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NDC Support Facility

The Cost of Coastal Zone Degradation in Georgia

A Tool for the Coastal Zone Adaptation and the Nationally Determined Contributions

February 2021

Contents

Table of Figures

Table of Tables

Table of Maps

Preface

Environmental degradation is costly for individuals and societies, both now and in the future. In Georgia, coastal degradation takes an important toll on public health and on quality of life. People residing along the coastline suffer from the effects of erosion, flooding, and pollution, which leads to loss of land, agricultural topsoil, and infrastructure. Climate change, characterized by rising sea levels and more and violent storms, is exacerbating these impacts.

How large are the economic impacts of this degradation? This report quantifies in economic terms how large is "large." As such, we expect to capture the attention of decision makers in order for them to improve coastal policy making in Georgia.

Despite data limitations due to constraints in time and resources, evidence-based findings can inform debate amongst decision makers on how to fund and stimulate the collaboration needed to protect coastal areas and avoid future damage.

Acknowledgements

This report was prepared by a World Bank team led by Darejan Kapanadze (Senior Environmental Specialist) and Paola Agostini (Lead Natural Resources Management Specialist) and composed of international consultants: Sergio Vallesi (water and ecosystems), Riccardo Scarpa (environmental economics), Elena Strukova Golub (economics), Camilla Sophie Erencin (economics), and local consultants George Shikhashvili (architecture and urban development), Ivan Vashakmadze (cultural heritage and tourism), Maka Murvanidze (entomology and biosecurity), Gigia Aleksidze (climate change and GIS), Irakli Ugulava (GIS), Mamuka Gvilava (marine and coastal zone management), Mamuka Makhatadze (economics), and Mamuka Berdzenishvili (tourism).

Special thanks to the following peer reviewers for their valuable contributions to the report: Lelia Croitoru (Environmental Economist), Klas Sander (Senior Environmental Economist), and Berengere Prince (Lead Natural Resources Management Specialist). The team would like to thank Ms. Kseniya Lvovsky, Practice Manager, Environment, Natural Resources and Blue Economy for the Europe and Central Asia Region, and Sebastian-A Molineus, Regional Director, South Caucasus Country Unit, who provided valuable support to the team.

The team is grateful for the information provided by officials of the Ministry of Environmental Protection and Agriculture and its National Environmental Agency, the Ministry of Economy and Sustainable Development, government of the Autonomous Republic of Adjara, regional governments of Guria and Samegrelo-Zemo Svaneti, and the Batumi Municipality City Council. The Team also wishes to thank all stakeholders from governmental, non-governmental, academic and private institutions who participated in two workshops dedicated to discussing climate change impacts on coastal infrastructure and tourism, held in the seaside town of Batumi in 2018 and in the capital city of Tbilisi in 2020.

The report was funded by the Nationally Determined Contribution Support Facility (NDC-SF).

Front cover photo: *Batumi, Adjara, Georgia*
Editorial credit: Grisha Bruev / Shutterstock.com

Acronyms

AAP	Ambient Air Pollution
ASP	Average Selling Price
BBSE	Blueing the Black Sea
CCRA	Climate Change Risk Assessment
COED	Cost of Environmental Degradation
CZ-NAP	National Action Plan for Adapting to Impacts of Climate Change in the Coastal Zone of Georgia
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
ha	Hectare
HAP	Hazardous Air Pollution
m	Meter
MAGNET	Modular Applied General Equilibrium Tool
NDC	Nationally Defined Contribution
NDC-SF	Nationally Defined Contribution – Support Facility
NOAA	National Oceanic and Atmospheric Administration
NTFP	Non-Timber Forest Resources
PM	Particulate Matter
PPP	Purchasing Power Parity
PV	Present Value
RUSLE	Revised Universal Soil Loss Equation
SLR	Sea Level Rise
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNDRR	United Nations Office for Disaster Risk Reduction
$	United States Dollar
VSL	Value of Statistical Life
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WTA	Willingness to Accept
WTP	Willingness to Pay

Executive Summary

This cost of environmental degradation (COED) report focuses on Georgia's coastal zone. The report will help to inform the new nationally defined contribution (NDC) of Georgia by providing additional data on the COED along the Black Sea coast of Georgia, and serves as a basis for preparing the World Bank report *Impacts of Climate Change on Georgia's Coastal Zone: Vulnerability Assessment and Adaptation Options* (November 2020) and the World Bank report *Georgia: Towards Green and Resilient Growth* (November 2020).

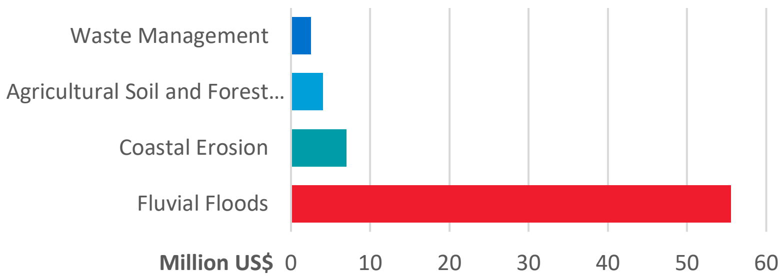
Georgia's coastal zone is crucial to the national economy but has been affected by substantial environmental degradation. The coastal zone includes eight municipalities–Khelvachauri, Batumi, Kobuleti, Ozurgeti, Lanchkhuti, Poti, Khobi, and Zugdidi–and is home to valuable river deltas, coastal crops, forestry and commercial activities, and is an area of high potential for the expansion of the tourism industry. In 2017, Georgia's coastal zone generated about $2 billion. However, the occurrence of landslides, as well as fluvial and pluvial floods have damaged urban infrastructure and the natural environment. The installation of man-made barriers along rivers, such as dams, has caused rapid changes in the patterns of freshwater volumes, which were aggravated by sudden and increased glacier thawing. These fluvial barriers have also contributed to the reduction of water-transported sediment and its deposition along coastal shores. Therefore, beach retreat has accelerated, while climate change and increased disaster risks are intensifying these outcomes.

The current global crisis associated with the COVID-19 pandemic presents a variety of economic implications and impacts on environmental governance. As the consequences of the crisis escalate, public expenditure might be redirected towards other priorities, especially the medical sector. This will most probably result in reduced funding for environmental activities, including investments in reducing environmental degradation and addressing climate vulnerabilities. One major threat is the danger of authorities investing in cheaper, polluting technologies, which will have long-term negative effects on the environment and will affect future COED.

This report estimates the impact of degradation that occurred in 2017, as a result of pollution, flooding, coastal erosion, and agricultural soil and forest degradation in eight of coastal Georgia's municipalities. Economic values are expressed in 2017 prices. They are reflected in absolute ($) and in relative terms, as an equivalent percentage of the region's GDP. This study is a first attempt to estimate the COED of Georgia's coastal zone and so features some uncertainties regarding data and information used for cost estimates. Therefore, estimates of this report provide an order of magnitude of the COED for selected areas affected by degradation.

The economic cost of degradation in the eight coastal municipalities of Georgia is equivalent to 5 percent of the coastal zone-produced GDP in 2017 (the estimated GDP for this zone is approximately $2 billion). The main causes of COED are flooding and coastal erosion (Figure 1 and Table 1).

Figure 1: Estimated annual COED by impact origin, 2017



Source: World Bank estimates.
Note: The COED estimates of areas impacted by degradation cannot be compared directly because of differences of methodological approaches and data availability.

Waste pollution costs in 2017 are estimated at $2.5 million. Waste pollution management is a complex challenge, as it relates to a wide range of waste categories. At present, Georgia's waste management system depends largely on landfills, which are well known to cause adverse effects both on the environment and on human health.

Adding agricultural soil and forest degradation together produces an annual cost of approximately $4 million per year. Landscape degradation mostly affects the fertile topsoil of Georgia's coastal municipalities and hence reduces crop productivity. Agricultural soil degradation leads to an annual loss ranging between $1.2 and $2.4 million per year. Deforestation and forest degradation–mostly driven by people sourcing firewood from public forests–leads to the loss of a wide variety of ecosystem services, and costs $2.1 million per year.

Coastal erosion is the process by which sea level rise (SLR), strong wave action, and coastal flooding wear down or carry away rocks, soils, and/or sand along the coast. Ongoing coastline erosion–if uncontrolled–leads to extensive damage of natural features and infrastructure, with severe economic repercussions, particularly in countries where most of the economic activity takes place close to the shoreline, such as in parts of coastal Georgia. Missed sediment deposition along coastal shores is estimated to cost $7 million per year, and is expected to increase considerably in the future, as a consequence of climate change.

Damage due to fluvial flooding accounted for $56 million in 2017. Flooding, as a result of high rainfalls (pluvial floods), overflowing rivers (fluvial floods) and sea surges (coastal floods), leads to major damage of buildings, private and public infrastructure, and critical ecosystems, such as beaches and protected areas. Fluvial floods are estimated to have cost approximately $56 million in 2017, while coastal flood cost estimates are imprecise and therefore not included in the final estimate.

Table 1: Estimated annual COED in Georgia's coastal zone

Impact Area	Estimated Annual Cost ($ million)	of Coastal GDP in 2017 (%)
Coastal Zone Degradation		
- fluvial flooding Damage to assets and economic productivity, valued with benefit transfer	56	2.8
- coastal erosion Damage to infrastructure, residential houses, tourism and other businesses, due to severe waves, storms and sea surges, valued at restoration cost	7	0.35
- waste Damage due to uncollected municipal waste, damage due to inappropriate disposal of municipal waste, valued at the annual loss of property values	2.5	0.13
- agricultural soil and forest degradation Loss of agricultural productivity and forest ecosystem services in the coastal zone	4	0.2

Source: World Bank estimates
Note: The annual COED is measured in terms of percentage of GDP in 2017 to benchmark the damage against a well-known macro-economic indicator. However, this does not mean that the GDP has been decreasing in real terms due to environmental degradation. The COED estimates of impact areas cannot be compared directly because of differences of methodological approaches and data availability.

Climate change is expected to aggravate COED, assuming the continuation of current government practices (Table 2). In the absence of proactive investments, climate change will likely see a deterioration of water quality, due to higher temperatures and the increased frequency of rain and floods. As a result of higher temperatures and more rainfall, it is expected that the impact of pollution from waste increases. However, this should be moderated by improved waste disposal and waste treatment practices, which the government has already committed to. Coastal flood risk and degradation is expected to increase due to intensification of SLR, socio-economic developments and ground subsidence. The damage from fluvial and pluvial floods is also likely to escalate as the number of days with extreme precipitation and the duration of periods with and without precipitation increases.

In terms of coastal zone erosion, it is assumed that climate change will increase the volume of beach-forming sediments. These sediments should be naturally carried from the upstream portion of Georgia's rivers, mostly as a result of the retreat of glaciers, leading to additional availability of sediments upstream of dams. However, old and new barriers (such as green and grey infrastructure) to the free flow of sediments will prevent this material from reaching the seashore. Furthermore, it is assumed that climate change will drive further demand for flood protection and climate resilience for the agriculture and power generation sectors, leading to a decrease of beach-forming sediments.

Table 2: Qualitative assessment of climate

Category	Change
Water pollution	++
Solid waste disposal	-
Fluvial flooding	++
Coastal flooding	++
Coastal erosion	+++
Agricultural soil degradation	++
Forest degradation	++
Global impact from CO_2 emission	+

Note: + increased cost, - decreased cost)

Coastal zone development plans need to focus on addressing the diverse environmental issues that affect Georgia's Black Sea coast in order to reduce the impact of natural hazards and minimize economic losses. The recently established Nationally Defined Contribution Support Facility (NDC-SF), a multi-donor trust fund created to facilitate the implementation of the Nationally Determined Contributions (NDC) pledged by countries under the Paris Agreement in 2015 to achieve countries' climate goals and enhance sustainable development, supports the development of the National Action Plan for Adapting to Climate Change Impacts in the Black Sea Coastal Zone of Georgia (CZ-NAP). This plan is a building block for the evolving general national action plan for adapting to impacts of climate change. It is designed to build resilient coastal communities and reduce the high cost of coastal zone degradation, with a focus on managing flood risk and coastal erosion with green and grey infrastructure investments.

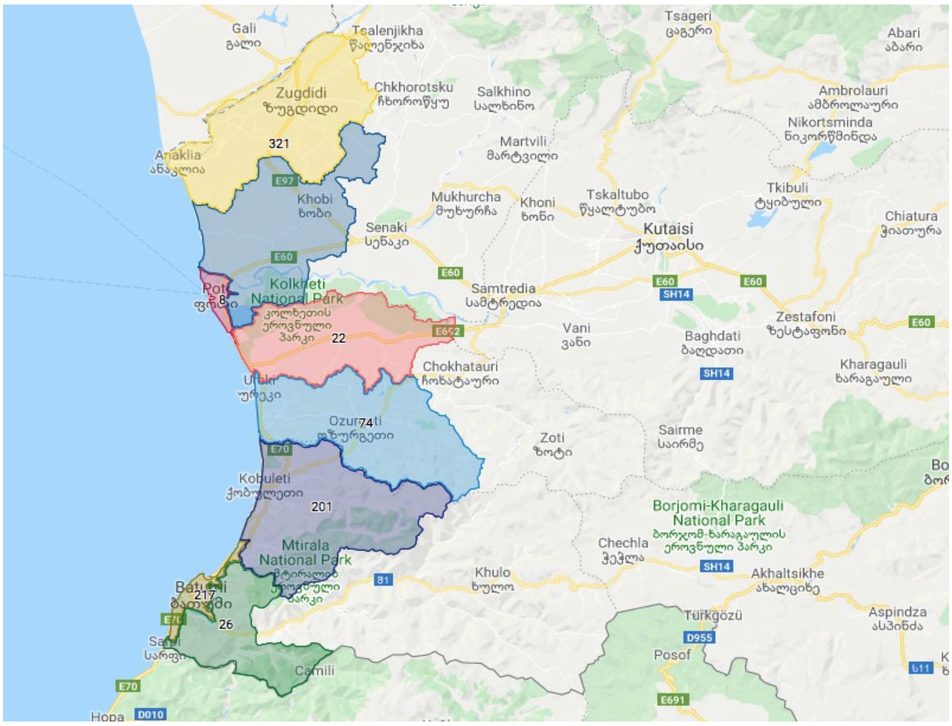
The World Bank report *Georgia: Towards Green and Resilient Growth* (November 2020) includes the cost of coastal zone degradation as a further justification of broader actions in vulnerable coastal communities. The high cost of pollution in its coastal zone made Georgia an important stakeholder in the new Blueing the Black Sea (BBSEA) regional program funded by PROBLUE and Global Environment Facility (GEF), under which a pollution diagnostic for the coastal zone of Georgia will be carried out. The timely implementation of plans to strengthen coastal resilience will reduce current environmental damages and risks.

Damage to Batumi boulevard from heavy waves.
Source: Municipal Development Fund of Georgia (used in the World Bank, Impacts of Climate Change on Georgia's Coastal Zone, 2020)

Chapter 1. Introduction

Georgia's coastal zone is critical to the country's economy, and currently generates about 15 percent of the national GDP. Georgia's four Black Sea regions include the Autonomous Republic of Ajara, Guria, Samegrelo and Abkhazia (currently not under de facto jurisdiction of the Government of Georgia). The eight municipalities that are the focus of this report are: Khelvachauri, Batumi, Kobuleti, Ozurgeti, Lanchkhuti, Poti, Khobi, and Zugdidi, which have a combined population of 554,700 (Map 1). The coastal zone is home to one-seventh of Georgia's population and has a regional GDP of about $2 billion.[1]

Map 1: Georgia's coastal zone and eight municipalities covered by the report



Source : World Bank GIS operative

Georgia's coast is a popular tourist attraction. Due to changes in foreign policies, the country has seen visitor numbers grow in the past 20 years from around 100,000 tourists annually to 6.5 million in 2017. In the past two decades, the country's economy has grown steadily, even amid the global financial crisis, tensions with Russia in 2008, and a fall in commodity prices. At the same time, poverty has halved from 32.5 percent in 2006 to 16.3 percent in 2017. Tourism is a key contributor to these positive changes, accounting for 7.5 percent of the country's GDP growth in 2018.

However, the recent growth of tourism facilities along the southern part of the coast has increased demands on land, water and other natural resources. Some of the adverse impacts of Georgia's strong coastal growth and economic advancement include the loss of historic character and natural landscapes; the reduced capacity and quality of natural resources–despite efforts to protect them under state and federal laws–and disruption to local communities.

The increased cost of environmental degradation is reflected in the loss of assets (e.g., beaches, infrastructure) and damage to critical ecosystems (e.g., forests, river deltas). For example, reduced natural sediment transportation as a result of river barriers decreases natural beach nourishment via sediment deprivation. The local population is vulnerable to this natural resource degradation as well as the future threats from climate change.

[1] The coastal GDP is estimated based on GDP per capita at regional level, available at the National Statistics Office of Georgia under Economic Activity: https://www.geostat.ge/en/modules/categories/93/regional-statistics. Estimates are scaled down to municipal level.

The global COVID-19 outbreak in February 2020 reinforced the importance of reducing the vulnerability of both the population and the economy and facilitating a sustainable recovery. Georgia's economy is significantly affected by the impacts of lockdown, global demand shocks, and travel restrictions. The IMF predicted that Georgia's real GDP growth would fall by 4 percent by end of 2020 before recovering by 3 percent in 2021[2]. During the economic downturn, Georgia adopted a national anti-crisis package focusing on social support, stimulating economic growth and strengthening the healthcare system to fight the pandemic.

Yet, beyond this direct post-pandemic crisis response, all nature-based sectors would benefit from implementing a transformational green recovery and adapting to the climate change challenge. Environmental risks remain a substantial concern, and there is a number of persistently problematic areas where environmental degradation has reached unsustainable levels.

Raising awareness of the magnitude of coastal degradation is a critical step towards enacting positive change. Therefore, this report focuses on coastal Georgia's eight municipalities, estimating, in monetary terms, the COED in 2017. Estimates provide an indication of the real magnitude of damage and of the urgency of action needed to protect Georgia's coastal zone. The rest of the report is organized as follows. Chapter 2 provides an overview of the methods used for estimating the COED and covers the report limitations. Chapter 3 reports estimates of costs related to pollution, Chapter 4 addresses the cost of flooding and coastal erosion, while Chapter 5 analyzes costs associated with soil and forest degradation. Chapter 6 qualifies potential risks due to climate change in the coastal zone of Georgia. The final Chapter outlines some recommendations that Georgia might take to reduce annual degradation costs.

[2] IMF. 2020. https://www.imf.org/en/Countries/GEO.

Batumi, Adjara, Georgia
Editorial credit: Siarhei Liudkevich / Shutterstock.com

Chapter 2. Methodology

A solid methodology is needed to ensure that the costs imposed on society by environmental degradation are captured as accurately as possible and consistently across different environmental impacts. The methodological framework used in this COED is based on the World Bank study *The Cost of Coastal Zone Degradation in West Africa: Benin Côte d'Ivoire, Senegal and Togo* (Croitoru et al. 2019).

2.1. Objective and scope

This COED report focuses on Georgia's coastal zone. The report will help to inform the new nationally defined contribution (NDC) of Georgia by providing additional data on the COED along the Black Sea coast of Georgia and serves as a basis for preparing the World Bank report *Impacts of Climate Change on Georgia's Coastal Zone: Vulnerability Assessment and Adaptation Options* (November 2020) and the World Bank report *Georgia: Towards Green and Resilient Growth* (November 2020).

The report values the impact of environmental degradation due to pollution, flooding and coastal erosion, as well as agricultural soil and forest degradation. Key environmental challenges were identified and prioritized by using readily available sources and were validated through interviews and consultations with local stakeholders across a variety of sectors and institutions. Priority areas for Georgia's coastal zone include man-made activities, such as waste pollution and deforestation caused by collection of firewood, as well as natural factors, such as flooding and coastal erosion. For example, the intensification of storms is a major concern and results in increased coastal instability. Coastal floods (or sea storm surges) occur when heavy storms cause abnormal surging of seawater. This is especially damaging in low-lying areas of Georgia's coastal zone and is often exacerbated by related coastline erosion.

This report aims at estimating in monetary terms the annual COED of the coastal zone of Georgia. Based on data availability, the report estimates COED for the year 2017, assessing damages to productive assets (e.g., beaches, agricultural topsoil and forests) due to environmental impacts, as well as the reduced aesthetic value of areas located near landfills. Some areas experience short-term impacts, such as water pollution from biological agents causing transient health problems (such as diarrhea and skin rashes) that can last from a few days to several weeks, during which economic damage can be approximated by the loss of income, medical cost and care. Other areas have long-term impacts. For example, the erosion of coastal zones often causes a loss of assets and requires long-term investment. In cases with prolonged effects, this report estimates the present value (PV) of the current and future COED for 2017. The analysis uses a 3 percent discount rate and a time horizon of 30 years.[3] Results are expressed in 2017 market prices. They are reported in monetary terms, in $2017, and in relative terms, as percentages of the GDP (2017) produced in the eight coastal municipalities to provide "order of magnitude" information.

The valuation of the COED also includes—at least to some extent and in a qualitative manner—comments on the impacts of climate change (e.g., increased flooding due to higher rainfall). However, it is important to note that: (i) the impacts of climate change cannot be easily separated from those of other factors; (ii) since the valuation refers only to the events relating to one year, climate change impacts are likely to have a minor impact, but a variable one from year to year; and (iii) addressing landscape degradation will have both climate change mitigation and adaptation potential.

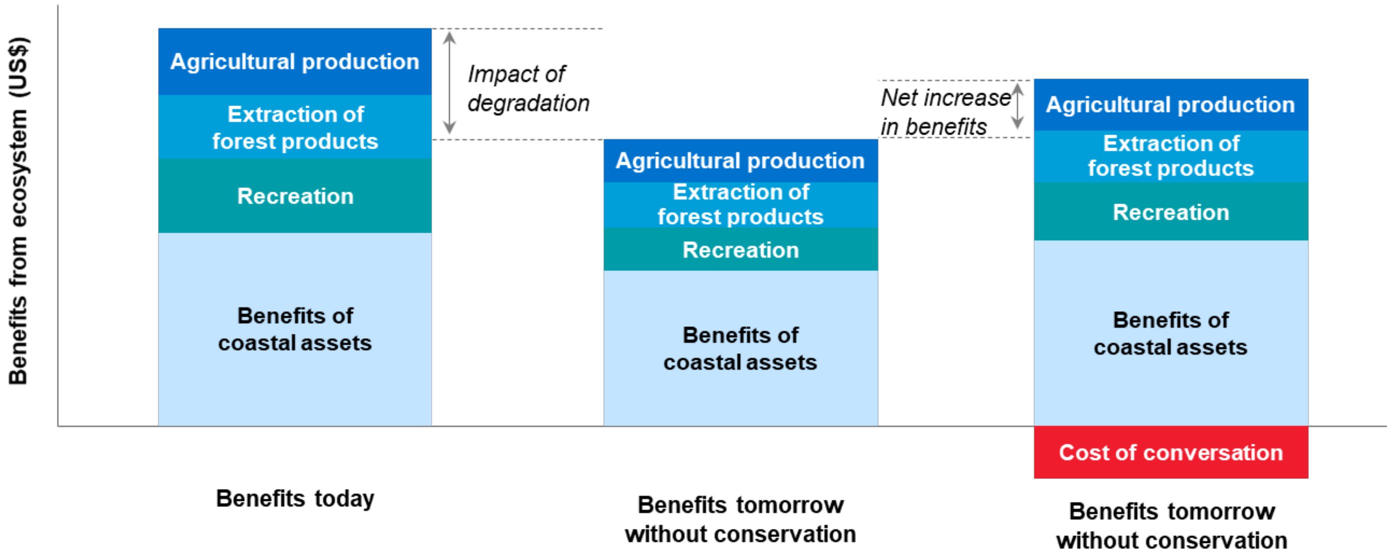
2.2. What does the COED measure?

The COED estimates changes in benefits and costs caused by current environmental management practices over a period of one year. Figure 2 illustrates a potential relationship between the cost of preventing degradation and its potential benefits. At any given time, the coastal zone provides certain benefits (e.g.,

[3] Based on other COED studies, including Croitoru et al. (2019).

industrial and agricultural production, recreational value, commercial opportunities, and income from tourism), depending on what the territory is used for and on the socioeconomic context. The first column shows the economic value of these benefits in a given year. The second column presents the value of these benefits in the future diminished by the impact of environmental degradation. This is due to either suboptimal management (e.g., discharge of untreated municipal wastewater) or other natural factors, aggravated by climate change (e.g., coastal and top-soil erosion due to flooding). The difference in value represents the cost of damage caused by current degradation, that is the COED.

Figure 2: Diagram of benefit gains from preventing degradation



Source: Croitoru et al. 2019

It is important to note that degradation costs only indicate the extent of damage and identify impact areas that need urgent interventions for improvement. They provide no information on the best manner to intervene or their economic effectiveness. While the third column illustrates the net increase in the benefits of preventing degradation, this report only estimates the COED (the difference between the first and the second column). Thus, it ignores the benefits from potential interventions for environmental improvement as their economic effectiveness is assessed in cost-benefit analysis studies.

The estimation of the COED involves the valuation of damages to goods and services for which there are market prices (e.g., houses and agricultural land), and others that do not have clear market prices (e.g., non-market services, such as pollution). While valuation of marketable goods tends to be straightforward (e.g., by using the market price after eliminating distortions), estimating the value of non-market goods and services poses considerable practical challenges and rests often on assumptions.

2.3. Valuation methods

The COED is estimated based on different valuation methods (Table 3). This report estimates annual environmental degradation costs to the extent that negative impacts can be captured with available information and data. Estimates of areas impacted by degradation cannot be compared directly because of differences of methodological approaches and data availability.

Table 3: Environmental degradation valuation methods used in the report

Coastal Zone Degradation	Estimation Method
- waste	
Damage due to uncollected municipal waste, and damage due to inappropriate disposal of municipal waste.	Benefit transfer of the reduction of residential property value studies.
- fluvial flooding	
Damage to assets and economic productivity.	Replacement costs to ecosystem service.
- coastal erosion	
Damage to infrastructure, residential houses, tourism and other businesses, due to severe waves, storms and sea surges.	Damage to assets and economic productivity.
- agricultural soil and forest degradation	
Loss of agricultural productivity and forest ecosystem services.	Benefit transfer.

Insufficient or inappropriate water supply, sanitation, and hygiene (WASH) can affect human health (e.g., due to water-borne diseases) and the environment (e.g., due to discharge of untreated wastewater). This category concerns estimated impacts on health through water-borne diseases caused by unsafe WASH in Georgia's coastal zone. Given the limitations of data on morbidity and mortality attributable to water pollution, this report could not estimate COED related to water pollution. Available information suggests that although this type of environmental degradation was not prominent in 2017, water pollution reduced tourism opportunities, and led to fish contamination, groundwater pollution, and increased morbidity. At the time of the COVID-19 pandemic, other issues are evolving that link the risk of virus dissemination to deficiencies of wastewater management.

Inappropriate management of waste can lead to reduced tourism opportunities, fish contamination, groundwater pollution, and human health damage. Section 3.2 on waste pollution addresses the impact of inappropriate management of municipal waste. The cost of landfill disposal is valued based on the observed depreciation of land value located in proximity to the landfills. Another effect, which could be quite significant in tourist areas, is the additional cost of cleaning marine litter and other waste disposed on the beach. This effect is not evaluated due to a lack of data.

Coastal Georgia is affected by fluvial floods, which occur when rivers burst their banks as a result of sustained or intense rainfall. Similarly, the coastal region suffers from pluvial floods, which occur when the ground cannot absorb rainwater effectively or urban drainage systems are overwhelmed by excessive water flow. In Section 4.1 the potential annual impact of floods on the coastal GDP is estimated using the Aqueduct model[4] for the coastal municipality of Zugdidi. This model is used to produce corresponding flood water depth, which along with its area of coverage, is translated into losses using flood damage functions. To reflect the damage functions, the review of global literature on flood damage functions by Huizinga et al. (2017) is used.

Coastal floods occur when heavy storms cause abnormal seawater surges. Flooding constitutes a particular challenge in low-lying areas as well as land subsidence caused by sediment deficits or ground water extraction. In Section 4.2 the annual cost of coastal flooding is estimated based on the calculation of expected annual damage associated with a high magnitude event. Given the limited information on economic costs related to coastal flooding events in Georgia, the cost estimate provides only an indication and is, therefore, not included in the total estimates.

Georgia's coast is experiencing accelerated rates of shoreline change, primarily erosion. Key factors include sea level rise (SLR) as well as disruptions in sediment supply from rivers. Given data limitations, it was only possible to undertake a very high-level economic valuation of the annual COED caused by dams impounding sediments along the river Chorokhi. Additional COED for sediment deprivation due to the presence of dams in Georgia could be estimated, based on recent studies on the overall amount of sediment carried by

[4] https://floods.wri.org.

Georgian rivers (Berkun, 2012). Cost of sediment replacement along the coast was computed, based on the opportunity cost of use elsewhere in the economy.

Unsustainable management of agricultural soil and forests leads to continuous degradation of these natural resources. Both are important resources for coastal communities with a large share of Georgians maintaining some direct link to forestry and agriculture-related activities by ownership or co-ownership of land, and with crops being mostly destined for self-consumption. The COED estimates related economic losses due to agricultural soil and forest degradation in Section 5.1 and 5.2.

2.4. Report limitations

Due to data limitations, estimates provide an order of magnitude of the COED for selected areas affected by degradation. This report is a first attempt to estimate the COED of Georgia's coastal zone to support the World Bank report *Impacts of Climate Change on Georgia's Coastal Zone* (November 2020). Given data limitations and uncertainties regarding information used for estimating degradation costs, this report's estimates are indicative. When no data was available for the eight municipalities, the valuation was based on assumptions and benefits transfer of measures from other countries of similar economic development. Further studies can focus on specific thematic areas and build upon identified data gaps to provide estimates with lower margins of error.

COED estimates are presented in absolute terms and as percentage of Georgia's 2017 coastal GDP. In this report, expressing the COED as a percentage of GDP is meant only to benchmark the damage against a well-known macro-economic indicator. However, this does not mean that the GDP has been decreasing in real terms due to environmental degradation.

Seaside waste dump near Batumi.
Source: Adjara Solid Waste Management project, Autonomous Republic of Adjara, Georgia Framework for Restoration and Resettlement, supported by EBRD and SIDA (used in the World Bank report Impacts of Climate Change on Georgia's Coastal Zone, 2020)

Chapter 3. Pollution

3.1. Water pollution

The sectors with the highest water usage in Georgia are agriculture, industry, energy, and domestic households. Over the past number of years, the total volume of water taken without permission from surface water bodies has declined (in 2017 it fell by 3.7 percent compared to 2013). Withdrawal of water from groundwater sources, on the other hand, has increased by 21 percent in the same period. Water consumption in the agriculture and hydropower sectors is likely to increase, as more hydropower stations are planned for construction and irrigated land will also be further extended. Unless water loss (63 percent) is reduced in the household sector, water consumption is expected to grow as an increased number of households will have access to improved drinking water supply and sanitation services. In 2017 the share of the total population with access to improved drinking water supply reached 66.4 percent; and 48.6 percent had access to sanitation services (MEPA 2019). Wastewater treatment facilities provide services to about 1.4 million people (37 percent).

Ensuring good quantitative and qualitative status of surface and groundwater bodies, as well as coastal waters, is an important prerequisite for the protection of human health and maintenance of aquatic ecosystems. Georgia has made considerable progress in reducing water pollution, especially in rural areas, which have been impacted significantly by poor wastewater management. However, many wastewater treatment plants in Georgia are non-functional or perform only primary treatment that results in the discharge of untreated wastewater and the resulting contamination of surface water. A city particularly impacted by poor liquid waste disposal standards is Batumi, which is experiencing significant growth in tourism numbers. The seasonality of tourism places increased pressure on local resources during the tourist season exceeding the city's infrastructure capacity. Untreated water or poorly treated water also negatively impacts tourism through polluted rivers and beaches.

Given data limitations related to water pollution impacts, this report could not give an estimate of related economic costs. Interviews with local experts highlighted the fact that Batumi is well known in Georgia for suffering significant incidents of water contamination during the summer months. It was reported that many children have experienced health issues, including mild vomiting and diarrhea in the past. This issue is unreported as most parents tend not to visit doctors for mild symptoms, which usually last only a few days. While this situation is certainly improving, due to ongoing upgrades of the water disposal standards, the lack of data made it impossible to quantify the impact of water pollution on human health, as well as on economic sectors, and in particular the tourism sector. Two categories of data are missing: data that will link the fraction of morbidity cases to water pollution, rather than other causes, such as foodborne pathogens, food allergies etc., and data that will establish the economic cost of each reported case.

3.2. Waste pollution

Waste is a pressing environmental, social, and economic issue, and one of the biggest challenges faced by most urban areas. While managing waste in an environmentally friendly, safe, and sustainable way should be a top priority, many countries are not yet implementing current available best practices in waste management. Waste pollution management is a complex challenge, as it relates to a wide range of waste categories, each of which require distinct ways of handling: municipal, medical, industrial, transport, agricultural, construction, demolition, etc. Inappropriate management of these waste categories can deteriorate marine water quality, impact ecosystems, reduce tourism opportunities, lead to fish contamination, and sometimes increase human morbidity.

Upgrading waste management to modern standards and preventing pollution caused by waste are major Georgian Government priorities. Given increased public awareness and the environmental requirements of the EU-Georgia Association Agreement, the waste management sector in Georgia is gradually improving. The first legislative act regards waste management policy, including the reuse of waste, was approved in January 2015. The National Waste Management Strategy and National Action Plan were approved by Government Resolution N160 on April 1, 2016. The National Strategy sets out the country's waste management policy and strategic direction for a 15-year period (2016-2030). The strategy is based on the EU-Georgia Association Agreement requirements and international waste management principles.

In 2017, more than 915,000 tonnes of municipal waste were generated and disposed on operating non-hazardous landfills in Georgia (MEPA 2019). There are a total of 58 official landfills in Georgia with 34 of them being operational (MEPA 2019). Official landfills are defined as dumpsites where the disposal of waste is measured and monitored by the Georgian Waste Management Company. Of the total amount of municipal waste, 78 percent is generated in urban areas, while 22 percent is generated in rural areas. As waste management services throughout the country are not fully accessible and there are many unauthorized and uncontrolled landfills/dumpsites that are not operated by the Georgian Waste Management Company, the amount of municipal waste generated is expected to exceed official figures. In the Adjara Region, including in Batumi, all landfills are unregulated and as a result there is no accounting of municipal waste.

In the Black Sea coastal zone, the overall annual uptake of municipal waste is assumed to be about 220,000 tonnes per year.[5] Out of those 220,000 tonnes, 90,000 tonnes are generated in the Adjara region (information received from the Director of the Adjara Solid Waste Company), while the remaining municipal waste is collected in the other coastal municipalities. While the Adjara region has currently no regulated landfills, landfills in other municipalities (Zugdidi, Khobi Ozurgeti and Poti) are operated by the Georgian Waste Management Company. There are seven regulated/official landfills within the eight coastal municipalities[6] and about 195 unregulated/unauthorized landfills.[7] In many cases unauthorized landfills are located on the banks of rivers or close to the population, and thus endanger human health as well as the environment.

The uncontrolled disposal of domestic and hazardous waste and the existence unregulated landfills pollute soil and water, and the methane generated by the decomposition of organic waste has a negative impact on climate change processes. Sub-standard disposal sites, like the one located to the South of Batumi, have negative impacts on the coastal environment. Situated right on the seaside, near the river mouth, and in a high-water table area, this dump is likely to remain a pollution hotspot even after closure, especially under the forecasted climate change scenarios. The problem of inappropriate waste management has become more acute due to growing concerns related to other types of diffuse waste, such as waste from plastic fragments.

This report estimates the impact of regulated and unregulated landfills through the depreciation of property values in areas located close to landfills. These estimates are based on hedonic pricing, by comparing the average price of land in similar locations with that of land in proximity to active landfills. A property has a collection of attributes: physical characteristics (e.g., surface, construction material, etc.), location (e.g., proximity to businesses, schools, hospitals, etc.) and other environmental features (e.g., clean air, no noise, nice view, etc.). The price of the property depends on the level of its attributes. If the quality of the environment surrounding the property declines, (e.g., due to landfill location), the value of the property is also expected to decrease.

Using a Geographical Information System (GIS), all waste sites in the study area have been identified. The area of the eight coastal municipalities was crossed with a database of an inventory of all regulated and unregulated landfills in Georgia. The selection of unregulated landfills is based on the Greens Movement of Georgia/Friends of the Earth Georgia project “Clean-up Georgia.” Despite the clean-up performed under the

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[5] Based on an expert assumption.

[6] In the study the landfill in Batumi was classified as regulated.

[7] Information on unregulated landfills is based on the project “Clean-up Georgia” by the Greens Movement of Georgia/Friends of the Earth Georgia (GMG/FoE-G), http://www.cleanup.ge/?lang=eng&go=gis_map . Selection of unregulated landfills by the Cleanup Georgia project is based on the maximum number of unregulated landfills, without any specific selection criteria.

program, the report assumes that sites will continue to be polluted with waste if no regulated standard landfills exist in these areas.

In the next part of the process, property market values were identified. Batumi's property value information is based on data from nominal costs of publicly owned land included in the Decree of the Batumi municipality dated February 2017. The data indicates that public land value fluctuates between 7 and 140 $/m2 for periphery and central locations, respectively. Information on residential costs was also supported by recent research in Batumi (Kordzaia, 2019). The report reveals that the Average Selling Price (ASP) for Batumi's residential real estate sector in 2017 was around 730 $/m2, which is among the highest property values along the coast. Using GIS functions, the land and number of residential houses and other property types in the proximity of landfills were identified.

A unit transfer value approach was used for both official/regulated and unauthorized/unregulated landfills to value property depreciation attributable to landfill proximity. The effect of lost property values from proximity to landfills has been studied by Ready (2010) in the US, suggesting a loss of 13.7 percent of the property's market value for residential property adjacent to high-activity landfills, on average. The term 'adjacent to' landfills is defined as a radius of 500m from the seven regulated (official) landfills located within the eight coastal municipalities. Based on the assumption of an average rental value of $800/month per house in Batumi, $600/month in Poti, and $400/month in remaining municipalities along the coast, the 2017 cost of property value depreciation for the 183 houses located within 500m from regulated landfills is calculated at an average of $154,207. The study by Ready (2010) predicts a property value decline of 2.5 percent for residential property adjacent to lower activity landfills, on average, declining by 1.2 percent per mile, and no effect for properties more than 5 miles away. These values are used for the 195 unregulated active landfills located in the eight coastal municipalities, which we presume to have lower activity compared to regulated landfills. There is no information available on the number of properties adjacent to unregulated landfills. Therefore, for land within 500m of proximity to unregulated landfills, the property value of $3,000-5,000 per hectare is used, with a capitalization rate of 5 percent. An annual property value depreciation of $2,327,920 is obtained as an estimate of amenity value lost due to the 195 unregulated landfills. The total yearly loss is approximated at $2,482,127.

The range of property value loss in Georgia's coastal municipalities due to proximity to regulated and unregulated landfills is equivalent to $2.5 million in 2017 (Table 4). The estimate of waste pollution has several data limitations and is based on many assumptions. Therefore, cost estimates related to waste are only indicative.

The World Bank CEA 2015 on property value loss reports an annual cost of $7.4 million (2015) for the entire country. The Section on "Estimate of annual loss of property value because of proximity to a landfill in Georgia" estimates an annualized cost including houses within a 5-km radius to landfills and disposal sites in Georgia. The estimate of this report is about one-third of the CEA estimate, but refers only to properties in the coastal zone, which–despite being on a smaller area than one third of the country–tend to be more appealing to the real estate market, and hence more valuable.

Table 4: Estimated cost of waste pollution, 2017

Waste Pollution	
Cost of property value depreciation from regulated landfills ($, million)	0.15
Cost of property value depreciation from unregulated landfills ($, million)	2.33
Total ($, million)	**2.5**
Equivalent to % of coastal GDP in 2017	*0.13*

Source: World Bank estimates

Flooding in Batumi, August 10, 2018.
Source: Photo by Government of Adjara's press office, available at https://agenda.ge/en/news/2019/2963

Chapter 4. Flooding and Coastal Erosion

Floods are one of the most important categories of natural disasters in the world. Out of all types of floods (pluvial, coastal, etc.), river floods are among the most damaging in terms of their cost to the economy. To illustrate some magnitude, over the period 1995–2015, floods accounted for about 43 percent of all documented natural disasters, affecting 2.3 billion people, killing 157,000 and causing $662 billion in damage (UNISDR, 2015). Global meteorological models suggest that the intensity of rainfall events and the number of floods are expected to continue to grow in the future due to climate change. Combine this with rising populations in flood-prone lands, and the number of people vulnerable to flood disasters is expected to reach 2 billion by 2050 (UNESCO, 2012). This is going to be further exacerbated by ongoing deforestation and continued drainage of wetlands.

Under global warming scenarios, river floods are expected to drastically increase, emphasizing the urgency to increase adaptation and mitigation efforts. A recent study estimated human losses, economic damage and welfare losses due to river flooding under a range of socio-economic and global warming scenarios, assuming current vulnerability levels and in the absence of future adaptation (Dottori, 2018). The study revealed that with global mean temperature increases of 1.5 °C, human losses could rise by 70–83 percent, damage by 160–240 percent, and welfare could reduce by 0.23–0.29 percent. With temperature increases of 2 °C, human losses could be 50 percent higher, economic damage could double, and losses to welfare could grow to 0.4 percent (Dottori, 2018).

Analysis of multi-year data shows that floods occur in almost all of Georgia's rivers. Rivers of particularly high risk are the Imereti, Samegrelo, Guria, and Mtskheta-Mtianeti. The average number of floods before 1995 ranged from 3 to 5; between 1995–2006 from 4 to 20; and between 2007–2017 from 7 to 27 (MEPA 2019). The damage caused by floods between 2013–2017 reached about $44 million, resulting in the loss of 26 lives. Georgia is actively involved in international processes aimed at disaster risk reduction and mitigation. The Association Agreement between Georgia and the EU contains provisions of the Directive on Flood Risk Management (2007/60/EC), which provides for the development of flood risk management legislation, as well as the preparation of flood risk assessments and flood risk maps.

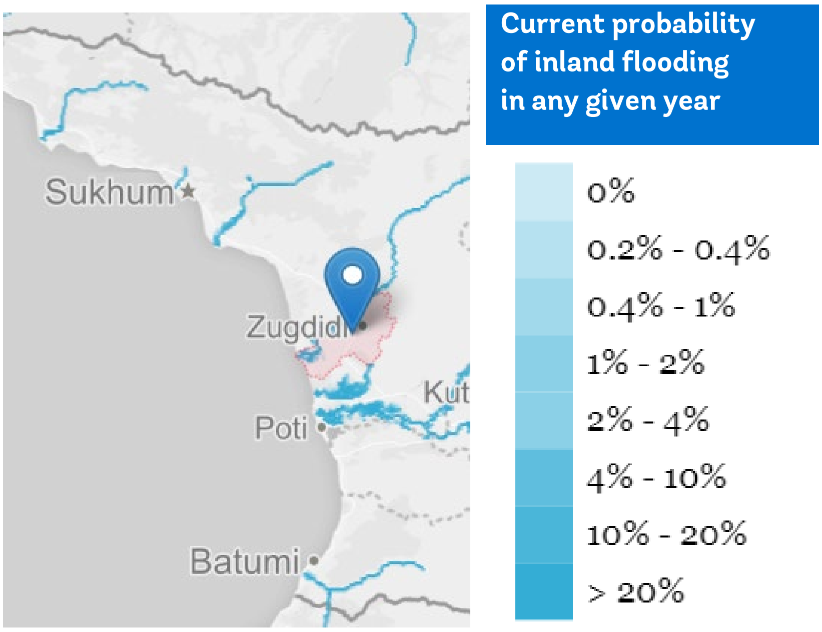
Several areas of coastal Georgia are prone to various types of flooding. Fluvial floods (or river floods) occur when rivers burst their banks as a result of sustained or intense rainfall. Pluvial floods, including surface water, occur when heavy precipitation saturates drainage systems, particularly in flat and urban areas, while flash floods are characterized by intense and high velocity torrent of water triggered by torrential rainfall within a short amount of time. Coastal floods (or sea storm surges) occur when heavy storms cause abnormal surging of seawater. This last type is especially damaging in low-lying areas and is often exacerbated by associated erosion of the coastline.

The change in climate change-related precipitation patterns could increase flooding in West Georgia. Information included in the CZ-NAP indicates a 14 percent increase in annual precipitation in West Georgia, especially in the hills behind coastal Adjara, for the period 1986–2010, compared to the period 1961–1985. The same data shows the opposite trend in Adjara's mountainous region. Predictions from the same report indicate that annual precipitation growth is expected to continue in West Georgia until 2050, but is likely to decline after that date, except in the Batumi area. The Adjara coastal zone is the only region in Georgia that will show an increasing trend in annual precipitation, at least in the near future, while the rest of Georgia is experiencing a steady decreasing trend. The number of days with extremely abundant precipitation–as well as the duration of dry periods between precipitation events–is also expected to increase in West Georgia's lowlands, leading to increasing risks of flash floods due to a decrease in the absorption power of soil. This Section estimates in monetary terms the impacts of flooding in Georgia's coastal zone with respect to both fluvial floods and coastal floods. Pluvial flooding is not included in the analysis, due to data limitations.

4.1. Cost of fluvial flooding

International databases and models were used to estimate the costs associated with fluvial flooding events. Information on cost estimates associated with fluvial flooding events are only provided for the Guria region in 2017, where estimated damage totaled $57,415. To extend estimates to the rest of the coast, the annual expected impact of fluvial floods is estimated using the Aqueduct model,[8] applied to the Zugdidi municipality, which includes the city Zugdidi and the coastal town Anaklia, located next to the river Enguri (Figure 3).

Figure 3: Probability of fluvial floods in Georgia



Source: Beta Aqueduct Floods. 2020. floods.wri.org .

Floods of different magnitudes have different periods of reoccurrence. These frequencies are necessary to compute the expected value of flood magnitude based on available past records. The Aqueduct model provides impact values for floods of the following magnitudes: 2-year flood (the impact of which is deemed to be zero), 5-year-flood, 10-, 25-, 50-, 100-, 250-, 500-, and 1,000-year floods, which present a probability of occurrence of 50 percent, 20 percent, 10 percent, 4 percent, 2 percent, 1 percent, 0.4 percent, 0.2 percent and 0.1 percent, respectively. The annual expected impact is calculated as the area under the risk curve for these magnitudes (the function of the exceedance probability-impact curves), assuming a 2-year flood protection system is in place. Such a protection system, inclusive for example of dams or levees, protects the area against anything equal to or smaller than a 500-year flood.

For the study area, the model provides a value of annual expected affected GDP at about $8.4 million and a value of annual expected urban damage (in terms of damage to urban assets), at about $1.1 million ($ 2010). If adjusted by GDP deflator to 2018 from 2010 (1.42 from World Bank Open Data, 2020), the annual expected GDP loss is about $11.9 million, and the annual expected urban damage is about $1.6 million.

Not all flood events are severe floods, and not all municipalities would be subject to the same flooding impacts as predicted for the Zugdidi municipality. To overcome this limitation, flood damage functions are used to translate flood water depth into losses. The review of Huizinga et al. (2017) on literature of flood damage functions provides continental damage functions for Asia. Assuming a flood water depth of 1.5 m,[9] Huizinga et al. provides a damage function of about 0.66 percent, which is an average between 0.66, 0.63, 0.73, 0.55, and 0.74 for commerce, industry, transport, infrastructure and agriculture, respectively. The impact on GDP for the municipality of Zugdidi is therefore corrected to about $7.9 million or $76.7 per inhabitant of Zugdidi

[8] https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon-technical-documentation.html.

[9] The assumption on 1.5 m flood water depth is based on Huizinga et al. (2017) and the very limited information on flood depth in Georgia.

municipality (total of 103,000 inhabitants). The same study provides a damage function for residential building of 0.62 percent, again assuming a flood water depth of 1.5 m. Therefore, the expected impact to urban assets is corrected to about $1 million, or $23.3 per inhabitant of urban areas of Zugdidi municipality (total of 42,700 inhabitants).

The total cost of fluvial floods to Georgia's coastal population is estimated at $55.5 million annually. Due to the lack of data on the average GDP of residents outside municipal areas, the same estimates on a per capita basis are applied to each person living in the coastal zone (about 555,000 people in 2017) to estimate GDP loss, and to each person in urban areas (308,000 people in 2017) to estimate impact on urban assets. Costs attributable to fluvial floods are approximated at $100 per capita in Georgia's coastal zone, equivalent to a loss of 2.8 percent of coastal GDP in 2017.

4.2. Cost of coastal flooding

The data for 2017 did not include costs associated with coastal flooding events. Data provided by Poti municipality indicates that 26 coastal storm events with a force equal or higher than 5 Beaufort scale occurred in 2017, but the data does not provide further information on related economic costs. Therefore, the cost estimate for coastal flooding–similarly to the approach used for fluvial flooding–is based on the calculation of the expected annual damage associated with a high magnitude event. Given the high degree of uncertainty, this cost provides only some indication and is not included in the total estimates.

The expected impact of coastal floods is estimated using available data from European cities (Prahal, 2018). The study provides estimates for the impact from coastal floods for 2016, assuming no protection levels were in place and a hypothetical 5m flood height was to occur. Bulgaria and Romania were selected, as they are similar to Georgia in terms of geographic location, coastal zone length, infrastructure, and land use. Converted to 2017 $, the impact of coastal flooding in Bulgaria and Romania was $1.9 billion and $3.8 billion respectively.

The expected annual damage is the sum of the annual damage for each of the event probability bands, which is the integral of the area under the damage probability curve. Unlike for fluvial floods, for coastal floods only information for 5m-high events was available. Therefore, the COED calculates the expected annual damage for this single type of event. To assess the probability for such an event in Georgia the information from one of the Deltares reports (Giardino, 2015, Part B) was used, which provides some information on the wave trends for Georgia, and more specifically for Batumi (Table 5). To determine the event probability, information from Innovyze software guidelines *InfoWorks ICM RiskMaster: Calculation of Event Probability and Annual Damage* is used (Table 6). The expected annual damage for Bulgaria and Romania results in $44 million and $88 million, respectively.

Table 5: Extreme wave conditions for different return periods

Return Period (years)	Hs (m)	95% Confidence Interval
1	2.4	2.3 – 2.5
10	3.5	3.2 – 3.8
50	4.2	3.6 – 4.9
100	4.5	3.7 – 5.5

Source: Giardino, 2015, Part B

Table 6: Calculation of event probability

Return Period (years)	Probability of Non-exceedance (calculated from [ ])	Event Probability
2	0.606531	
5	0.818731	0.212200
10	0.904837	0.086107
25	0.960789	0.055952
50	0.980199	0.019409
100	0.99005	0.009851

Source: Innovyze software

The annual cost of coastal flooding in Georgia is about $27 million. In order to transfer costs of Bulgaria and Romania to Georgia, the impact of coastal flooding per linear km is calculated. Assuming the length of coast for the two countries as 414 km and 256 km, respectively (Stanched, 2011), the estimated linear cost for Bulgaria is $0.11 million/km and for Romania $0.35 million/km, or an average of $0.23 million/km. Multiplying the average linear cost for Bulgaria and Romania, $0.23 million/km, with the length of Georgia's coast, 120 km, the expected annual damage of coastal floods is estimated at about $27 million.

Overall, damage due to fluvial and coastal flooding indicates the need to strengthen adaptation and mitigation efforts to deal with the increasing occurrence of floods in Georgia's coastal zone. Although subject to large uncertainties, these results indicate the importance of integrated planning and management of flood defense structures and green sustainable coast protection, such as dams and coastal plantations. These require planning, design, and monitoring to be climate resilient in order to avoid the risk of exacerbating flood hazards.

Table 7: Estimated cost of flooding, 2017

Fluvial Flooding	
$, million	56
Equivalent to % of coastal GDP in 2017	*2.8*
Coastal Flooding (not included in total estimates)	
$, million	27
Equivalent to % of coastal GDP in 2017	*1.35*

Source: World Bank estimates

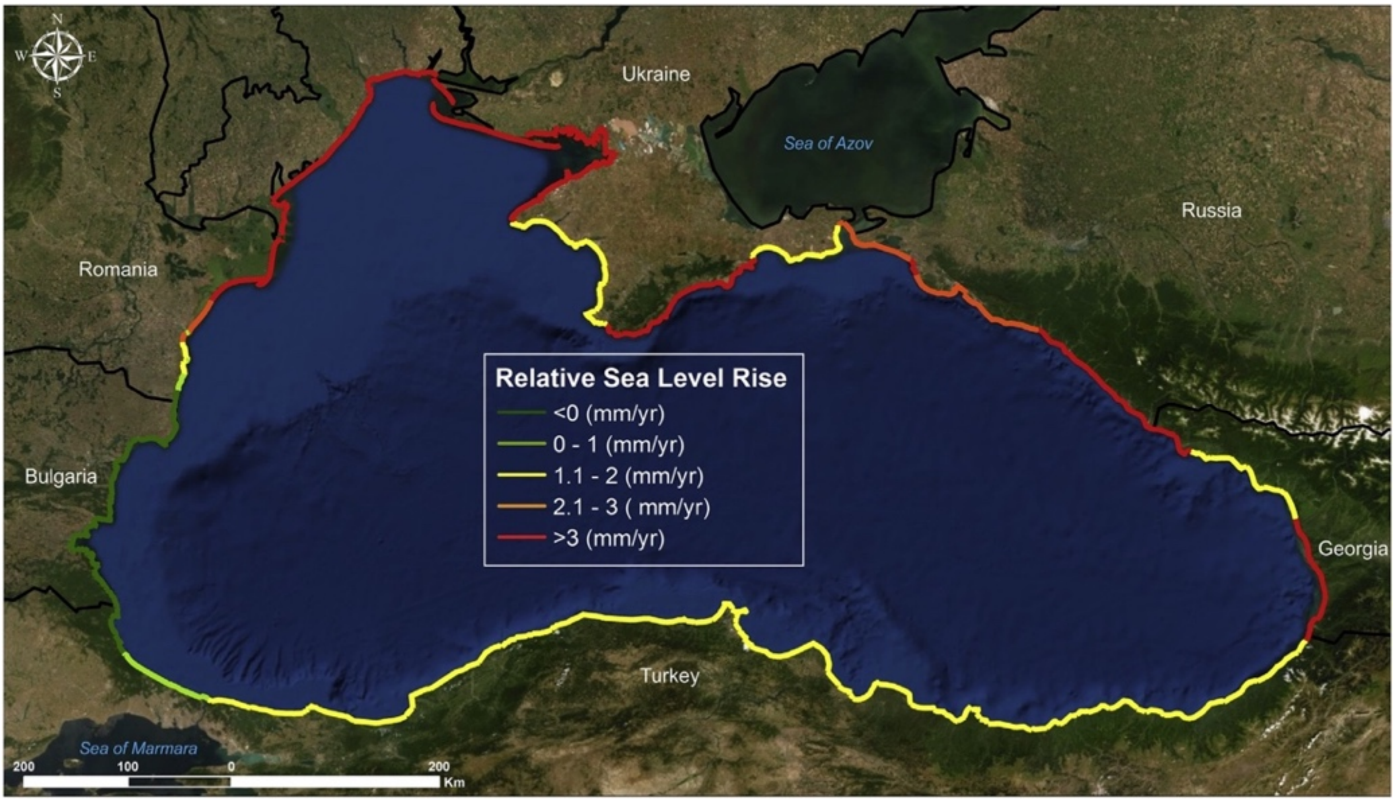
4.3. Cost of coastal erosion

Coastal erosion–like most environmental problems–occurs as a consequence of both natural and anthropogenic causes. Worldwide, 24 percent of coastal zones are eroding at rates exceeding 0.5 m per year (Luijendijk, 2018). If uncontrolled, ongoing coastline erosion leads to extensive damage of natural features and infrastructure, with severe economic repercussions, particularly in countries where most economic activity takes place close to the shoreline, such as in parts of coastal Georgia.

The coast of Georgia has suffered significantly from the ongoing use of beach deposits as construction material for infrastructure and buildings. It is estimated that more than 30 million m^3 of sand and gravel were removed from Georgian beaches between 1945 and 1965 (Zenkovich, 1987). This led to an extensive narrowing of Georgia's beaches, and in some cases, to the complete loss of beaches. For several years passive coastal protection interventions such as the construction of groynes on an as-needed basis were used to protect specific sectors of the coastline. This caused updrift sediment accumulation and down-drift erosion, leading to new erosion issues. Consequently, the length of Georgian coast eroded increased from 155 km in 1961, to 183 km in 1972, to 220 km in 1981. The situation got even more complicated as most rivers got dammed, leading to a sudden drop of sediments being naturally carried to the sea (Zenkovich, 1987).

The situation is expected to further deteriorate due to the effects of SLR. Batumi in particular is facing high risks, especially as it is already characterized by a high relative SLR, the third highest in the Black Sea area with 12.6 mm/year relative SLR (Figure 4).

Figure 4: Ranking of the relative SLR variable for the Black Sea coast



Source: Tatui, 2019

Without the necessary information, it was possible to undertake only a very high-level economic valuation of the annual COED attributable to coastal erosion. Annual costs are calculated based on dams and other barriers that cause the impounding of sediments carried by water flows[10] of the two rivers, for which specific and reliable data was provided by government authorities (the National Transport Agency, the Directorate for Environment of the Autonomous Republic of Adjara, and Khobi municipality), the Chorokhi river and the Enguri river.

With a natural unobstructed river flow, sediments from the two rivers would reach the coastline and replenish shores with a combined amount of 2,790,000m^3 of potential beach forming sediment per year. Only a fraction of this amount is effectively retained by the beach, as the rest is lost due to the presence of underwater canyons and wearing. Thus, the theoretical volume of effective beach forming sediments provided yearly by the Chorokhi and Enguri rivers is estimated to be 690,000 m^3 and 294,000 m^3, respectively. However, the presence of dams reduces the current volume of sediments supplied by the two rivers to 0 m^3/year and 78,000 m^3/year, respectively. The cost of sediment replacement along the coast is estimated based on volumes of yearly beach nourishments implemented at the Batumi coast and Anaklia coast, nearby Chorokhi and Enguri river mouths, and the opportunity costs of using necessary resources elsewhere in the coastal economy. The opportunity costs include nourishments of other coastal sites affected by erosion, based on the study by Berkun (2012) on the overall volume of sediments carried by remaining rivers. The estimated total cost of erosion is around $7 million annually, equivalent to 0.2 percent of the coastal GDP in 2017 (Table 8).

[10] There are three type of costs associated with sediments: (1) sediment deprivation caused by river barriers leading to erosion along the coast and subsequent cost for protection measures; (2) soil erosion in upper catchment areas causing sediment build up in reservoirs and additional cost for sediment dredging; and (3) topsoil erosion in the entire catchment area causing loss of productive land and additional cost for topsoil fertilization. As this study focuses on the COED of Georgia's coastal zone, estimates are based on sediment deprivation leading to coastal erosion.

Average sediment cost provided by local consultants is used to estimate the cost of environmental degradation for sediment deprivation due to the presence of dams along the Chorokhi and Enguri rivers, with the following assumptions: that yearly beach nourishments–used to calculate actual costs–are implemented using gravel; and that potential alternative uses of sediment volume– used to calculate opportunity costs– are implemented using half gravel and half sand. These costs amount to $ 3,219,000 and $996,000 for Chorokhi and Enguri rivers, respectively. The opportunity cost for all of coastal Georgia's remaining rivers were clustered in a single computation, with the following assumptions: that approximatively half of the rivers in coastal Georgia present dams obstructing the natural river flow; and that not all coastal areas are seeing the same development as in the Chorokhi and Enguri area. These costs amount to $2,465,000. The total cost therefore rises to about $7 million annually (2017 base year), or $12.6 on a per capita basis.

Extreme weather, SLR, and other climate change impacts can intensify coastal erosion. It is assumed that climate change will increase the volume of beach-forming sediments that should be naturally carried from the upstream portion of Georgia's rivers, mostly due to the retreat of glaciers, leading to additional sediments upstream of dams. However, the presence of old and new barriers (such as dams) in free-flowing rivers will prevent this material from reaching the seashore. In addition, climate change can drive the demand for new dams for irrigation and power generation, aggravating the deprivation of natural beach-forming sediments. Consequently, the total cost of environmental degradation due to sediment deprivation, which includes the opportunity cost of alternative use of volume used for artificial nourishment, is expected to increase. This is likely to be exacerbated by delayed development of tourism locations, which thrive on large sandy beaches.

Table 8: Estimated cost of coastal erosion, 2017

Coastal Erosion	
$, million	7.0
Equivalent to % of coastal GDP in 2017	0.35

Source: World Bank estimates

Vineyards, in a beautiful valley, a summer sunny day, a barn for storing the harvest.
Source: Shutterstock/photo by Solveig Filipenok.

Chapter 5. Agricultural Soil and Forest Degradation

5.1. Cost of agricultural soil degradation

Agriculture is the largest economic sector in Georgia both in terms of number of employees and land use. In 2017, 42 percent of the population lived in rural areas, and 43 percent were employed in rural, forestry and fish farming, which totaled 8 percent of the country's GDP (MEPA 2019). In Georgia, 40 percent of land is used for agriculture, with most of the agricultural lands (59 percent) dedicated to pastures, arable lands (6 percent), perennials (9 percent) and meadows (5 percent).

Nearly half of coastal Georgia's population derives some form of income from agricultural activities. This is predominantly the case in Zugdidi (25 percent), Khelvachauri (21 percent) and Kobuleti (18 percent) municipalities. Consequently, a large portion of the population is highly vulnerable to any event that affects the performance of the agricultural sector. The coastal zone features a variety of agricultural activities, including high value crops such as berries, kiwi, persimmon, and bay leaf, that are mainly exported to neighboring countries, such as Ukraine, Belarus, Russia, Kazakhstan and Armenia. Despite these commercial avenues, agriculture in the coastal zone is mostly dedicated to local consumption. As such, the yearly value of agricultural yield is difficult to estimate, except for the main commercial crops. About 90 percent of the production value derives from activities taking place in small-scale family operated agricultural holdings. In 2012 the average family holding had an area of 1.22 ha and was fragmented in two or three land parcels of an average size of 0.45 ha each. The areas are managed for subsistence farming, and when production is in excess of family needs, some yield is sold for income, but with little efficiency.

Unlike the rest of the country, the coastal zone's climate is humid and subtropical. The average temperature is about 14° to 15°C and annual rainfall averages between 1,500 millimeters and 2,500 millimeters. The mitigating effect of the Black Sea results in mild winters, hot summers, and relatively abundant and well distributed rainfall. Pluvial water and strong winds have a negative effect on topsoil, mostly via erosion and compaction of its micro-structure, which inhibits aeration, especially in sloped surfaces and grazing plots, already degraded through the overuse of cattle that puts unsustainable pressure on vegetative cover.

This report assesses the cost of soil degradation due to agricultural use impacting the long-term fertility of agricultural land. Using high-level cost estimate, an annual absolute land productivity loss of 1.15–2.3 percent was estimated at the national level, based on the combined use of the Revised Universal Soil Loss Equation (RUSLE) (Borrelli 2017) and the Modular Applied GeNeral Equilibrium Tool (MAGNET) (Woltjer and Kuiper 2014). The local market price ($1,575) is multiplied by the lower and upper bound land productivity loss at the national level and weighted by the land area of coastal municipalities, equivalent to 6.5 percent of the total land area of Georgia. The result shows a lower bound land productivity loss of $1,575 × 0.0115 × 0.065 = 1.17 million and an upper bound loss of 1,575 × 0.023 × 0.065 = 2.35 million (Table 9). The specific losses in 2017 for the three main commercial crops in the coastal municipalities (tea, hazelnuts and tangerines, according to the Georgian National Statistics Office data) weighed by the agricultural land proportions, amount to approximatively $0.7 million. This amount is included in the previous total estimate of $1.17–2.35 million.

Table 9: Estimated cost of agriculture soil degradation, 2017

Agricultural Soil Degradation	
$, million	1.17-2.35
Equivalent to % of coastal GDP in 2017	0.06-0.12

Source: World Bank estimates

5.2. Cost of forest degradation

For the forestry sector, costs attributable to forest degradation are estimated. Given the lack of pre-existing studies and data limitations, a high-level estimation was carried out. The main approach used to estimate the cost of forest degradation is a benefit transfer of value losses of forest ecosystem services based on the Adjara region. The Autonomous Republic of Adjara lies on the coast of the Black Sea with the highest forest cover in the coastal region of Georgia. The value of ecosystem services produced by forestry in Adjara was studied by Brander et al. (2016) under different degradation scenarios. The study obtains value estimates for fuel wood and non-timber forest products (NTFP) by combining geographical data of supply zones within a 5-km radius to villages with household surveys on provisioning services.

The approach of Brander et al. to model landslide regulation under each scenario involves various steps and data sources. They combine spatial data on land cover with a bio-physical model (InVEST) of sediment retention and export. The baseline data on sediment export is then combined with data on landslide damage frequency to houses in Adjara. Data on sediment export under each scenario is then fed into this function to predict changes in landslide damage frequency in each village under each scenario. The costs of predicted damages are estimated using data on average compensation payments. The estimation of damage costs from avoided landslide damage was computed by multiplying the number of houses damaged by the average government compensation payment to households that had suffered natural hazard damage during the period 2013–2015.

The simulation provides a difference in forested area between the business-as-usual scenario and the forest degradation scenario for 2035. This suggests a loss of 160,141 - 131,316 = 28,825 hectares over a period of 20 years between 2015 (date of the report data) and 2035. This implies an average yearly loss of 1,441 ha/year, or 0.5 percent/year of the total area of the Adjara region (288,000 ha) (Table 10). Brander et al. (2016) estimated the yearly losses of ecosystem services for the 2035[11] degradation scenario. These are separated into fuel wood losses ($412,548/year), non-timber forest products ($203,021/year) and landslide regulation ($655,758/year), for a total of $1,271,327/year. To obtain a hectare value, the total loss of ecosystem services is divided by the 1,441 ha lost to degradation per year, leading to $882/lost hectare of forest/year (Table 10).

Table 10: Value of forest ecosystem services for Adjara

Environmental Services	Degradation Cost, $/year
Fuel wood	412,548
NTFP	203,0210
Landslide regulation	655,758
Total	**1,271,327**
Value of forest loss per ha/year	*882*

Source: Brander et al. 2016

Translating the forest degradation cost to Georgia's coastal area, an annual cost of approximately $1.7 million is estimated. Assuming that 0.5 percent of the total coastal area (395,100 ha) is subject to forest loss per year (Brander, 2016), the yearly value of ecosystem service loss is obtained by multiplying the area of forest loss by the value of forest loss/ha/year: 395,100 ha/year × 0.005 × 882 $/ha = $1,742,000/year.

The cost of deforestation in 2017 in terms of forgone ecosystem services is approximated at $364,000. The loss of forest area in the eight coastal municipalities was obtained based on a 20-year average using the interactive land degradation map of the Ministry of Environment Protection and Agriculture of Georgia.[12] The total forest land cover loss in 2017 is approximated at 40 ha. Assuming an average rotation length of 28

[11] This report uses the 2015–2035 scenario as it provides a more appropriate time horizon (compared to the 2015–2020 scenario) to assess average yearly degradation. The rate of change was divided by the time window of 20 years to estimate an average yearly loss.

[12] https://atlas.mepa.gov.ge/maps/LandDegradationmap?l=en.

years, a 3 percent discount rate, and all forests were at mid-cycle when the loss occurred in 2017, accumulating the benefits over the remaining 13 years gives a present value of the loss of $9,108/ha. The total present value of the 40-ha loss due to deforestation in 2017 in terms of foregone ecosystem services is hence $9,108 × 40 =$364,314.

The sum of forest degradation and deforestation gives a lower bound estimate of $2.1 million in 2017, or approximately $3.8 per capita. This estimate is taken as the lower bound of the forestry sector. An upper bound estimate can be obtained starting from the values reported by De Groot et al. (2012). The study reports the value in Int.$/ha/year (2007) for provisioning, regulation, habitat and cultural services of various biomes. The temperate forest values of 3,013 Int.$/ha/year (2007), which is $2,271/ha/year (2017) is used. Scaling up this per hectare figure to the area of coastal municipalities loss under the forest degradation scenario used for 2035 by Brander et al. (2016), the following costs are obtained: 1,975.5ha × $2,271/ha/year = $4,485,410 for 2017, or $8.07 per capita. The value estimates are therefore associated with a large level of uncertainty, where the upper bound is more than twice the lower bound. This suggests that future studies should focus on narrowing down this large degree of uncertainty. While these upper bound values are reported for the purpose of illustrating the range of uncertainty surrounding these estimates, only lower bound values are used in the results.

Coastline protection work north of Batumi
Source: Sergio Vallesi. 2019

Chapter 6. Climate Change Impacts on the Coastal Zone

Climate change is expected to exacerbate the COED in coastal Georgia in the coming years, particularly impacting infrastructure, agriculture and tourism. The best practice to prepare for these impacts is to first develop what is known as a Climate Change Risk Assessment (CCRA). Following the CCRA format, the following risks would apply to Georgia (DEFRA, 2018):

Natural environment (includes forestry, agriculture, water availability and quality):

- Risks to species and habitats due to the inability to respond to changing climate conditions;
- Risks to agriculture, water quality and wildlife from flooding;
- Risks to soils from increased seasonal aridity and wetness and risks to natural carbon cycle;
- Risks of land management practices exacerbating flood risk;
- Risks to habitats in the coastal zone from SLR; and loss of natural flood protection.

Infrastructure (includes energy, transport and telecommunication sectors):

- Risks to infrastructure from river/surface/groundwater/coastal flooding and erosion;
- Interdependency risks to infrastructure asset management;
- Risks to transport networks from embankment and bridge failure;
- Risks to infrastructure from heavy rain, high winds, lightning, storms, and high waves.

People and the built environment (includes flood, and coastal erosion):

- Risks to health and wellbeing from high temperatures;
- Risks to people, communities and buildings from flooding;
- Risks to the viability of coastal communities from SLR;
- Risks to health and social care delivery from extreme weather.

Business and industry (includes tourism):

- Risks to business sites from flooding (people and built environment);
- Risks to business from loss of coastal locations/infrastructure (people and built environment);
- Risks to business from reduced productivity due to infrastructure/meteorological disruption.

According to Georgia's Third National Communication to UNFCC, several climate change statements and projections for Georgia confirm a number of high risks to Georgia's coastal zone imposed by climate change (MEPA 2015). Based on these projections, it is possible that the sectors that will be most impacted by climate change in the coming years are:

- Urban infrastructure mainly in the Anaklia, Zugdidi, Poti, and Batumi areas will be exposed to increased coastal zone floods and erosion (exacerbated by lack of sediment deposition from main rivers);
- Agriculture and forestry sectors will see higher vulnerability of crops and forest stands to diseases/pests from invasive species (due to increased temperatures and humidity) and higher soil erosion (due to increasing extreme events).

CZ-NAP provides some quantitative projections of warming and precipitation for the coastal zone, based on RegCM4 modelling. According to the model, minimal temperatures are going to rise in the whole country and so are maximal temperatures, but with lower intensity. In coastal zones, more specifically in Batumi and Poti, mean annual temperatures are expected to rise by 4.2 and 2.9° C, respectively, by 2071-2100. This is particularly significant for the city of Batumi, which is expected to reach an average annual temperature of 19.4° C by 2100. These findings are consistent with international projections, which forecast that Georgia's mean annual temperature will rise by 2.5° C in 2050.[13]

[13] https://climateknowledgeportal.worldbank.org/country/georgia/climate-data-projections.

As for precipitation, RegCM4 shows that annual precipitation growth is expected to continue in West Georgia until 2050, but subsequently it is likely to decline, except in the Adjara coastal zone. The number of days with extremely abundant precipitation and the duration of periods with and without precipitation is likely to increase in West Georgia's lowlands. These factors are expected to increase the risk of flash floods, floods, and waterlogging. A further aggravation is expected due to faster melting of glaciers, which would lead to an increase of Glacial Lake Outburst Floods (GLOF) and extreme river peak flows, which are already a matter of concern. While the largest glaciers are in the mountains outside of Georgia, the local effect of melting is expected in Georgia's lowland areas. This also makes management of existing and planned dams a critical matter for the country. To capture the overall impacts of climate change on the coast, a study should use projections of impacts on a much longer time horizon (e.g., 30–50 years).

In order to provide a qualitative assessment of the effect of climate change on COED estimates of this report, an aggravating factor was estimated for each category, assuming the continuation of current government efforts (Table 11). In the absence of proactive investments, deterioration of water quality will likely increase with climate change, due to higher temperatures and the higher frequency of rain and floods. In the presence of higher temperature and stronger rainfall, it can be expected that the impact of pollution from waste increases. However, this should be moderated by the improved waste disposal and waste treatment practices to which the government has already committed. The risk of coastal flooding is expected to increase due to an intensification of SLR, socio-economic developments, and ground subsidence. In terms of fluvial and pluvial floods, damage is also likely to escalate as the number of days with extreme precipitation and the duration of periods with and without precipitation increase.

Table 11: Qualitative assessment of climate change

Category	Change
Water pollution	++
Solid waste disposal	-
Fluvial flooding	++
Coastal flooding	++
Coastal erosion	+++
Agricultural soil degradation	++
Forest degradation	++
Global impact from CO_2 emission	+

Note: + increased cost, - decreased cost
Source: World Bank estimates. Based on consultation with local experts and stakeholders during a workshop held in Georgia in February 2020.

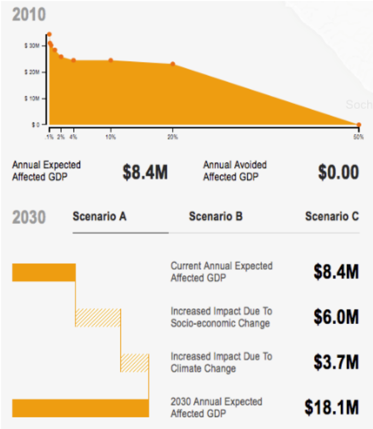
For fluvial floods, an example for a first level of approximation is provided for Zugdidi municipality (Table 12). The scenario analysis is based on numbers from the Aqueduct analyzer,[14] and assumes an unchanged protection level. In terms of coastal zone erosion, it is assumed that climate change will increase the volume of beach-forming sediments that should naturally be carried from the upstream portion of Georgia's rivers, mostly due to the retreat of glaciers, leading to additional availability of sediments upstream of dams. However, old and new barriers (such as green and grey infrastructure) to free flow of water will prevent this material from reaching the seashore. Furthermore, it is assumed that climate change will drive further demand for flood protection and climate resilience for agriculture and power generation sectors, leading to an increase in the deprivation of beach-forming sediments. Consequently, the total cost from environmental degradation due to sediment deprivation, which includes the opportunity cost of alternative use of volume used for artificial nourishment, is expected to significantly increase. This is likely to be exacerbated by the delayed development of tourism areas, which thrive on large sandy beaches.

[14] https://floods.wri.org.

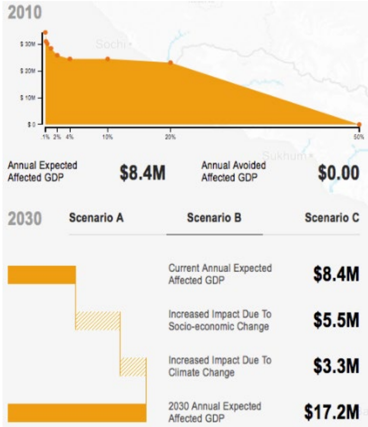
Table 12: Scenario outputs from impact analyzer

Affected GDP

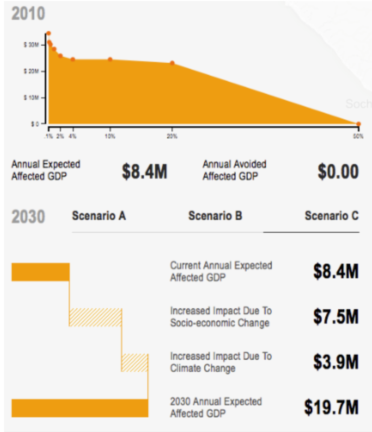
Scenario A



Scenario B



Scenario C



Source: https://floods.wri.org
Note: Scenarios A, B, and C refer to a moderate, intermediate, and severe climate change outlook, respectively.

The analysis highlights the need for integrated planning and management of existing and yet-to-be-built grey and green infrastructure (specifically to ensure bypass of sediments). An integrated management plan could reduce the impact of floods on Georgia's coastal zone, while ensuring the availability of sufficient volumes of material for artificial nourishments and infrastructure construction.

Batumi, Adjara, Georgia

Chapter 7. Conclusion and Recommendations

The economic cost of degradation in the eight coastal municipalities of Georgia is equivalent to 5 percent of the GDP produced in the coastal zone in 2017. The cost of coastal degradation is associated with pollution, floods, coastal erosion, agricultural soil and forest degradation. People residing on the coastline are directly affected by coastal degradation that reduces land and agricultural topsoil and damages dwellings and commercial buildings.

Comparing the economic cost of degradation with other countries of similar development to Georgia is difficult, given the use of different methodologies and the difference in data availability and accuracy. However, some comparisons with the World Bank report Croatia: *Cost of Environmental Degradation* (forthcoming) and the World Bank report *The Cost of Coastal Zone Degradation in West Africa* (Croitoru et al. 2019) are made. Suboptimal planning of waste management, including insufficient separate collection and low recycling rates of municipal waste, costs Croatia about $40 million in 2018[15] equivalent to 0.06 percent of Croatia's GDP. In comparison, property value loss in Georgia's coastal municipalities–due to their proximity to regulated and unregulated landfills–is equivalent to $2.5 million in 2017, equivalent to 0.13 percent of the region's GDP. The cost of flooding in the coastal zone of West Africa (Benin Côte d'Ivoire, Senegal and Togo) is estimated at 2.1 percent of the region's GDP, while coastal erosion cost is approximated at 1.4 percent of the region's GDP. Compared to Georgia's coast, with cost equivalent to 2.8 percent of the region's GDP and 0.35 percent, respectively, the annual cost of flooding is higher and could increase further due to climate change impacts.

The current COVID-19 pandemic presents various economic implications, as well as impacts on environmental governance. The assessment of the potential COVID-19 impact on the environment is complex. While some impacts, such as less carbon emissions and cleaner air, are said to be positive, others are negative, including increased plastic waste due to higher use of masks and food containers. As the consequences of the crisis escalate, public expenditure might be redirected towards other priorities, especially in the medical sector. This will most probably result in reduced funding for environmental activities, including investments in reducing environmental degradation and addressing climate vulnerabilities. The major threat is related to increased investments in cheaper polluting technologies which have long-term negative environmental effects and could impact the future COED. As expenditures for defensive measures decrease, it is expected that future COED may be higher as a result of the reduced protective level against existing and new vulnerabilities.

Climate change and increased variability characterized by rising sea levels and more frequent and violent storms push COED upwards. Coastal flood risk and degradation are expected to increase due to the intensification of SLR, socio-economic developments and ground subsidence. In terms of fluvial and pluvial floods, damages are likely to grow as the number of days with extreme precipitation and the duration of periods with and without precipitation increases. In terms of coastal zone erosion, it is assumed that climate change will increase the volume of beach-forming sediments that should be naturally carried from the upstream portion of Georgia's rivers, mostly due to the retreat of glaciers, leading to additional availability of sediments upstream of dams.

A targeted response to environmental degradation is needed in order to address the multiple challenges Georgia's coastal ecosystems face. The Government's primary goal should be to reduce the negative impact of natural hazards on human health and ecosystems, specifically related to flooding in Western Georgia, as well as minimizing economic losses. Government resources need to be directed to improve the climate change planning process for coastal Georgia, with a focus on mainstream risk management from extreme weather events, including hazard identification, risk assessment/analysis, and modern prevention and monitoring systems. The high cost of pollution in Georgia's coastal zone made the country an important stakeholder in the new Blueing the Black Sea (BBSEA) regional program funded by PROBLUE and Global

[15] Cost are estimated based on reduction of real estate values near active landfills using benefit transfer from hedonic studies.

Environment Facility (GEF), under which a pollution diagnostic for the coastal zone of Georgia will be carried out.

The World Bank report *Georgia: Towards Green and Resilient Growth* (2020) includes the cost of coastal zone degradation as a further justification of broader actions to reduce the current environmental damages and strengthen Georgia's coastal resilience. The report discusses a coastal zone development program to improve climate resilience and reduce COED. A "climate resilient" coastal zone development program would consist of targeted investments that support flood and other natural hazard management and mitigation, as well as prevention of coastal erosion, landscape restoration and waste management. The key reference point for designing such investment programs would be the National Action Plan for Adapting to Impacts of Climate Change in the Coastal Zone of Georgia (CZ-NAP) developed with the assistance from the Nationally Defined Contribution Support Facility (NDC SF). The estimated investment needs of the coastal area adaptation program are about $600 million.

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