# Kazakhstan | Impacts of Climate Change and Adaptation in Agriculture I

Find the underlying analysis in the sectoral policy brief "Kazakhstan: Economy-wide Effects of Adaptation in Agriculture" and in the report "Supporting climate resilient economic development in Kazakhstan"

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's agriculture is vulnerable to climate change

**Lower pasture productivity** and **livestock production** may result from **droughts** and **heatwaves.**

**Wheat yield losses** induced by water scarcity can be a consequence of **droughts** and **heatwaves.**

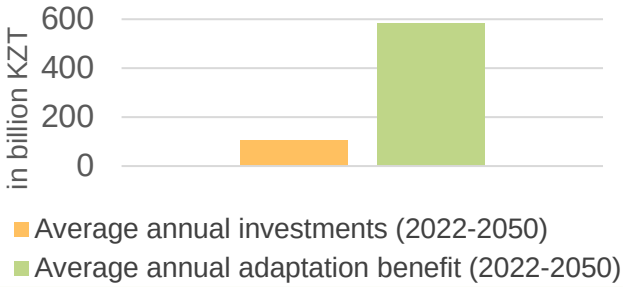
The **productivity of people working outside** as e.g. in the agriculture sector may decrease during **heatwaves**.

Negative impacts on agriculture can lead to **lower growth in other sectors, GDP** and **employment.**

## Exemplary adaptation measure for reducing vulnerability to droughts: Irrigation Systems

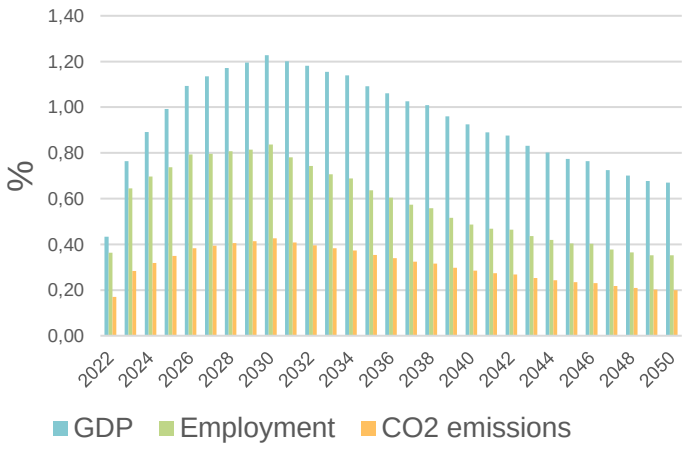
Rehabilitating and expanding the water infrastructure and the use of water-efficient drip **irrigation systems** are key responses to reduce water scarcity and to improve agricultural productivity. The irrigated area could be increased by one million hectares without a significant increase in water consumption (Kazakh Government, 2020).

**Costs and benefits of investments in drip irrigation & reconstruction of canals and reservoirs**




## Economy-wide impacts of investments in irrigation systems

**Economy-wide impacts of irrigations measures (SCCA compared to SCC)**




Macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation measures.

→ Investments in the agricultural water infrastructure result per year in a maximum **1.2% higher GDP (resp. KZT 833 bn.)** and **up to 0.8% higher employment corresponding to up to 78,000 additional jobs** (SCCA compared to SCC).

→ Investments in **irrigation systems increase agricultural output – also in years without droughts occurring.** Other sectors along the value chain are **indirectly, positively affected e.g., food producers** (SCCA compared to SCC). Positive effects can be expected in the construction sector which profits from the rehabilitation and expansion of water canals and reservoirs.

→ A higher growth path without further climate protection measures leads to annual increases of energy demand and energy-related $CO_2$ emissions of up to 0.4%.

**References**
Kazakh Government (2020): Eighty-eight thousand jobs to be created during modernization of irrigation infrastructure in Kazakhstan. URL: Eighty-eight thousand jobs to be created during modernization of irrigation infrastructure in Kazakhstan - Official Information Source of the Prime Minister of the Republic of Kazakhstan

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# Kazakhstan | Impacts of Climate Change and Adaptation in Agriculture II

Find the underlying analysis in the report "Economy-wide Impacts of Climate Change and Adaptation in Kazakhstan" (2025)

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's agriculture is vulnerable to climate change

**Lower pasture productivity** and **livestock production** may result from **droughts and heatwaves**.

**Crop losses** induced by water scarcity can be a consequence of **droughts** and **heatwaves**.

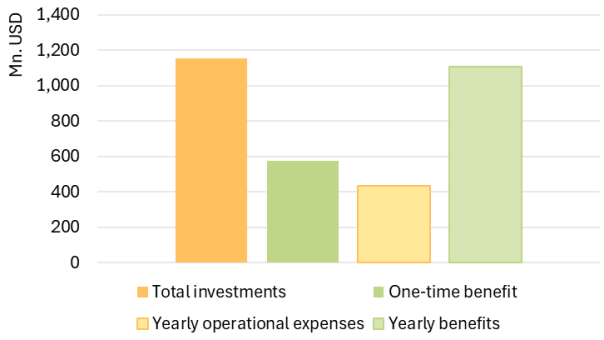
The **productivity of people working outside** as e.g. in the agriculture sector may decrease during **heatwaves**.

Negative impacts on agriculture can lead to **lower growth in other sectors, lower GDP** and **employment.**

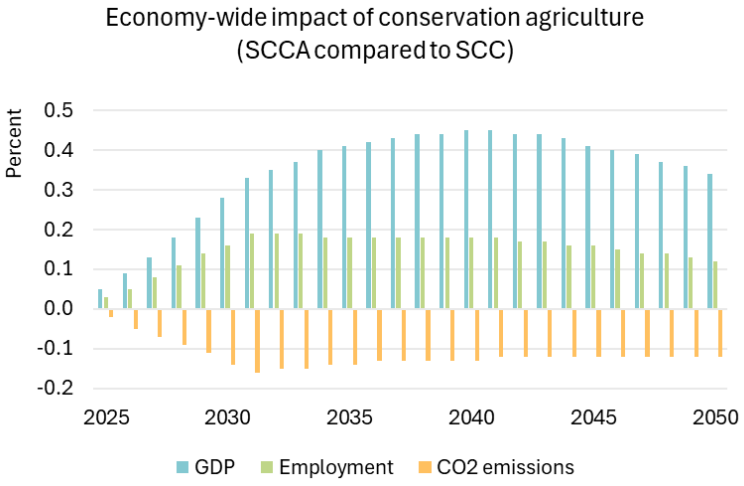
## Exemplary adaptation measure for reducing vulnerability to droughts: conservation agriculture

Moisture saving technologies such as **conservation agriculture** including minimal and no-till farming are key responses to reduce water scarcity and to improve agricultural productivity.

Conservation agriculture is already adopted in Kazakhstan but there is still room for improvement.




## Economy-wide benefits of investments in conservation agriculture




Macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation measures.

→ Investments in the **conservation agriculture** result per year in **up to 0.45% higher GDP** (resp. 262 bn. KZT) and **up to 0.2% higher employment** corresponding to more than 18,000 additional jobs (SCCA compared to SCC).

→ Investments in **conservation agriculture** reduce the drought impact which results in **higher agricultural output.** Other sectors are positively affected from value chain and income-induced effects **e.g. food producers and chemical industry** (SCCA compared to SCC).

→ The investments lead to annual decreases of **energy-related $CO_2$ emissions of up to -0.16%.** The expected fuel savings in agriculture will not be offset by other sectors.

**References**
World Bank (2024). Republic of Kazakhstan: Climate Adaptation Options and Opportunities in the Agriculture Sector. World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/099060424004022607/pdf/P5021121 6a88d304191601df346d0b1713.pdf

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# Kazakhstan | Impacts of Climate Change and Adaptation in Agriculture III

Find the underlying analysis in the report "Economy-wide Impacts of Climate Change and Adaptation in Kazakhstan" (2025)

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's agriculture is vulnerable to climate change

**Lower pasture productivity** and **livestock production** may result from **droughts and heatwaves**.

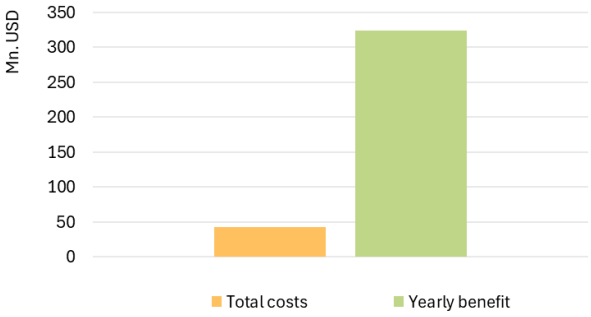
**Crop losses** induced by water scarcity can be a consequence of **droughts** and **heatwaves**.

The **productivity of people working outside** as e.g. in the agriculture sector may decrease during **heatwaves**.

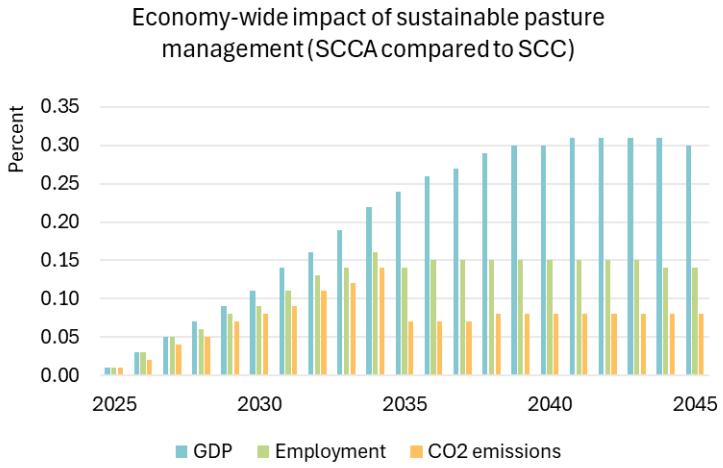
Negative impacts on agriculture can lead to **lower growth in other sectors, lower GDP** and **employment.**

## Exemplary adaptation measure for reducing vulnerability to droughts: sustainable pasture management

**Sustainable pasture management** helps to **rehabilitate degraded pastures** in particular in semi-arid and arid ecosystems with high livestock densities. The examined measure comprises to a limited extend soil tillage, the **planting of varieties of perennial grasses, and crop protection measures**.




## Economy-wide benefits of investments in sustainable pasture management




Macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation measures.

→ Investments in the **sustainable pasture management** result per year in **up to 0.3% higher GDP** (resp. 195 bn. KZT) and **up to 0.16% higher employment** corresponding to more than 15,000 additional jobs (SCCA compared to SCC).

→ Investments in **sustainable pasture management improves livestock productivity.** Other sectors are positively affected from value chain and income-induced effects **e.g. food producers and chemical industry** (SCCA compared to SCC).

→ The investments lead to annual increases of **energy-related $CO_2$ emissions of up to 0.14%** if no mitigation measures are taken and economic activity accelerates.

**References**
World Bank (2024). Republic of Kazakhstan: Climate Adaptation Options and Opportunities in the Agriculture Sector. World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/099060424004022607/pdf/P5021121 6a88d304191601df346d0b1713.pdf

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# Kazakhstan | Impacts of Climate Change and Adaptation in Energy Sector I

Find the underlying analysis in the sectoral policy brief "Kazakhstan: Economy-wide Effects of Adaptation in the Energy Sector" and in the report "Supporting climate resilient economic development in Kazakhstan"

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's energy sector is vulnerable to climate change

**Floods** damage energy infrastructure such as power transmission lines causing power losses and costs for reconstruction.

**Heatwaves** lead to higher electricity demand for cooling and reduced thermoelectric power potential due to insufficient cooling.

**Droughts** and **heatwaves** cause lower hydro power production as a result from lower water levels.

Negative impacts on the energy sector can lead to **lower growth in other sectors, lower GDP** and **employment.**

## Exemplary adaptation measures for reducing vulnerability to heavy rain and heatwaves

### Wind power deployment and energy efficiency in the housing sector

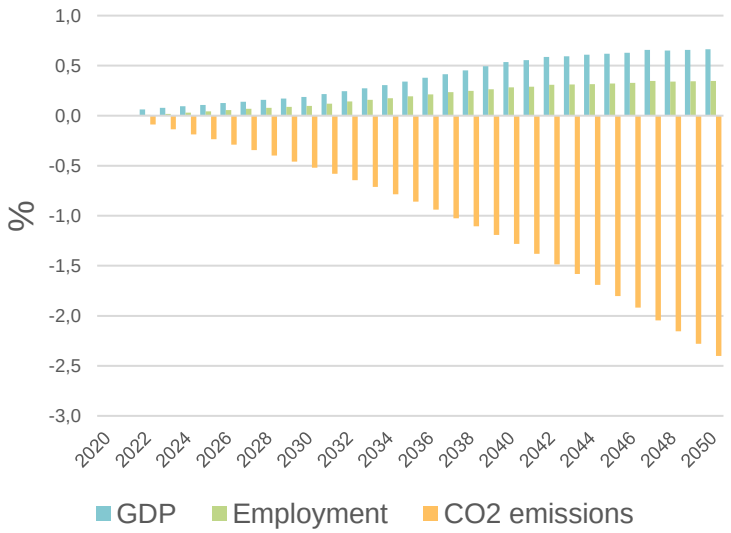
The expansion of water-independent energy technologies like **wind power** and the **reduction of energy consumption** are important elements to respond to possible imbalances of energy supply and demand during heatwaves. These measures also make use of **synergies between adaptation and mitigation**.

### Underground powerlines

**Underground powerlines** are well suited to prevent damages from extreme precipitation and storms. They increase the climate resilience of the grid as they **reduce the number of power outages** and thereby **limit production failures** in other sectors.

## Economy-wide impacts of wind power, energy efficiency and underground powerlines

### Economy-wide impacts of wind power & energy efficiency (SCCA compared to SCC)




Macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation measures.

→ Investments in wind power and energy efficiency improvements in the housing sector result annually in up to **0.7% higher GDP (resp. KZT 558 bn.)** and **up to 35,000 additional jobs (resp. 0.35% higher employment)** (SCCA compared to SCC).

→ Investments in **underground powerline expansion** also have positive economy-wide effects: **GDP** rises annually by **up to 0.6%** and **up to 17,000 additional jobs** per year are created (SCCA compared to SCC).

→ Both measures harness **mitigation and adaptation synergies**: with investments in wind power and energy efficiency (underground powerlines) **energy-related $CO_2$ emissions drop up to 2.4% (0.35%)** per year (SCCA compared to SCC). They avoid energy losses or use renewable energy sources.

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# Kazakhstan | Impacts of Climate Change and Adaptation in Energy Sector II

Find the underlying analysis in the report "Economy-wide Impacts of Climate Change and Adaptation in Kazakhstan" (2025)

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's energy sector is vulnerable to climate change

**Floods** damage energy infrastructure such as power transmission lines causing power losses and costs for reconstruction

**Heatwaves** lead to higher electricity demand for cooling and reduced thermoelectric power potential due to insufficient cooling.

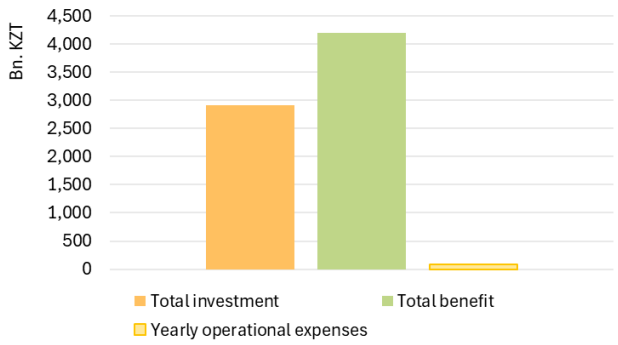
**Droughts** and **heatwaves** cause lower hydro power production as a result from lower water levels.

Negative impacts on the energy sector can lead to **lower growth in other sectors, lower GDP** and **employment.**

## Exemplary adaptation measures for reducing vulnerability to heat and cold waves

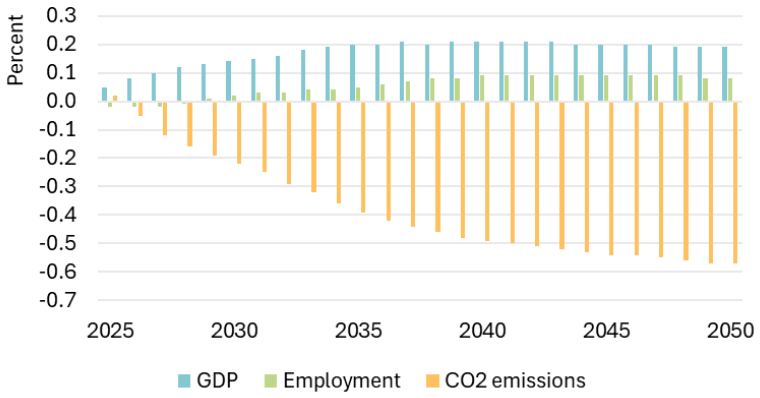
The **reduction of energy consumption** is an important element to respond to possible imbalances of energy supply and demand during heat and cold waves. It helps to decrease heat stress and reduces the energy costs for heating and cooling buildings.

This measure also make use of **synergies between adaptation and mitigation**.




## Economy-wide benefits of energy efficiency improvements in buildings

Economy-wide impacts of energy efficiency in buildings (SCCA compared to SCC)




Such macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation and mitigation measures.

→ Investments in energy efficiency improvements buildings result annually in up to **0.2% higher GDP (resp. 136 bn. KZT)** and **up to 0.1% higher employment corresponding to more than 8,700 additional jobs** (SCCA compared to SCC).

→ The construction sector and other sectors along the value chain are positively affected. The demand for energy decelerates as intended by the measure.

→ The measure harness mitigation and adaptation synergies: with investments in energy efficiency in buildings energy demand is stabilized during heat and cold waves. Energy-related $CO_2$ emissions decrease by up to 1.9 Mt $CO_2$ (0.6%) per year (comparing SCCA to SCC).

**References**
AvantGarde (2025). Interim report in the project "Policy Recommendations for Climate-Resilient Economic Development". Section: "Comprehensive analysis of efficiency through cost-benefit assessment (CBA) of improving energy efficiency of residential buildings in Kazakhstan". Astana

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# Kazakhstan | Impacts of Climate Change and Adaptation in Infrastructure

Find the underlying analysis in the sectoral policy brief "Kazakhstan: Economy-wide Effects of Adaptation in Infrastructure" and in the report "Supporting climate resilient economic development in Kazakhstan"

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's infrastructure is vulnerable to climate change

**Floods** damage infrastructure like roads and buildings, which then need to be reconstructed.

**Extreme wind events** may partly or fully damage buildings and cause costs for rebuilding them.

**Extreme temperatures** can deform roads and rails.

Negative impacts on infrastructure can lead to **lower growth in other sectors, lower GDP** and **employment.**

## Exemplary adaptation measures for reducing vulnerability to extreme precipitation & wind

### Climate resilient roads

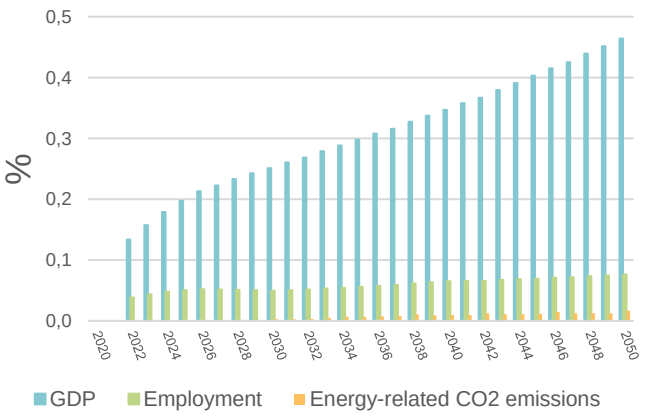
**Construction** and **regular maintenance of road infrastructure** offers the opportunity to adapt to climate change impacts like floods following extreme precipitation in a proactive manner. Climate-proofing roads (e.g., drainage structures, new pavement structure) increase costs by 7-9% of regular road investments.

### "Green belt" Mass afforestation

The **"Green Belt" of Nur-Sultan** consisting of approximately 12 million trees around the city is a prominent example of how to **reduce wind speed, improve soil moisture and reduce $CO_2$ emissions** (Tulepov, 2019). Such "green belts" are a **nature-based adaptation measure** to mitigate damages from extreme wind while also harnessing climate adaptation and mitigation synergies.

## Economy-wide impacts of climate resilient roads and "green belt" mass afforestation

**Economy-wide impacts of investment in climate resilient roads (SCCA compared to SCC)**




Macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation measures.

→ Investments in climate resilient roads result annually in up to **0.46% higher GDP (resp. 389 bn. KZT)** and **up to 0.1% higher employment corresponding to a maximum of 7,700 additional jobs** in e.g., construction and transport sector (SCCA compared to SCC). However, $CO_2$ emissions rise by up to 0.1% per year – mainly in the energy and transport sector (SCCA compared to SCC).

→ The economy-wide impacts of investments in **mass afforestation to create "green belts"** are positive once the benefits of the measure are fully exploited. GDP growth is slightly higher compared to SCC due to the import dependency of the forestry sector on e.g., machinery and trailers.

**References**
Tulepov (2019): Climate change: the capital's experience. URL: https://vechastana.kz/izmenenie-klimata-opyt-stolicy/

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# Kazakhstan | Impacts of Climate Change and Adaptation in Infrastructure and Agriculture

Find the underlying analysis in the report "Economy-wide Impacts of Climate Change and Adaptation in Kazakhstan" (2025)

Annual changes in % are between a climate change scenario without adaptation (SCC) and a climate change scenario with adaptation (SCCA).

## Kazakhstan's infrastructure and agriculture are vulnerable to climate change

**Floods** are a risk for the infrastructure and the people. They cause soil erosion impacting agricultural productivity.

**Floods** may lead to production losses due to interruptions in energy supply and supply chains.

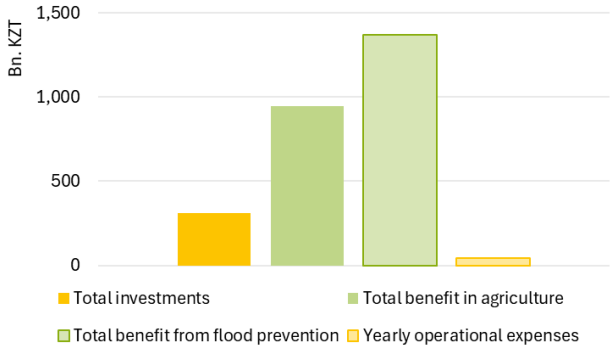
**Crop losses** induced by water scarcity can be a consequence of **droughts** and **heatwaves**.

Negative impacts on infrastructure can lead to **lower growth in other sectors, lower GDP** and **employment.**

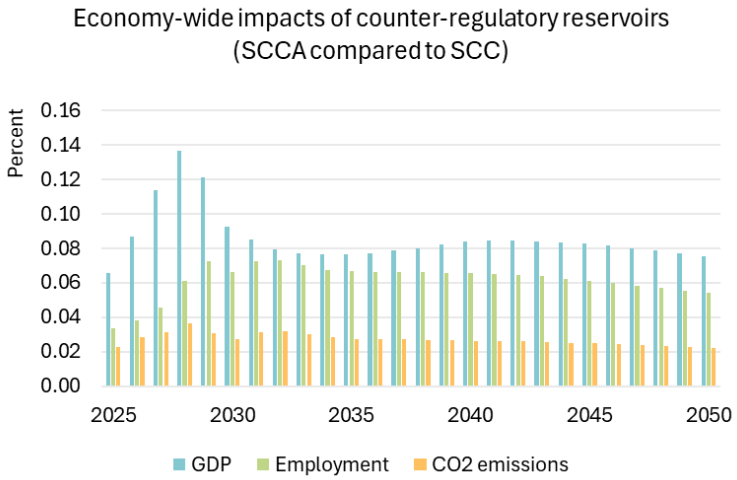
## Exemplary adaptation measures for reducing vulnerability to floods: counter-regulatory reservoirs

**Multi-purpose water infrastructure** reduces the risk of being flooded by collecting excess water. Furthermore, reservoirs provide additional water to be used for irrigation during droughts and for additional cultivable land.

It is expected that 50% of the damage caused by flooding can be avoided.




## Economy-wide impacts of counter-regulatory reservoirs with application in agriculture




Macroeconomic modelling allows for **long-term assessment of economy-wide effects** of adaptation measures.

- → Investments in counter-regulatory reservoirs result annually in up to **0.14% higher GDP** (resp. 82 bn. KZT) and **up to 0.07% higher employment** corresponding to more than 6,900 additional jobs (SCCA compared to SCC).
- → The measure is beneficial for agriculture due to more irrigated land and better irrigation during droughts**.**
- → $CO_2$ emissions slightly rise by up to 0.04% per year due to higher economic activity (SCCA compared to SCC).
- → Involuntary spendings and reconstruction activities can be avoided due to damage reduction.

**References**
Economic Research Institute (2025). CBA counter-regulatory reservoirs. Internal documentation.

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