, Martvili municipalities etc.). Poaching is a problem within and outside protected areas. Given the rapid infrastructure development, natural ecosystems including relic forests of Ajameti protected areas, Borjomi-Kharagauli PAs and Imereti Cave are under constant risk to be affected one or other infrastructure projects. For instance, initial route of the Black Sea high voltage transmission line was supposed to pass through the significant portion of the Borjomi-Kharagauli national park. However, due to the high pressures from NGO and donor community as well as concerns expressed by the Agency for Protected Areas the route has been corrected during the ESIA procedure. Still, some important areas of Ajameti forests, floodplain forests of r. Kvirila, etc. will be affected by the project. Hydropower potential of the Rivers of the Basin in middle to lower reaches is significantly used with several large regulating and diversion type of HPPs operating there. These schemes significantly altered the sedimentation regime and hindered the delta formation, especially, Gumati dam and reservoir, which is highly silted. There are significant reserves in the lake for construction materials, but they are not extracted. Moreover, new regulating scheme of Namakhvani cascade will have significant impact on the delta and the coastal zone and will accelerate their loss. Due to such manipulative interventions the areas downstream Kutaisi, Tskaltubo and, Rioni Delta are highly vulnerable to the floods.

The extreme lower reaches of the basin, including Rioni delta and coastal zone are significantly altered as a result of wetland drainage, land reclamation, urban development. Only small area of unique wetlands relative to the original area is retained, which is now protected by the government. However, pressures although at lower rates continue to be imposed from local population in terms of illegal timber harvesting, fishing, hunting, grazing and artificial fires, peat extraction within and outside Kolkheti National park. Pollution loads from upstream urban and agriculture areas rich in nutrients are discharged to the delta area and ultimately to the Sea. Infrastructure projects have also impacts on the ecosystems of the Kolkheti National Park in terms of their fragmentation, disturbance of habitats and pollution of natural environment. For instance, Kulevi oil terminal had significant impact on the Supsa section of the Kolkheti National Park. In addition, the new road from Poti to Anaklia is supposed to cross the part of the Park that will have serious impact on it. Senaki-Poti gas pipeline will cross one of the artificial canals of r. Rioni very rich in local and transitory fish, including sturgeon. Among natural factors, climate change and eustasy dramatically affect the Rioni Delta and the coastal zone through sea level rise, flooding, sea surges and leading to the loss of the delta and coastal area and sinking of the land.

Thus, similar to Alazani and Iori River Basins, natural resources of the Rioni Basin are used unsustainably without taking in to consideration various functions of ecosystems and their integrity that in many cases lead to the degradation and loss of these ecosystems and their natural resource base.

V.II CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

Based on the analysis of baseline information, the report draws up following conclusions:

The upstream areas of all targeted Alazani-Iori and Rioni basins due to the low population density do not undergo significant pressures from technogenic activities and urban development. Therefore, large areas are occupied by natural landscapes and ecosystems of high ecological and aesthetic value that make these areas attractive for tourism development and recreation as well as for natural scientists; Tusheti and Batsara-Babaneuli PAs and Lagodekhi PAs consist of unique ecosystems and components of the Greater Caucasus. In addition, there is a planned PAs of the Central Caucasus in Racha-Lechkhumi region. Illegal hunting and fishing are the major threats to the species within the PAs and the most targeted mammals are bear, red and row deer, tur, chamois, wild goat, etc. Low enforcement is rather weak to effectively cope with illegal activities. Upstream, especially, the Rioni and Alazani river basins are rich in timber resources, which mostly have ecological functions of soil protection and water regulation. But, due to the limited access to fire wood local population intensively harvests fire wood illegally. In addition, there are a number of concessioners in Tianeti, Akhmeta, Ambrolauri and Lentekhi municipalities who produce commercial timber of this high ecological value forests. Upstream areas are highly vulnerable to mudflows, landslides and avalanches. These geodynamic processes are extremely intensive in Racha-Lechkhumi and Lower Svaneti as well as at southern slopes of the Greater Caucasus. Rivers Duruji and Kabali in Kvareli and Lagodekhi municipalities flow in mudflow basins and pose high threats to local population. Geodynamic processes are intensified by unsustainable wood harvesting and overgrazing. Impacts of these natural disasters are high due to the non-existent of early warning systems and low capacities of local authorities and populations to cope with these phenomena. Upstream areas, especially, Rioni river basin, followed by Alazani river Basin are rich in water resources, both surface and ground waters that are used for drinking water and hydropower generation. But, these resources are underutilized. The existing HPPs are managed unsustainably and silting of reservoirs is not controlled that reduces the efficiency of the plants on the one hand and, causes river flow change resulting in flooding of surrounding areas (e.g. Lajanuri reservoir). Although urban areas have centralized water supply systems, such systems do not exist in absolute majority of rural areas. Moreover, sewerage coverage of the region is relatively low, mostly represented by urban systems, which do not have wastewater treatment facilities. Waste disposal sites also do not meet any minimum health and environmental standards. In rural areas they are dumped on river banks and beds. Solar and wind energy is not used at all and only fire wood is used from alternative sources for heating. Upstream areas, especially, those of the Rioni river basin are rich in mineral resources, the majority of which are not currently utilized that on the one hand prevents the environmental degradation, but on the other hand, does not support the economic development of the already poor regions with high level of unemployment. The government has the plans to restart many abandoned mining activities or extract new deposits, e.g. arsenic and associated metals deposits in Racha-Lechkhumi and Lower Svaneti, new copper deposit in Kakheti region, etc. At the same time, the state thinks to develop tourism potential of upper reaches of the basins that might become in a conflict with mining and other economic development objectives of the region as well as with conservation objectives of these areas. The largest mining operations are related to the extraction of limestone, clays, sand and gravel. Most of mines are open quarries that have significant impacts on surrounding environments. Inert material is extracted instream, from river banks and floodplain terraces without any environmental considerations in particular, impacts on river morphology, hydrology and aquatic biota.

In the middle reaches of the targeted basins agriculture and technogenic pressures increase in comparison with upstream areas, although current levels are much lower than during Soviet times. Therefore, many of existing reversible or irreversible damages to the natural ecosystems are inherited from the past. For instance, during the 70-year communist rule, large areas of virgin forests and other natural landscapes were transformed into cultural landscapes, settlements and industrial zones, especially in Imereti region. After the break-up of the Soviet Union, due to the economic collapse the majority of industrial facilities shut down their operations and many have been completely abandoned, which now are turned into brown fields with polluted soils and industrial wastes accumulated there. Now a number of industries have re-started their activities and due to the out of date technologies release high amounts of pollutants into the environment. This is mostly the case for the Rioni river basin. In Alazani-Iori river basins, there was no such industrial development and industries were represented by food processing facilities and vineries having less impact on the environment than metal extraction and processing, heavy machinery, chemical and other industries located in Imereti. Particular danger from industrial activities come from manganese extraction and smelting in Imereti region (Chiatura, Terjola, Zestaphoni) seriously polluting waters and soils and posing high health threats to local populations. With the development and full operations of the Kutaisi free industrial zone the technogenic pressures on the natural resource base will increase. Kutaisi is the second largest city in Georgia and is surrounded by many densely populated cities and towns upstream and downstream that pose high pressures on water, land and biological resources and atmospheric air through urban run-off, vehicle emissions, untreated wastewater discharges and drainage water and leachates from waste disposal sites. Regarding the use of water resources the largest volumes are consumed by domestic and power generation sectors. Industrial consumption is also high compared with that of Alazani and Iori River Basins, where after power generation and drinking water the water is used for irrigation purposes. Central water supply systems are at large concentrated in urban areas. The majority of rural areas do not have central water supply systems. Sewerage systems exist only in urban areas without any wastewater treatment facilities. Wastes are disposed on so-called sanitary landfill the majority of which are outdated and does not meet minimum health and environmental standards. Moreover, in rural areas wastes are dumped directly into river gorges. As for the irrigation systems, although there have been some rehabilitation works on some of the major canals, the majority of systems need rehabilitation and proper maintenance. In addition, the lower level canals are in very poor condition. There are high losses in irrigation systems that cause irrigation erosion, salinization and bogging of large areas. Existing systems cannot recover the operational costs, since local communities do not have means to pay on the one hand, and state-owned irrigation companies – capacities to collect fees. Currently, it is planned to privatize the existing systems and introduce modern efficient technologies. However, the exact details and schedules of these plans are unknown. Regarding the utilization of energy resources, in the midstream of the target basins the hydropower for electricity generation, and gas and wood for heating are utilized. There is no utilization of solar and wind resources. Geothermal resources at very limited level are used for greenhouses in Imereti and Samegrelo regions. The government is planning to build new HPPs on the Rioni to use middle to low reaches potential. The first one is Namakhvani regulating HPP cascade that will definitely have an impact on downstream areas in terms of decline in sediment flow. The reservoirs will need to me operated and maintained properly and minimum ecological flow should be guaranteed. Similar to upstream areas illegal, logging, commercial timber production (Vani, Tskaltubo, Martvili, etc) pose threats to forest ecosystems as well as illegal hunting and fishing on terrestrial and aquatic fauna. In addition, mega-infrastructure projects, e.g. Black Sea transmission line have significant to moderate impacts on the natural environment in Imereti region.

Downstream Kutaisi and Tskaltubo, in Rioni Delta and the Coastal zone the population density is also high with the highest number of people living in the city of Poti, Black Sea port. These areas are highly impacted

by floods, coastal zone and delta erosion due to change in Rioni flow, climate change, land use and land use change, eustasy and sea surges. The coastal zone needs constant artificial enrichment with sediments. It is expected that such pressures will grow due to new HPP schemes to be built on r. Rioni. The delta area is known for its wetlands, which are designated as a Ramsar site. Now they are protected under the Georgian Law and are the part of the Kolkheti National Park. Even such status doesn't fully guarantee the full protection of these areas. Local population harvests timber, graze cattle and catch fish illegally, regardless of the fact that the law allows for such activities in the support zone. There is also peat extraction, but in smaller quantities and not for fuel use. Illegal fishing is the largest threat to the fish population especially; to the sturgeon that is the transitory fish for Rioni. Any medium- to large-size infrastructure project has an impact on Rioni low reaches and the estuary abundant in fish and therefore, careful consideration should be given to environmental impacts of such projects during the ESIA processes.

Downstream areas of Alazani and Iori basins are also extremely fragile since they represent the verge of the ranges for some of the endangered species; keep unique riparian forest ecosystems, having the elements untypical to arid and semi-arid areas and, very limited distribution of many rare and endemic plant species. Natural hydrometoeorological conditions are also very harsh there and any additional pressures cause serious damages to such ecosystems. Meanwhile, regardless of low pressures from settlements due to the lower population density, there are pressures from sheep grazing, hunting by sports hunters and local populations, cutting riparian forests and from, artificial fires made by hunters and shepherds. Furthermore, climate change impacts are high in downstream of the Kakheti region with more frequent, lengthy and intensive droughts. It is expected that this trend will be maintained within the next 50-year horizon. Moreover, climate change studies show that there will be significant reduction in Iori river flow and thus, adaptation measures have to be taken.

Regarding the natural resource policies and management practices they do not support integrated natural resources and watershed management principles. The only tools to take into consideration inter linkages among various resources are the ESIA and the environmental permit that is granted to a limited number of economic activities. During the implementation phases of these projects there is practically no compliance/very weak environmental compliance monitoring and control. Water allocations are done without taking into consideration demands by various sectors and minimum ecological flow is not guaranteed. Furthermore, currently, water flow is practically not measured and investment decisions are made based on old or estimated data. Climate change future impacts on the infrastructure projects are not taken into consideration as well. The most regretful situation existing in environmental monitoring. While in the Rioni river basin, water quality checking is more or less comprehensive it is practically absent in Alazani and Iori River Basins. Ground water and soil quality data are absent and there is no effluent monitoring and control. Early warning systems for disasters exist at very premature stage and need further development at both national and local levels.

2. Recommendations

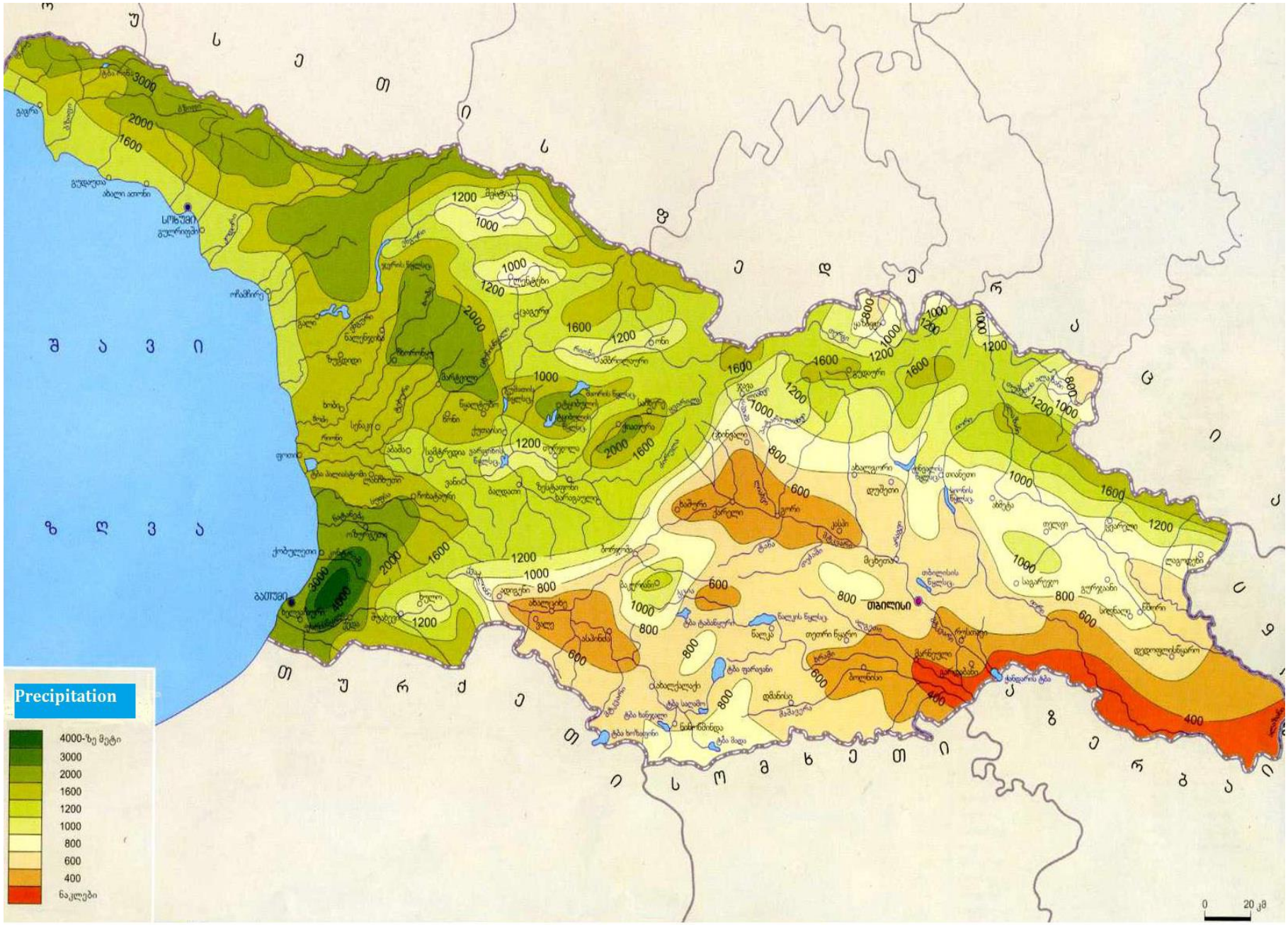
Based on the baseline study of the Alazani, Iori and Rioni river basins and, for the purpose of the project it is suggested to narrow down the scope of project activities to upstream and downstream watersheds/areas of the major rivers of the basin (Alazani, Iori and Rioni and Tskenistskali) since they have the largest and diverse functions and undergo the highest pressures from natural and anthropogenic factors. It is also suggested to consider municipalities, which mostly are delineated from each other by natural watershed boundaries (water divides), as units for INRMW planning, in order to guarantee manageable scale for assessment and planning of watershed resources, water safety, energy resources, disaster and climate vulnerability,

mitigation and adaptation and, at the same time to ensure coherence of watershed resources planning with existing geo-political structures and processes.

The criteria for selection of the pilot watersheds might be, but not limited to: 1. Ecosystem richness and ecological value; 2. Economic importance of the natural resources and potential for economic development; 3. Poverty level; 4. Existence of local governance structure; 5. Willingness of local authorities to participate in the program; 6. Presence of sufficient number of local communities; 7. Presence of USAID and other donor projects; 8. Degree of infrastructure complexity; 9. Population density; 10. Financial resource availability; 11. Ecological vulnerability; 12. Vulnerability to Climate Change; 13. Vulnerability to natural disasters; 14. Anthropogenic pressures and impacts; 15. High replication potential; 16. High likelihood for success, 17. Richness in energy resources; 18. Interlinkeages among resource use and ecosystem functions etc. This is only indicative list of criteria, the final set of which will be elaborated through close consultations with all the partners.

Based on above criteria, the high potential for the selection have the following smaller areas: upstreams of the Alazani and the Iori, where Akhmeta, Tianeti and Telavi municipalities are located; downstream area of the Iori and the Alazani, where southern part of Signagi municipality and the entire Dedoplistskaro municipality are located; upstream areas of the Rioni River where Ambrolauri and Oni municipalities are located and; the extreme low reach of the Rioni encompassing the Poti surroundings and adjacent to Poti municipalities of Khobi, Senaki, Abasha and Samtredia, etc. Upper reaches of the Alazani river, consist of wide areas of intact ecosystems, including protected areas well-representing the components of the Caucasus mountainous ecosystems; are abundant in water and timber resources that are currently under utilized for power and fuel generation but having a high potential for further development; currently they undergo pressures from unsustainable utilization of natural resources, agriculture and urban areas; Have a myriad of environmental problems of drinking water quality, drinking water supply for rural areas, wastewater treatment, waste disposal, illegal logging, fishing and poaching, overgrazing, land erosion, unsustainable irrigation, etc.; have high tourism potential for PA-based cultural, agricultural and recreational tourism development; have high poverty level and are most widely dependant on natural resources to support their livelihoods. In addition, Akhmeta and Telavi have high success and replication potential, since there is a regional center in Telavi that could well-coordinate and support the project activities. Donors are active in both, Telavi and Akhmeta municipalities, including existing PAs. As for Tianeti municipality, it is far from regional center and there are no donor-supported programs on-going. However, without considering upstream areas many problems in downstream areas cannot be solved. Besides there is large hydrotechical scheme starting in Tianeti that utilizes significant amount of water in Gardabani municipality (same as municipality) that if not correctly managed and if the water is correctly allocated among the sectors might increase the water shortage in downstream areas of Signagi and Dedoplistskaro municipalities Downstream of Alazani and Iori rivers are represented by very fragile arid and semi-arid ecosystems of semi-deserts, steppes and floodplain forests. These areas are the end line of the ranges of many endangered species and as well are inhabited by species (e.g. brown bear and lynx) that are not typical to arid and semi-arid areas; have various categories of PAs, including Vashlovani National Park. There is a conflict among various functions of ecosystems, including conservation function of the PAs and natural resources use. Therefore, they undergo pressures from sheep grazing, forest cutting by local population, hunting by sports hunters and locals, killing of predators to avoid sheep loss, etc. In addition, these areas are short in water resources and it is likely that this problem will further exasperate due to the climate change impacts and potential increased use by upstream users. Desertification, soil erosion, salinization and bogging due to overgrazing and unsustainable agriculture practices are widespread phenomena here. In addition, there are a number of

mining activities for limestone and oil extraction that have significant impacts on local ecosystems. The area is rich in solar energy that can be utilized to produce electricity and heat. Finally, a number of donor-supported programs are on-going there. Regarding the upstream of the R. Rioni, Ambrolauri, and Oni and to a lesser extent Tsageri are represented by high ecological value forests, sub-alpine and alpine meadows of the Western Caucasus that are habitats for Western tur and a number of other large mammals. There are high pressures from illegal and commercial logging, illegal hunting and fishing. The area is rich in water resources that have high power potential but are currently underutilized. The government plans to further develop this potential that if not properly managed might have high impacts on the river regime in downstream areas. The area is also rich in biomass and the biomass fuel can be produced from wood chips, saw dust, manure, etc. The area is rich in mineral resources, particularly in non-ferrous metals of arsenic and associated metals, including gold that are not extracted at present. Arsenic mines pose high pressures to local livestock and population and renewal and expansion of such activities will further enhance such pressures. This will be in a conflict with the government goals to develop the tourism, both recreational and health in Racha-Lechkhumi region. Furthermore, the area is highly vulnerable to natural disasters, including earthquakes, landslides, mudflows and floods, which are accelerated by forest cutting and grazing on the slopes. Ambrolauri municipality where the regional governor is sitting is between Oni and Tsageri municipalities can easily coordinate the municipal level activities and mobilize their resources. There are a number of donors or donor-support programs active in the region, e.g, Care has its program there, and USAID through its large-scale NEO program is going to enter the scene. UNDP is planning to implement flood management program in upper and low reaches of Rioni Basin. Therefore, catalytic effect of INRMW program might be high. As for the extreme downstream of the Rioni basin, it is one of the vulnerable and fragile ecosystems undergoing severe pressures from all upstream and downstream activities. It shelters tertiary relicts of Colchic refugium and is a habitat of many endangered, rare, endemic and relic fauna species. In addition, it a temporary shelter for a wide range of migratory birds and the waters there including brackish and fresh water are rich in both local and transitory fish, including sturgeon. There is a Kolkheti National Park in the region that is also undergoing of constant pressures from local population in terms of illegal logging, poaching, peat extraction, etc. Furthermore, many infrastructure projects end-up in the city of Poti, which is the major port for Georgia and therefore, have direct or indirect impacts on wetlands ecosystems and the delta. The area is highly vulnerable to climate change that exasperates the already on-going delta and coastal erosion due to the reduction of river sediment flow as a result of upstream man-induced river diversion and its regime change, eustasy, and sea surges, etc. The on-going Namakhvani HPP project together with other planned HPP projects will definitely have a negative impact on coastal zone. As for the natural disasters, floods threaten populations of lower parts of Khobi, Senaki and Abasha municipalities as well as the city of Poti.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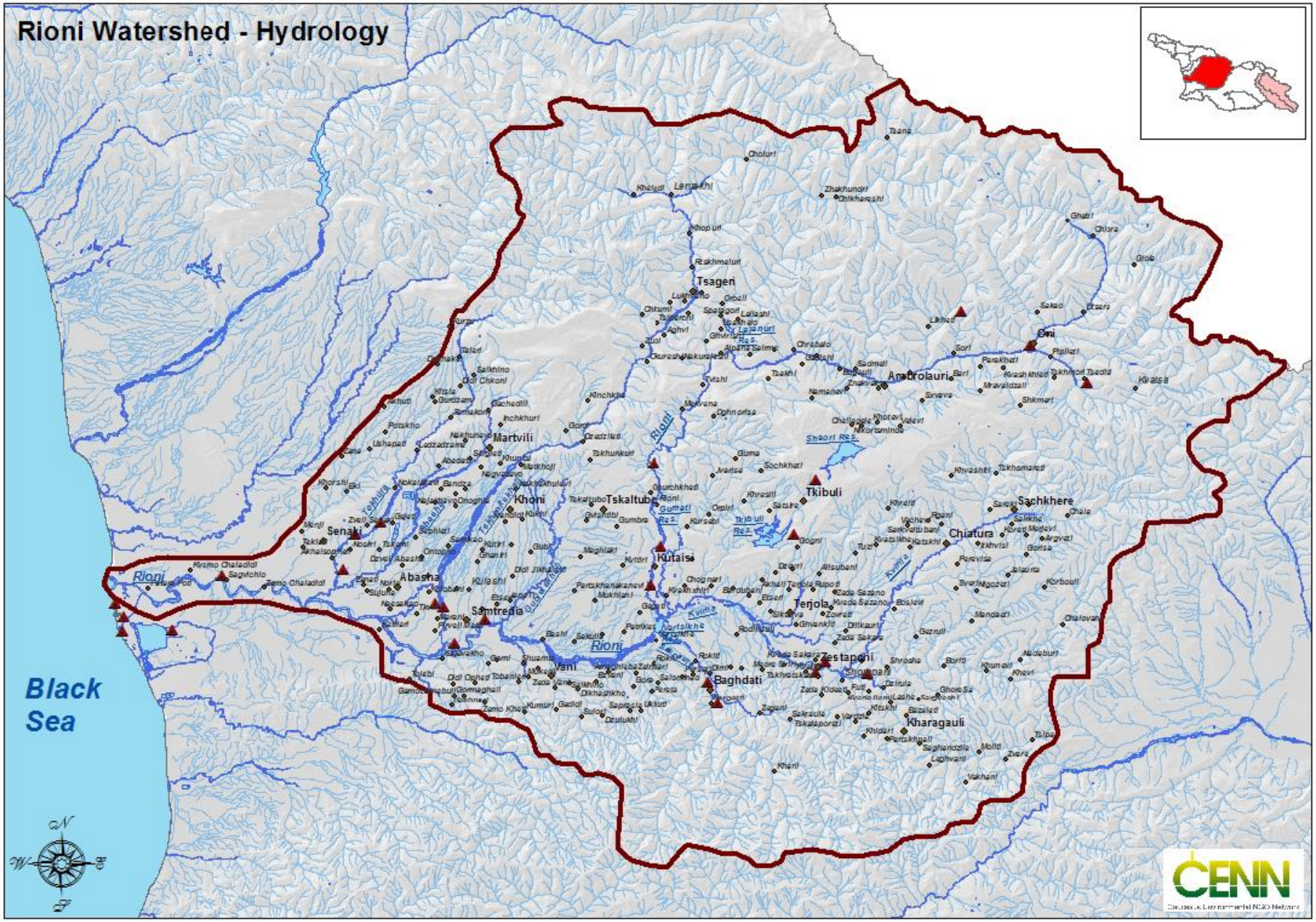
Rioni Watershed - Hydrology
Black Sea
Tsageri
Ambrolauri
Oni
Martvili
Khoni
Tskaltubo
Tkibuli
Sachkhere
Chiatura
Senaki
Kutaisi
Abasha
Samtredia
Terjola
Zestaponi
Vani
Baghdati
Kharagauli
Rioni
Lajanuri Res.
Shaori Res.
Gumati Res.
Tkibuli Res.
Kvirila
N
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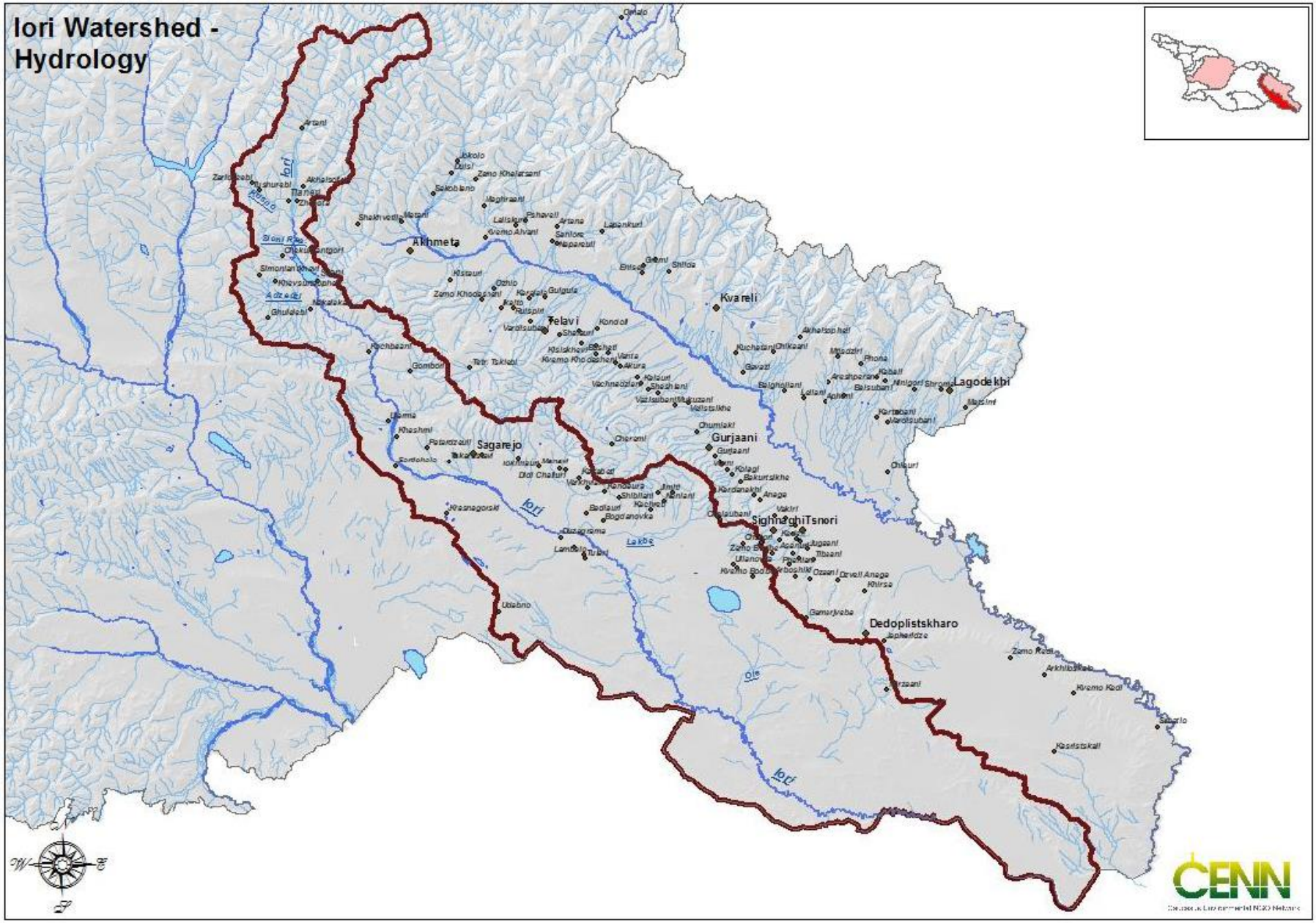
Iori Watershed -
Hydrology
Akhmeta
Telavi
Kvareli
Lagodekhi
Gurjaani
Sagarejo
Dedoplistskharo
SighnaghiTsnori
Iori
Alazani
Lakbe
Oli
W
E
S
CENN

Figure 1: View of Upper Rioni

Figure 2: View of Upper Alazani

Figure 3: View of Lower Alazani

Figure 4: View of Lower Rioni

Figure 5: Lower Alazani River

Figure 6: Lower Rioni River

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