

# *Georgia: Economy-wide Effects of Adaptation in Tourism and Road Infrastructure*

## **Applying the e3.ge Macro-econometric Model to the Cases of (Re-)constructing Coastline Protection and Constructing Climate Resilient Roads and Bridges**

### Executive summary

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Climate is one of Georgia's main competitive advantages for tourism (see USAID 2016). However, tourism activities are directly related to weather conditions, e.g., temperatures, precipitation, sea turbulence, the stability of beaches (see The World Bank 2020). Moreover, tourism is sensitive to all risks of climate change that may affect urban infrastructure, communications, utilities, and coast protection infrastructure (see UNDP 2013). Thus, **climate change negatively impacts the economic and social welfare and increases both sector and economy development risks.**

The alignment of economic development planning with climate resilient sector strategies like the Georgian Tourism Development Strategy is important. Several options exist for adapting to climate change that are relevant for both infrastructure and tourism. The adaptation measures can reduce the costs and risks induced by climate change and provide benefits not only to the tourism sector but to the whole economy. **A macro-economic analysis of such adaptation measures evaluates the economy-wide effects and allows to identify those measures with the highest positive effects on the economy.**

The analysis of two adaptation measures – (re-)construction of coastline protection and construction of climate resilient roads and bridges – in this policy brief illustrates that **investments in adaptation provide co-benefits**: Damages from climate change can be reduced, tourism flows increase and several industries benefit (e.g., accommodation, restaurants, transport). The domestic economy benefits from an increased domestic production, which also creates additional jobs. **The investment in (re-)construction of coastline protection could lead to a GDP increase by up to 0.2 % and more than 1,200 additional jobs p.a.**

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MINISTRY OF ECONOMY  
AND SUSTAINABLE  
DEVELOPMENT  
OF GEORGIA

In cooperation with:

**GLIS** SPECIALISTS IN  
EMPIRICAL ECONOMIC  
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## Current situation in tourism and infrastructure

Tourism is one of the priority sectors of the national economy and one of the fastest-growing industries in Georgia (at least before the Coronavirus disease (COVID-19) pandemic) (see *USAID 2016*). During the past decade, Georgia's tourism industry has increased on average by more than 12.8 % per year (see *TBC 2019*). Between 2009 and 2016, the tourism growth was one of the fastest globally (see *The World Bank 2018*). The international visitors contributed to the consumption in several economic sectors, namely accommodation (84 % contribution in spending in 2018), food and beverages (20 %), culture and entertainment (51 %), and transportation (16%) (see *TBC 2019* and *TBC 2020*). Tourism revenues to GDP was 21.6 % in 2019, out of which 18.7 % is international tourism revenues and domestic tourism revenues is 2.9 % (see *Geostat and NBG 2021*).

The number of international visits peaks in summer. Furthermore, the geographic location and the fact, that Georgia is located in different climate zones, also provide the possibility for winter tourism, which is still developing, but already today provides a comparative balance between summer and winter (see *TBC 2019*). The country strives for becoming a four-season touristic destination by offering appropriate activities (e.g., hiking, climbing, cycling, wine tasting, skiing etc.) (see *CZ-NAP 2020*).

Prior to the COVID-19 pandemic, strong growth was forecasted for the tourism sector. However, the severe travel restrictions during the global pandemic have made tourism one of the most affected economic sectors worldwide. In addition to that, further challenges for tourism arise from climate change. Tourism is also sensitive to all risks of climate change that may affect urban infrastructure, communications, utilities, and coastal protection infrastructure (see *UNDP 2013*).

## Impacts of climate change on tourism and infrastructure

Tourism activities are directly related to climate and weather conditions, e.g., temperatures, precipitation, sea turbulence, the stability of beaches and the number and seasonal distribution of sunny days (see *The World Bank 2020*). The characteristics of the destination are important so that the visitors and tourists can relax and enjoy their holidays (see *CZ-NAP 2020*).

Furthermore, climate change impacts tourist assets, including infrastructure, tourist attractions, and transportation systems. Thus, several threats from climate change may arise, such as the flooding of streets, power outages, failure of cooling systems, damaged roads, interruption of the provision of water, malfunctioning of wastewater (see *The World Bank 2020*). While these threats directly have an impact on the infrastructure, they also influence tourism in Georgia, since the industry depends on a well-developed and functioning infrastructure. Moreover, damaged infrastructure can implicate further economic effects, as supply chains may be disrupted, industrial buildings may be damaged, and production losses and disruptions may occur.

Climate change is about to cause an increasing severity of storms, warmer temperatures in summer, a loss in biodiversity, a decline in water quality, and increased disease outbreaks (see *The World Bank 2020*). In addition, the frequency and severity of extreme weather events are about to increase in the future. Besides these risks of climate change, tourism in Georgia could also profit from some opportunities. The summer season of seaside tourism may extend due to the forecasted increase in air temperature, accompanied with warming of sea water, decreasing precipitation and an increasing number of sunny days (see *CZ-NAP 2020* and *The World Bank 2020*).

## Options for adaptation in tourism and infrastructure

The aim of adaptation to climate change in tourism is to maintain the tourist attractiveness of a destination even under the future climate risks and conditions. Climate resilient infrastructure is crucial to ensuring that. Several options exist to adapt tourism and infrastructure to climate change. While the improvement and building of climate resilient infrastructure account for structural building activities, also softer measures such as information campaigns and warning systems can serve to adapt to climate change impacts in the tourism sector. Thus, adaptation measures can be grouped into two categories: 1) structural adaptation measures (e.g., changing the composition of road surfaces so that they are resilient to high temperatures, building seawalls etc.) and 2) management adaptation measures (e.g., early warning systems, insurances, monitoring of existing assets) (see *OECD 2018*).

Infrastructure relevant for tourism needs to be adapted to climate change. Already existing facilities like accommodation, utilities, roads, beaches etc. should be maintained and retrofitted by adaptation activities to make them climate resilient. New infrastructure assets should be built and operated to account for the climate change that may occur over their lifetimes (see *OECD 2018*). To do so, buildings and infrastructure need to be less exposed to the natural hazards and risks, e.g., by establishing new building standards, a beach and dune nourishment, and setbacks in the coastal development (see *The World Bank 2020*). The structural stabilization of the shoreline is one major adaptation measure to adapt to the coastline erosion. This infrastructure for stabilization could include both traditional infrastructure, such as hard defences, and natural infrastructure, such as wetlands and other nature-based solutions (see *OECD 2018*). The construction and development of new infrastructural facilities must be located at places recommended by the coastal protection service. Further adaptation measures increase human safety, healthy ecosystems, diversified livelihoods and planning (see *The World Bank 2020*). The establishment of a monitoring system to analyse future climate impacts as well as the establishment of a warning system are possible further adaptation measures. Planning and capacity building that address specific local needs increase the ability to respond to the effects of extreme weather events (see *The World Bank 2020*).

Adaptation could also lead to co-benefits regarding social and environmental aspects, e.g., by using green infrastructure. Ecosystem-based (or “green”) approaches can provide an effective complement or substitute for traditional built (or “grey”) infrastructure, providing on-the-ground climate adaptation and providing environmental benefits (see *OECD 2018* and *The World Bank 2020*).

## Macroeconomic analysis of adaptation measures

A macro-econometric simulation model for Georgia has been developed to analyse the overall macroeconomic impacts of climate change and sector-specific adaptation measures. This so-called e3.ge model (economy, energy, environment; Georgia) considers also indirect and induced effects of adaptation measures. It helps identifying those adaptation measures that have positive effects on the economy, employment, and environment. From an economic point of view, these measures should be considered first when setting up an adaptation strategy in Georgia.

For the purpose of this analysis, different scenarios are developed. A scenario is a consistent set of assumptions about the future development of certain characteristic model quantities. The model results do not only show the direct effects but also the macro-economic consequences for Georgia due to the economic interrelationships in the model. The results contribute to raising the awareness for climate change and respective options for adaptation. They can also be used as a decision-making basis for prioritizing adaptation measures.

In the following, the **(re-)construction of coastline protection** and the **construction of climate resilient roads and bridges** will be analysed in more detail. Both types of measures impact tourism as well as several other economic sectors. Against the background of impending climate change, they are currently being discussed in Georgia and considered as important measures to strengthen tourism and to make infrastructure more climate resilient.



## (Re-)construction of coastline protection

Climate change will impact tourism flows as well as respective activities and therefore needs to be considered when creating adaptation strategies and national action plans related to the tourism industry (see CZ-NAP 2020). Erosion of seacoast and sea-level rise are the most manifested impacts of climate change. Adaptation to these impacts is one of the most resource-intensive interventions. To retain the commercially important beaches and to protect the infrastructure located on the coastline, it needs to be stabilized (see CZ-NAP 2020), e.g., by (re-)construction measures. The selection of suitable adaptation measures depends on technical effectiveness, costs, expected benefits, and implementation characteristics (see *The World Bank 2020*). In the following, the economic effects of coastline protection on the tourism flows are analyzed exemplarily. However, sea-level rise also has an impact on assets and infrastructure, which can only be evaluated if the hazards are analyzed spatially and temporally in detail. Furthermore, the possible loss of valuable ecosystems through coastline protection needs to be evaluated, yet this goes beyond the scope of this analysis.

## Implementation and assumptions

The effects of climate change on the consumption of all goods and services demanded by tourists need to be implemented in the economic model to take climate change impacts into account. These goods and services are for example accommodation and foods service activities, transportation services, arts and entertainment services. Table 1 summarizes the average annual impacts of climate change on tourism expenditures for different European regions as calculated in the PESETA<sup>1</sup> project. Assuming the same climate conditions as in Southern European countries, Georgia could be faced with an average annual decrease in tourism expenditures of 11 % in the distant future (2071 – 2100). It is assumed that the climate conditions will change up to then to such an extent that there will be a linear increase in the impact of climate change on the tourism expenditures from the beginning of 2025, resulting in an impact of climate change on tourism expenditures of 11.5 % in 2070. Despite the reduction in tourism expenditures due to climate change, the respective economic sectors continue to grow, but with reduced growth rates compared to the baseline.

According to the results of the e3.ge model, climate change could lower the tourism revenues by up to 1 % of GDP per year in Georgia. The demand decrease of tourists leads to changes in demands for intermediate goods from the respective industries and services, and thus to demand changes throughout the economy. The results are in line with the results of Barrios and Ibañez (2013), who conclude a decrease in tourism revenues by up to 0.45 % of GDP for the Southern EU Mediterranean countries in the years 2071 to 2100.

**Table 1:** Impact of climate change on tourism expenditures (average annual changes in %, 2071 – 2100, 2° scenario)

IMPACT OF CLIMATE CHANGE ON TOURISM EXPENDITURES						
	EU	Northern Europe	UK & Ireland	Central Europe North	Central Europe South	Southern Europe
Changes in tourism expenditures	-5 %	-1 %	0 %	-4 %	-5 %	-11 %

Source: Ciscar et al. (2014)

<sup>1</sup>Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis



Accordingly, this result highlights once again the importance of tourism for the Georgian economy and the need to take climate change and adaptation into account when planning the future policy strategies. Likewise, Vousdoukas et al. (2020) conclude for Europe that applying adaptation for coastal protection along the European coastline would still result in losses from coastal flooding, but these losses could be significantly reduced. In addition, the number of people affected by floods in Europe can be reduced.

However, it is important to acknowledge that tourism flows are not a one-dimensional decision based only upon climate. Instead, they depend on multiple factors such as political system and stability in the respective destination country and its neighbouring countries, infrastructure, possible activities etc. Accordingly, an analysis to determine the impacts of an adaptation measure to climate change is associated with high degrees of uncertainty. The investment in the construction of coastline protection measures leads to additional construction activities and a reduction in the

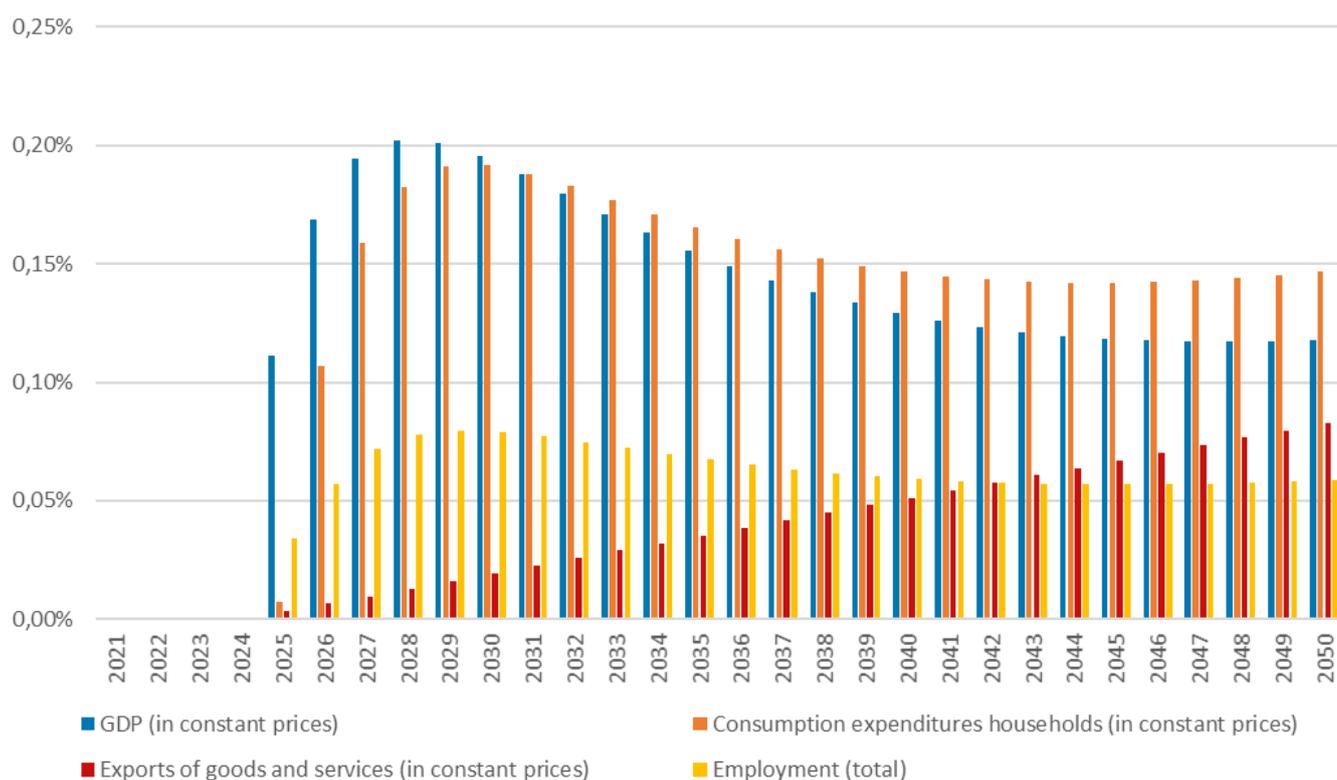
decrease in tourism-related consumption expenditures both of domestic and foreign visitors. Since each construction measure to protect the coastline needs to be planned and carried out individually, the cost estimate cannot be generalized. Beginning in 2025, an annual investment of GEL 100 million is assumed, reducing the loss of tourism flows by additional 0.025 % p.a.

### Results

The overall economic effects of the adaptation measure **(Re-)construction of coastline protection are positive**. Figure 1 shows the economic effects of implementing coastline protection in the e3.ge model on the components of GDP. The figure shows the relative differences between a scenario with adaptation and climate change and a scenario with climate change only.

Figure 1: (Re-)construction of coastline protection – Economic effects of the adaptation measure on components of GDP and Employment

#### LONG-TERM ECONOMIC BENEFITS OF ADAPTATION



Source: own figure

GDP increases by up to over 0.2 % against the baseline (see [Figure 1](#)). The annual investment in construction of coastline protection has a positive effect on GDP. The additional construction work also calls for additional intermediate goods necessary to build the coastline protection. Compared to the baseline scenario with climate change only, the consumption expenditures of tourists increase due to the adaptation measure, because more people are visiting the country. The positive effects in tourism and construction result in additional positive effects on consumption and investment, which in turn also have a positive impact on other economic sectors and thus on the GDP. In total, the consumption expenditures of households increase by up to 0.19 % in a single year and the exports of goods and services increase by up to 0.08 % (see [Figure 1](#)). Production is increasing not only in the construction and tourism related economic sectors but also in those sectors delivering inputs to these sectors, resulting also in higher employment and more people having higher wages (e.g., on disposal for additional consumption purposes). Up to 1,200 additional people can be employed. This corresponds to an annual increase of up to 0.08 % (see [Figure 1](#)). Analogous to the effects mentioned above, this additional employment takes place in different economic sectors: construction, tourism related sectors and the supplying sectors. Since the model assumes an increasing productivity in the respective economic sectors, the additional employment decreases over time but remains clearly positive.

## Climate resilient roads and bridges

Georgia's transport infrastructure is of low quality (see *OECD 2021*). According to *OECD (2021)*, transport projects with an investment volume of more than USD 10 billion are currently being implemented to modernize the transport infrastructure: the investments consist primarily of roads (around USD 6.6 billion) and port projects (USD 2.5 billion), while investments in railways (USD 2.1 billion) and intermodal projects are comparatively smaller (USD 83 million). The Government of Georgia has made the maintenance of existing road systems a high priority on its agenda (see *OECD 2021*). Several risks related to climate change exist which also impact infrastructure: an increased intensity of rainfall could lead to flooding and consequently to erosion of road and railroad foundations, and higher temperatures and heatwaves could lead to a higher deterioration of roads (see *CZ-NAP 2020*). Thus, not only infrastructure is vulnerable to climate change, but also economic activities based on it are therefore vulnerable to the failure and disruption of this infrastructure. Accordingly, the economic effects can be manifold, ranging from interruption of production processes due to delay in the supply chain to decreasing flows of tourists. By reinforcing and updating road infrastructure, roads and bridges could be built more resilient to climate change impacts and thereby the negative impacts of damaged infrastructure could be reduced. However, while sea level rise is relevant for infrastructure situated close the coastline, extreme weather events (e.g., heavy precipitation) can occur locally, thus infrastructure is affected to a different degree in each case.



### Implementation and assumptions

In addition to tourism related impacts of climate change mentioned above, the effects of heavy precipitation are being integrated in the e3.ge model. On the night of 13-14 June 2015, intense rainfall resulted in a flash flood, which affected the Georgian capital Tbilisi (see *GFDRR et al. 2015*). The economic impact was high, with transportation being the most affected sector. The estimated cost of damage to transport was GEL 33.2 million, the damages to houses were GEL 16.1 million. Moreover, the zoo and the water management were affected. A loss of production activity in different sectors is being assumed. These damages are considered as benchmarks and are entered into the e3.ge model at a frequency of 10 years in order to calculate the economic effects of heavy precipitation.

In addition to the reduction in tourism revenues, heavy precipitation causes negative GDP effects in the years with an extreme event. These additional negative impacts are caused by production losses due to heavy precipitation, which cause additional imports. The overall decreasing production has a negative impact on employment. In years with an extreme precipitation event, climate change could lower GDP by 1.4 %.

To analyse the macro-economic effects of the adaptation measure **construction of climate resilient roads and bridges**, information on the costs and benefits of the respective measure is needed. *GFDRR et al. (2015)* provides information on the cost to not just rebuild the damaged assets, but to build them back better (BBB<sup>2</sup>). These additional needs can be used as a benchmark for costs of the adaptation of roads and bridges for the evaluation of the macro-economic effects. As an assumption, GEL 50 million p.a. will be invested in climate resilient roads and bridges. To do so, the adaptation measure is financed by the government and public spending is reduced elsewhere.

Again, there is a high degree of uncertainty associated with estimating the benefits of the respective adaptation measure. While climate resilient roads may increase the tourism expenditures, they may also cause a reduced level of damages in years with an extreme event because they are able to better drain water. Thus, the benefits can only be estimated by assumption.

**Table 2:** Road damage and reconstruction costs of a number of Georgian roads (millions of GEL)

ROAD DAMAGE AND RECONSTRUCTION COSTS			
Roads	Damage	BBB needs <sup>2</sup>	Reconstruction
Chabua Amirejibi H'way	17	5	= 22
Bagebi-Tskhneti Road	2	5	= 7
Tbilisi roads affected by floods	8	12	= 20
Tskhneti-Akhaldaba Road	4	11	= 15
Protective works along the Vere River's embankments	1	9	= 10
<b>Total</b>	<b>33.2</b>	<b>42</b>	<b>= 75.2</b>

Source: GFDR et al. (2015)

<sup>2</sup>Building Back Better(BBB) is a strategy aimed at reducing the risk to the people and communities in the wake of future disasters and shocks. The BBB approach integrates disaster risk reduction measures into the restoration of physical infrastructure, social systems and shelter, and the revitalization of livelihoods, economies and the environment.



## Results

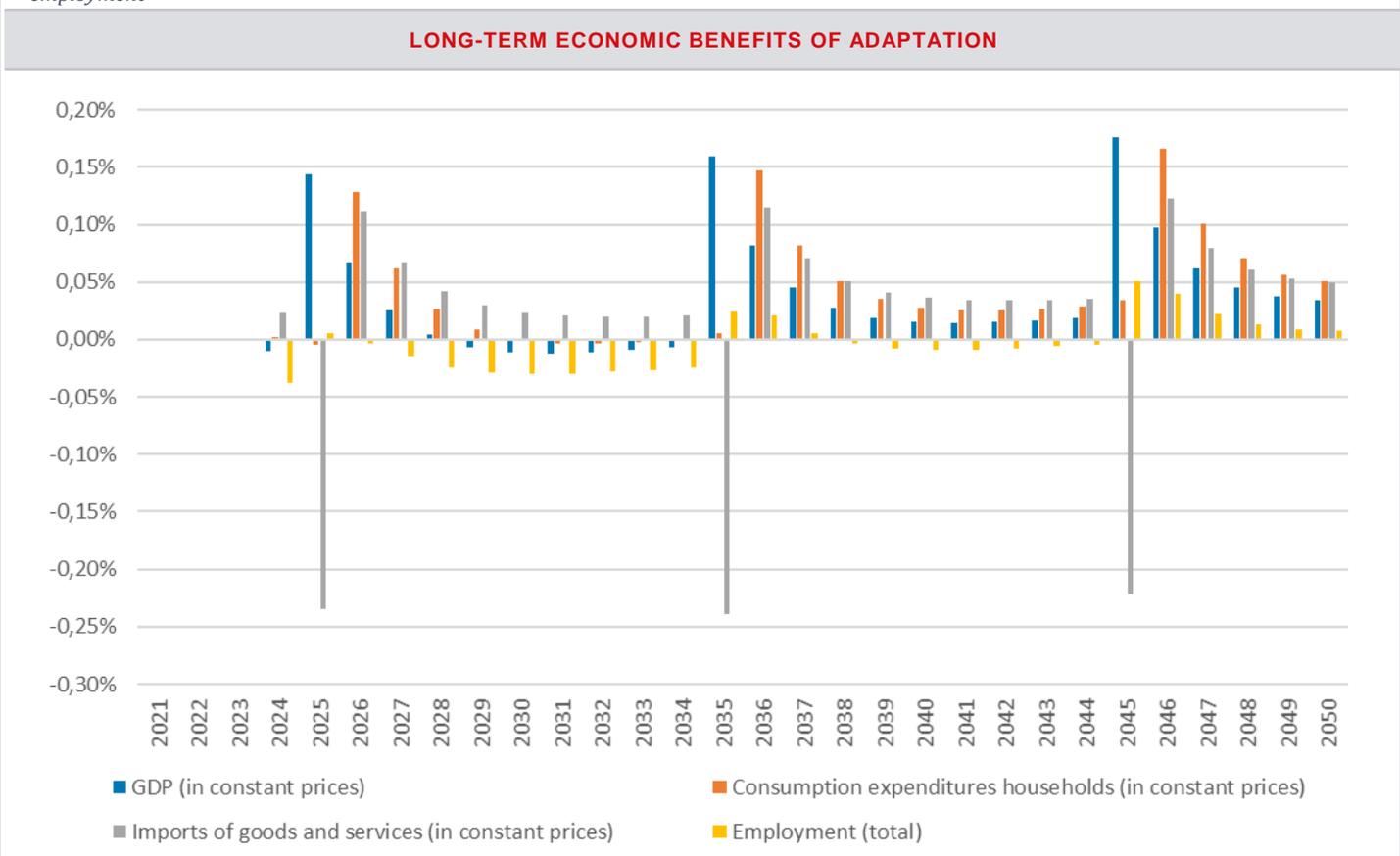
The overall economic effects of the adaptation measure **construction of climate resilient roads and bridges are mainly positive**. Figure 2 shows the economic effects of implementing climate resilient roads and bridges in the e3.ge model on the components of GDP. The figure shows the relative differences between a scenario with adaptation and climate change and a scenario with climate change only.

The GDP increases by up to 0.17 % in a single year in the period under review (see Figure 2). The annual investment in construction of roads and bridges has a positive effect on the GDP. Depending on the assumption, other government consumption expenditures may be redirected to finance the additional construction investments. In the years 2025, 2035 and 2045, the higher production activity and reduced damages to transport infrastructure both cause a positive GDP effect compared to the scenario without adaptation. Thus, the imports of goods and services are reduced by more than 0.2 % in the respective years

(see Figure 2). The positive impact on the GDP causes a reaction in consumption and investment, which is also positive. Due to the modern road infrastructure, more tourists visit the country.

Thus, compared to the scenario with only climate change, a positive GDP effect is being generated from the higher level of consumption expenditures of tourists and higher exports. Once again, this positive GDP effect causes additional consumption and investment in the following years. Assuming that government consumption expenditure is reduced to finance the additional investment in construction, the overall effect on the GDP and employment is negative at the beginning of the period under review. In the more distant future, more and more roads and bridges will be designed to be climate resilient, so that the positive impacts on GDP and employment will increase over time. Up to 1,000 additional people could be employed.

**Figure 2. Construction of climate resilient roads and bridges – Economic effects of the adaptation measure: components of GDP and employment**



Source: own figure



## Key messages

The consequences of climate change are already noticeable and will become more frequent and more severe. Both sectors, tourism and infrastructure, are vulnerable to climate change. More needs to be done to adapt to climate change, since coastline protection alone cannot stop the potential loss of tourists and damages to assets and infrastructure caused by sea level rise. Furthermore, the construction of climate resilient roads and bridges may have an impact on tourism flows and may reduce the expected damages from heavy precipitation. However, the quantification of this correlation is very complex and associated with a high degree of uncertainty. Thus, the overall negative impacts of climate change on tourism can only be reduced, but not eliminated with these single adaptation measures.

- **The results of the scenario analysis with the e3.ge model provide an economic evaluation of different adaptation measures.** These results are subject to several uncertainties due to the nature of climate change and the current limited knowledge. They can serve as a starting point for the development of an adaptation strategy. They should raise the awareness and illustrate how the economy in Georgia is developing under the effects of climate change and what the economic benefits of adaptation to climate change are.
- **Both adaptation measures analyzed with the e3.ge model show that investments in adaptation provide co-benefits:** not only can the **damages in years with climate change effects be reduced**, but also the **flow of tourists in every year could be increased and several industries benefit** compared to a scenario with no adaptation. The **domestic economy gets positive impacts resulting from an increased domestic production, which in turn calls for additional jobs**. Other adaptation measures may add up to this and can further enhance these positive effects.
- **Financing of adaptation measures through international funds was not assumed.** Given the promises of the industrialized countries to support climate protection measures such as adaptation measures with USD 100 billion per year in the future, the prospects for (partial) funding of the measures are good. In this case, **the macroeconomic effects of the measures would be even better.**
- Although the financial and economic impacts are relevant for policymakers to prioritize adaptation measures, other criteria must be considered as well such as health aspects and ecosystem services (biodiversity, regulation of the water balance) to get a more comprehensive evaluation of a measure, and to formulate an appropriate adaptation strategy. The economic effects should only be one possible basis for decisions on the selection of adaptation measures in Georgia.



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Current data used and basic assumptions behind are mostly up to date for the current project time being period under which study was conducted. Further contextualization and expansion of the results of the scenario analysis and economic evaluation of different adaptation measures presented should be respectively coordinated with the Ministry of Economy and Sustainable Development of Georgia (MoESD).

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