The future of the Portuguese Water resources and agroforestry under climate change

Severe Impacts of Inaction

Climate change induces shifts in precipitation, temperature, solar radiation, humidity, and wind speed, leading to heightened occurrences of droughts, heatwaves, and reduced soil moisture. These changes diminishing water availability, raise water demands, disrupt plant phenology, and reduce crop productivity.

Significant benefits of adaptation

Adaptation measures can balance water supply and demand. Without adaptation, costs may reach €425 million under moderate mitigation scenario (RCP4.5) or exceed €662 million under high emissions scenario (RCP8.5) on average by year.

RNA2100

The RNA2100 project aims to support public policy exercises of adaptation to climate change, at different levels of territorial intervention in Portugal. RNA2100's main aims include the characterization of climate change physical and socioeconomic impacts on the Portuguese most vulnerable domains, the assessment of financial costs and needs, and the implementation of a *National Spatial Planning Policy Programme*.

https://rna2100.apambiente.pt/

Water resources and agriculture projections

The imbalance between water demand and available renewable water resources is an increasingly frequent and widespread problem in mainland Portugal, especially in the regions of Alentejo and Algarve. With global warming, the duration and intensity of water scarcity will increase in areas where it is already felt, particularly in the southern areas of the Tagus River. Under high emissions scenario, water availability will decrease significantly throughout the country. However, the imbalance between water demand and supply will have significant implications mainly in the southern areas of mainland Portugal. In agricultural terms, biophysical crop modeling has shown that climate change could substantially lower the productivity of the main crops produced in the country, with particular relevance for grain and silage maize, potatoes, and tomatoes, more pronounced in the high emissions scenario with higher levels of warming.

The benefits of adaptation

As climate change intensifies, the gap between water supply and demand will widen. In regions north of the Tagus River, this gap can be addressed through adaptation measures, such as reducing demand (e.g., minimizing losses in distribution networks, enhancing irrigation efficiency) and increasing supply (e.g., water recycling and reuse, implementing soil conservation techniques). However, achieving balance south of the river may require investments in desalination. Selecting climate-resilient crops is crucial in agriculture to mitigate productivity losses and reduce water needs.

Reducing water loss and leakages

Non-revenue water poses both financial and environmental challenges for water utilities. This measure seeks to enhance distribution system efficiency and minimize unnecessary withdrawals.
Through the adoption of advanced technologies, pressure management, infrastructure, and upgrades consumer engagement. This proposal suggests that all irrigation perimeters and water losses in urban distribution network attain efficiency levels of 90%.

Improving irrigation efficiency

The aim of this measure is to decrease water usage in agriculture while maintaining optimal crop productivity. Achieving may entail technologies that facilitate precise control and monitoring of irrigation processes, such as soil moisture sensors and automated irrigation scheduling based on weather conditions. This proposal suggests transitioning all applicable crops to drip irrigation systems, where irrigation efficiency is typically around 90-95%.

Water recycling and reuse (ApR)

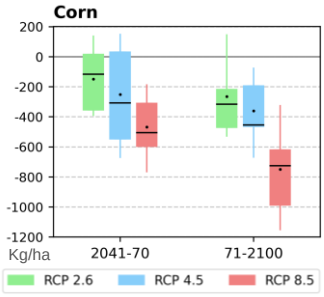
Seawater desalination converts saltwater into freshwater using thermal treatment or membrane processes. Thermal treatment vaporizes water with heat, leaving behind salts, while membrane processes separate saltwater through filters, producing pure water.

Selection climate-resilient crops

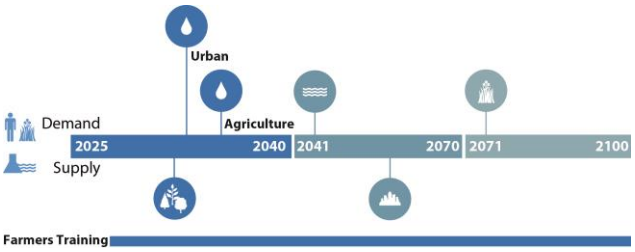
Selecting crops better suited to climate change projections involves a strategic approach to ensure agricultural resilience and sustainability in changing environmental conditions, such as temperature increases and the higher likelihood of extreme weather events. In situations of climatic stress, farmers may select plants with traits such as drought tolerance, heat resistance, but also resistance to pests and diseases associated with changing climate conditions.

Storylines for Portugal

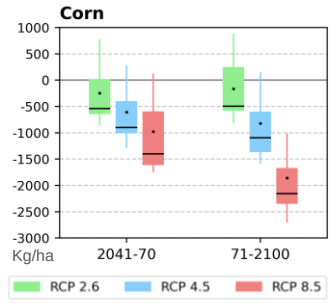
Norte



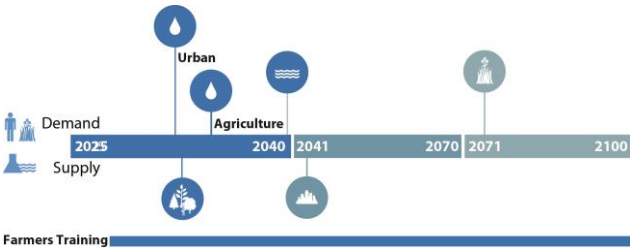
Climate change projections indicate decreased water yield for River Basin Districts in NUTS II Norte, especially in the Douro basin. RCP8.5 shows more pronounced losses, up to nearly 2000 hm3 annually by the end of the century. RCP2.6 projects no significant changes. The WEI+ will remain relatively stable under different scenarios with a maximum increase of +4 percent points in 2071-2100. Climate change impacts crop productivity, with corn, vineyards, and potato potentially facing decreases, while olive grove productivity remains stable.



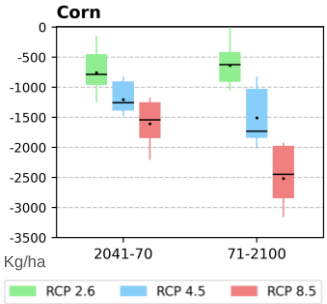
Centro



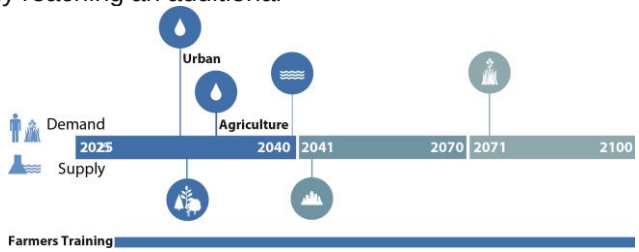
Climate change projections for River Basin Districts in NUTS II Centro indicate decreased water yield under RCP4.5, with more pronounced effects under RCP8.5. RCP2.6 shows no significant changes. The WEI+ shows slight changes under RCP4.5, while under RCP8.5, there are significant increases, up to an additional 12 percentage points in the Tagus and Ribeiras do Oeste basins. Crop productivity also shows a concerning trend, with grain corn facing a production decrease of up to -10.6% in RCP4.5, contrasting with olive grove stability. This decrease reached -18.9% in RCP8.5.



Lisbon Metropolitan Area



In the River Basins Tagus and Ribeiras do Oeste, climate change scenarios suggest a decrease in water yield under RCP4.5, with a more pronounced trend under RCP8.5 for the period 2071-2100. In the Paris mitigation scenario (RCP2.6), no significant change in water yield is projected. The WEI+ projection indicates a slight increase under RCP4.5 and a clearer upward trend under RCP8.5, potentially reaching an additional 12 percentage points by 2071-2100. Tomato, corn, and potato face decreasing productivity, with potential losses up to -9%, -14%, and -24% respectively in RCP4.5, which may escalate to -33% in RCP8.5 for potatoes.



Soil conservation techniques

Soil conservation techniques aim to protect and improve soil attributes, enhance moisture retention, and support agriculture. Methods include spreading manure/compost, mulching with organic or inorganic materials, and conservation tillage. These practices reduce soil moisture loss, improve fertility, prevent erosion, and suppress weeds, promoting sustainable agricultural production.

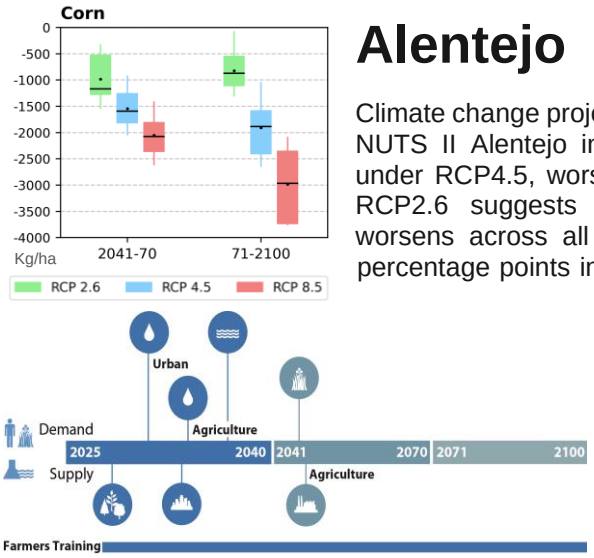
Seawater desalination plant

Converts saltwater into freshwater using thermal treatment or membrane processes. Thermal treatment vaporizes water with heat, leaving behind salts, while membrane processes separate saltwater through filters, producing pure water.

Awareness and training of farmers

Climate change training for farmers imparts knowledge and skills to adapt to its impacts. This includes sustainable farming practices, resilient crop varieties, and conservation techniques, enhancing productivity and environmental sustainability. The awareness and training of farmers has the potential to disseminate knowledge, enabling them to make decisions and implement practices that foster both productivity and environmental sustainability in response to climatic changes.

Storylines for Portugal

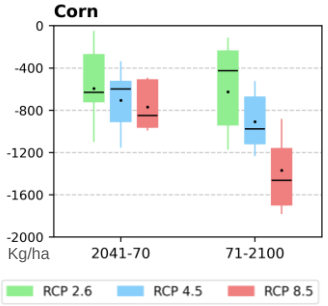


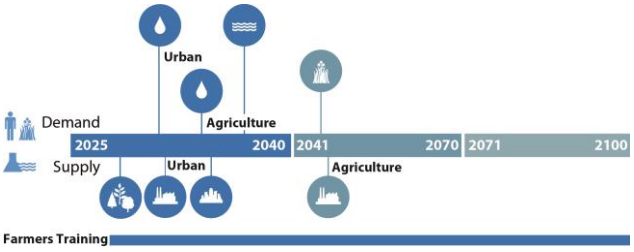
Alentejo

Climate change projections for River Basin Districts in NUTS II Alentejo indicate a decline in water yield under RCP4.5, worsening under RCP8.5. However, RCP2.6 suggests a slight increase. The WEI+ worsens across all scenarios, reaching up to +22 percentage points in RCP4.5 and +99 in RCP8.5 for the Guadiana River Basin. Climate change will affect irrigation requirements and crop productivity, with tomato and corn facing declining yields, potentially resulting in a -20% reduction in corn production under RCP4.5, which may escalate to -28.7% in RCP8.5.

Algarve

Severe drought in recent years has depleted water reserves in the Algarve, worsening with projected decreases in water yield under RCP4.5 and RCP8.5 scenarios. Although RCP2.6 suggests a slight increase, water scarcity will intensify, impacting agriculture. Anomalies in WEI+ worsen across all scenarios, driven by increased water demand due to crop needs modifications. Olive groves and almonds remain relatively stable, while orange productivity faces a -7% loss under RCP8.5. Grain corn is also expected to decrease, potentially by -9% under RCP4.5, and -14.4% under RCP8.5





The Water Exploitation Index plus (**WEI+**) is a ratio comparing water use to renewable water resources and serves as a common tool in the European Union and Portugal for assessing this equilibrium. The values are presented in percentage points. Positive values mean that the relationship will worsen in the future, while negative values indicate an improvement compared to the current situation.

Methodology

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Projections of temperature, precipitation, solar radiation, humidity, and wind speed under the **Paris mitigation scenario (RCP2.6)**, **moderate mitigation scenario (RCP4.5)**, and **high emissions scenario (RCP8.5)** were utilized to estimate various factors such as water availabilities, reservoir storage, reservoir inflow, irrigation needs, crop productivity, biomass production, and calculation of the Water Exploitation Index plus, among other variables. The methodology employed for evaluating water resources in climate change scenarios for mainland Portugal utilizes the restructured and recently available version of the SWAT+ model. The crop growth module of SWAT+ is based on a simplified version of the Environmental Policy Integrated Climate (EPIC) model, which has demonstrated effectiveness in simulating plant growth across different crop types, climatic conditions, agricultural practices, and soil management techniques.

RNA2100 publications – https://rna2100.apambiente.pt/pagina/programa-ambiente-alteracoes-climaticas-e-economia-de-baixo-carbono