POLICY BRIEF

IBERIAN CASE STUDY

INTEGRATED SOLUTIONS TO ADDRESS HIGH LEVELS OF CLIMATE CHANGE

Region: Mediterranean **Scale**: Transboundary river basin **Sectors**: Agroforestry, Water, Hydropower, Biodiversity

The river basins of the Iberian Peninsula are particularly vulnerable to climate change. This case study focused on the impacts of high levels of climate change (global mean temperature more than 2°C above pre-industrial levels) on the Tagus River basin, one of five river basins shared between Portugal and Spain, which faces multiple challenges for the management of transboundary water resources and sensitive social-ecological systems. Water scarcity is likely to increase, as the high demand for irrigation on both sides of the border is combined with growing urban water demand and large-scale water transfers to the Segura basin in south-eastern Spain. In addition, the unique dry oak-grassland agroforestry systems known as "Dehesa" in Spain and "Montado" in Portugal are highly vulnerable to projected increases in the frequency and intensity of droughts, especially when coupled with socio-economic trends such as rural depopulation, unemployment and declining demand for cork. Combined climate and land-use pressures could have a major impact on agriculture, forestry, energy production and nature conservation. This case study aimed to develop integrated solutions that take account of synergies and trade-offs between these sectors, by exploring the potential for Integrated River Basin Management and Ecosystem-based Approaches to land management.

The Tagus transboundary river basin showing the Tagus-Segura water transfer ("Trasvase Canal") that diverts water to the Segura river basin in south-east Spain.

Key Messages

- Iberia faces severe challenges from climate change. Modelling projects significant changes in annual and seasonal precipitation, continuing the current trend towards a drier and more vulnerable landscape.
- Water availability in the Tagus River basin is projected to decrease significantly under all scenarios by 2071-2100, cutting hydropower production and contributing to a failure to meet the Albufeira Convention on water sharing between Spain and Portugal. Water volumes supplied to Segura will decrease significantly and will not be able to meet projected demands, especially under the higher climate change scenarios. Hydropower production falls by 45-50% by the end of the century.
- It will only be possible to sustain sufficient flows in the Tagus headwaters to safeguard river ecology by altering reservoir management, implementing an environmentally-oriented water management strategy, and substantially reducing the supply of water to Segura.
- Production of cork in the Montado / Dehesa could cease completely by the 2080s and forage production for livestock could be substantially affected under the high levels of climate change expected without additional global mitigation action (RCP8.5 scenario). Pine productivity may also be severely affected under these levels of climate change. Even without climate change, cork production could fall unless grazing densities in the Tagus River basin area are reduced.
- A representative group of stakeholders (reflecting multiple roles and interests in the Tagus River basin) have defined a common 'Vision for Iberia' and a set of climate adaptation and mitigation pathways and response strategies up to 2100, centred around equity and wellbeing; sustainable management of the environment; energy, food and water; a sustainable economy and lifestyles; and participatory governance. These pathways provide transformative strategies that are expected to be robust to climate and socio-economic uncertainties.

What could a future above 2°C look like?

Four scenarios were co-developed in a series of workshops with Iberian stakeholders. These were based on the global Shared Socio-economic Pathways (SSPs), adapted to reflect contrasting plausible futures for Iberia up to 2100, paired with relevant climate change scenarios based on the IPCC's Representative Concentration Pathways (RCPs). Two fossil-fuel dependent scenarios (SSP3 and SSP5) were paired with the highest warming scenario (RCP8.5), which is expected without additional climate change mitigation action, and two low carbon scenarios (SSP1 and SSP4) were paired with a lower warming scenario (RCP4.5).

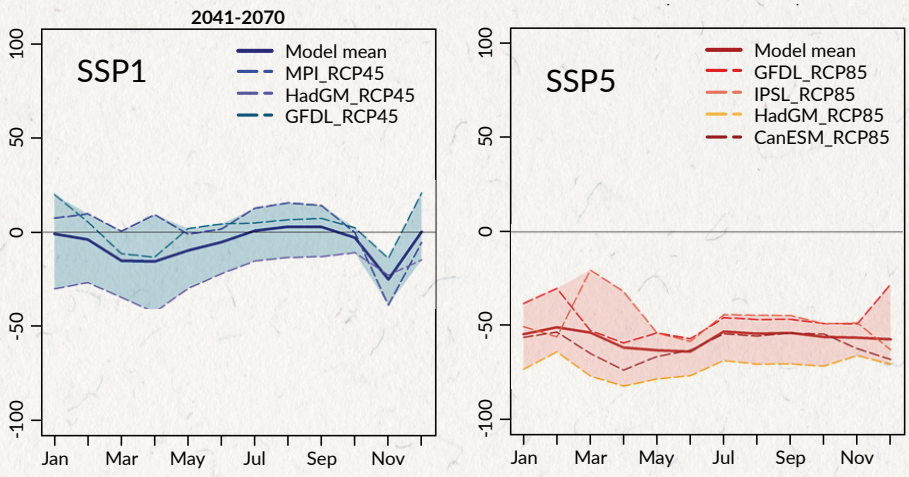
Socio-economic scenario	Climate scenario[1]	Narrative for Iberia and the Tagus River Basin to 2100
Sustainability (SSP1)	RCP4.5 Temperature +1.9 to +2.8°C Precipitation -7% to -19%	Increased societal involvement in environmental policymaking and integrated climate governance result in positive transformations towards sustainable, equitable and collaborative societies.
Inequality (SSP4)		A strong focus on unconstrained technological development leads to economic growth and further centralisation of power by private-public elites. Redistribution policies fail.
Fossil-fuelled Development (SSP5)	RCP8.5 Temperature +3.4 to +5.6°C Precipitation -18% to -27%	Innovation provides a high return on capital investment and temporary increases in social equity and health, at the cost of overuse of non-renewable resources. This leads to environmental degradation, which is partly addressed by technological solutions until an eventual socio-economic collapse.
Regional Rivalry (SSP3)		Political volatility sparks a rise in social tensions. Institutional co-ordination falls, reducing society's capacity to address climate change. Short-termism dominates, leading to social and political fragmentation, stratification, sectarianism and conflicts within and between groups and regions.

[1]*Annual average change for Iberia in 2071-2100 relative to 1981-2010*

What are the impacts and risks in a future above 2°C?

Modelling projects significant decreases in precipitation, continuing the current trend towards a drier and more vulnerable landscape in the Iberian Peninsula. Winter flows in the Tagus River are expected to fall by 25% under RCP4.5 and 50% under RCP8.5. This could have a major socio-economic impact, since water supply and agroforestry are highly dependent on precipitation accumulated during the wet period from October to April.

Overall water availability is projected to fall under all scenarios, but in SSP1 the impact is lower because water use efficiency improves by 40%, and there is more efficient water use during the irrigation period (late spring to early autumn). In contrast, higher climate change impacts and water withdrawals in the other scenarios reduce flows at the Tagus River outlet drastically, by up to 55% (SSP3) or 65% (SSP5) in 2071–2100, contributing to a failure to meet the Albufeira Convention, which specifies the amount of water that should be discharged from the Spanish section of the Tagus into the Portuguese section. In SSP1, changes to the management of the Buendía and Entrepeñas reservoirs help to sustain natural environmental flows (i.e. higher discharge in winter and lower in summer) in the Tagus River, and keep reservoir volumes above the critical level. However, this involves cutting the water volume transferred to Segura to less than the 350 hm^3 specified in the Segura Basin Management Plan. Even less water is supplied to Segura under SSP3 and SSP5, due to higher water demand and more severe climate change. Hydropower production also falls dramatically, by up to 45% for RCP4.5 and up to 50% for RCP8.5 in 2071-2100.

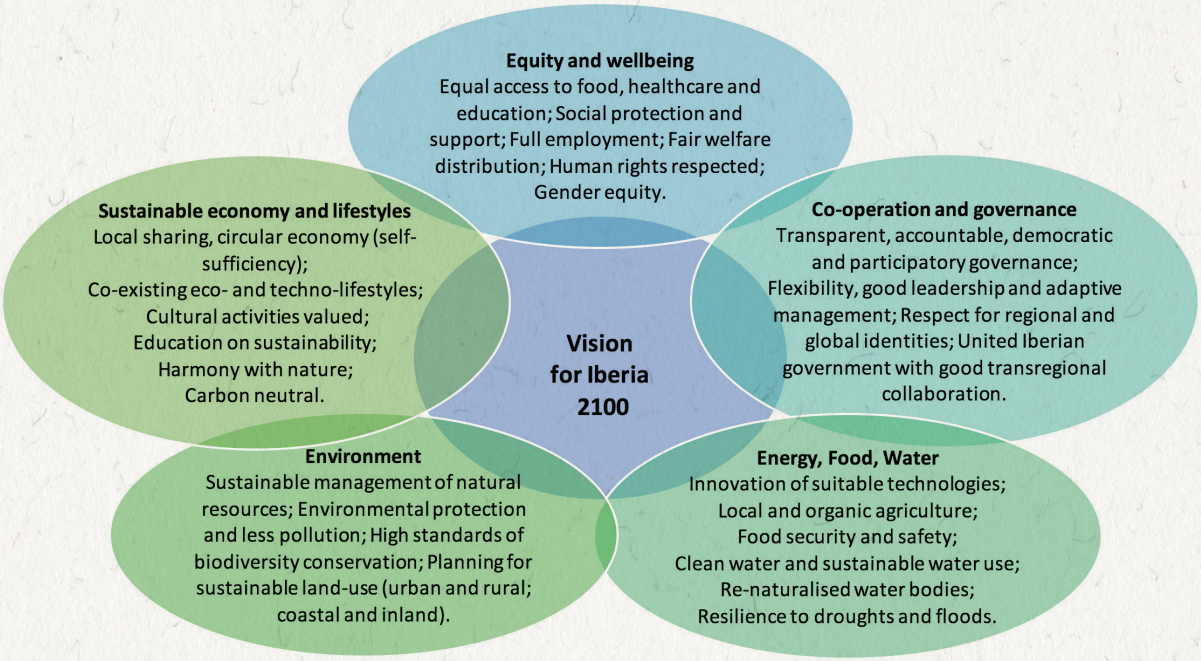


Change in discharge of the Tagus River (%) in 2041-2070 compared to 1981-2011 for SSP1 (RCP4.5) and SSP5 (RCP8.5)

More frequent and intense droughts are expected to reduce the supply of ecosystem services from agro-forestry landscapes under all scenarios. Droughts increase the number of years where not enough forage is produced, so that livestock graze oak saplings, preventing them from establishing. If grazing is maintained at current levels, cork production will decrease even without climate change, but droughts will kill adult trees and cut production even further. In RCP4.5 (SSP1 and SSP4) cork production declines after 2050, but in RCP8.5 (SSP3 and SSP5) it falls steeply by 2050. Both cork and pine production may cease by the end of the century under high levels of climate change.

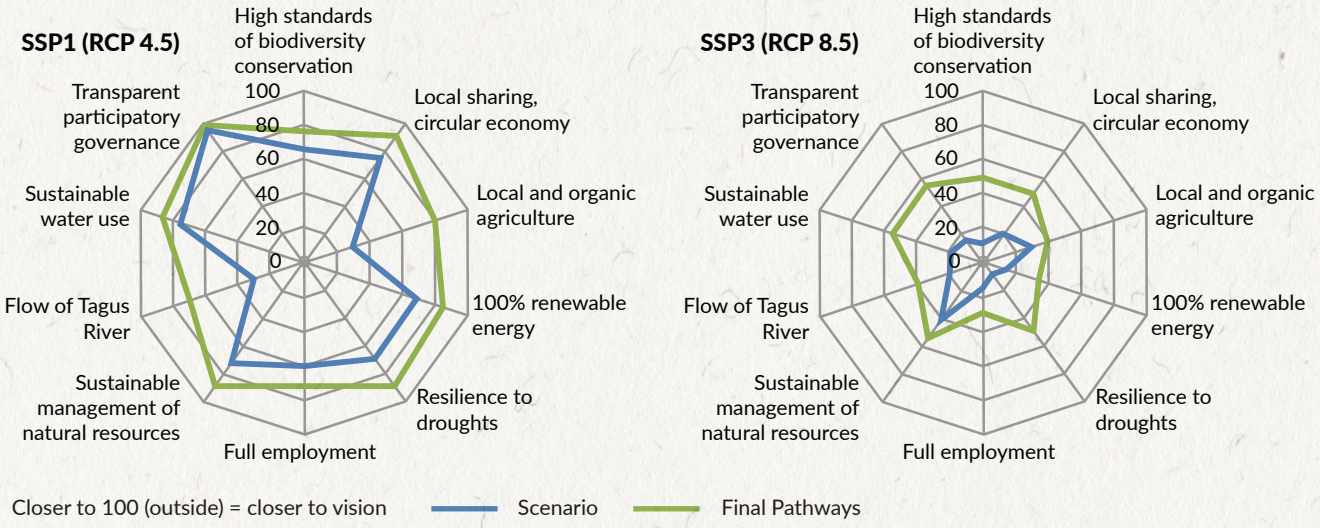
What do we want our future to look like?

Stakeholders and researchers co-created a common 'Vision for Iberia' in 2100 from the perspective of the two countries (Spain and Portugal), but including awareness of macro-scale framework conditions such as EU-level governance. The vision depicts a world of environmental, social and economic sustainability.



How can a sustainable future be achieved?

IMPRESSIONS stakeholders were asked to identify innovative solutions that would enable the achievement of their long-term 'Vision for Iberia' in the context of the four scenarios. Solutions were clustered and co-developed into adaptation, mitigation and societal transformation pathways for each scenario, from the present to 2100.



Assessment of the achievement of the 'Vision for Iberia' under the scenario (blue line) and pathways (green line) for SSP1 (RCP4.5) and SSP3 (RCP8.5). Achieving 100 (outside of the spider diagram) means that the vision has been achieved.

Analysis shows that it is difficult to achieve some vision indicators, due to path dependent scenario conditions and climate change. For example, in all scenarios, it is difficult to maintain the flow of the Tagus River and to achieve resilience to droughts, due to climate change and over-exploitation. However, it is harder to achieve the vision in a world moving towards SSP3/SSP5 than in SSP1.

These pathways were generated during stakeholder workshops to match the main priorities and constraints under each scenario. Omission of a pathway for a certain scenario does not necessarily imply that it would not be needed.

Pathway	Scenario				Examples of strategies
	SSP1	SSP3	SSP4	SSP5	
Integrated and collaborative water management and sustainable water use	✓	✓	✓	✓	This sets goals (e.g. 100% water re-use) to protect water quality and quantity and ensure equal access to water. It includes participatory transboundary water governance systems that are regularly revised; new infrastructure (e.g. for rainwater harvesting, water treatment and re-use, metering, efficient irrigation and appliances); strong regulations, incentives, eco-labels, taxes and quotas to cut water use; and real-time monitoring systems to control water quality and river flows.
Sustainable lifestyles	✓	✓	✓	✓	This involves fundamental shifts in values and behaviours. A new education system, accessible by all age groups, is underpinned by research on how to communicate environmental and social problems. Awareness-raising activities promote energy efficiency, local renewable energy, healthy food, different diets, waste reduction, intermodal mobility, water saving and reuse, social cohesion and tolerance.
Organic and conservation agriculture following ecosystem-based adaptation principles	✓	✓	✓	✓	Conservation agriculture; new (or traditional) crops and livestock adapted to drier and warmer conditions; agro-forestry and sustainable forestry; natural fertilisers; technological innovation (e.g. hydroponics; soil sensors for irrigation); regulations; integrated land use management (e.g. shifting irrigated crops to the north-west; reduced grazing density); payment for ecosystem services; training for farmers.
Democratic multi-level governance for sustainability and social equity	✓		✓	✓	This involves fundamental shifts to orient the governance system towards long-term sustainability and resilience goals. It integrates environmental protection into all policies and markets, forbids planned obsolescence, redistributes wealth to ensure social cohesion, decentralises political power, sets up participation forums in local communities and ensures that scientific evidence is used in decision-making.
Low-carbon local energy systems and markets	✓	✓	✓		This mitigation pathway invests in technical innovations and applies subsidies, carbon taxes and regulations to support energy efficiency, renewable energy and a circular economy, with an emphasis on using local resources to create local jobs and enable both urban and rural development.

What are the transformative solutions?

Transformative solutions contribute to changing social institutions and structures, and develop new forms of information and knowledge systems to transform the way energy and resources are used, resulting in positive tipping points that accelerate social change to a sustainable society. Three of the pathways offer transformative solutions that are expected to produce robust results for Iberia across all scenarios: sustainable water management, sustainable lifestyles and ecosystem-based adaptation in agriculture. These tackle some of the most severe climate-related problems facing Iberia – water scarcity and falling crop yields – at the same time as reducing reliance on resources and strengthening social, human and natural capitals so that society is more resilient to future change.

Policy Recommendations

- Strengthen efforts to meet the Paris Agreement in conjunction with pursuing the UN Agenda 2030 Sustainable Development Goals. All impacts are more severe under higher levels of climate change and adaptation pathways cannot avoid all impacts, so both mitigation and adaptation are essential. Early moves towards sustainability, as in the SSP1 scenario, make it possible to avoid some of the worst impacts.
- Set up participatory, multi-level and transboundary water governance systems that manage water use, quality and quantity, taking into account the need to maintain environmental flows of the Tagus (and other rivers) and the projected decrease in water availability that will threaten the Albufeira convention, cut hydropower production, and reduce the amount of water that can be transferred to Segura, under all scenarios.
- Support integrated water and land use policies promoting conservation agriculture and ecosystem-based adaptation for Iberian agro-forestry landscapes (Montado / Dehesa). Reduce grazing pressure in the Montado / Dehesa to historic levels to increase cork tree regeneration and support the long-term recovery of these systems under high levels of climate change.
- Urgently invest in efficient water and energy-saving technologies and promote behaviour change to cut water and energy demand in all sectors (household, agriculture, business and energy), using awareness campaigns, regulations and incentives.
- Integrate sustainability into education systems to promote behavioural change across all age groups.
- Support cross-regional structures, such as Euroregions and Working Communities, in the development of climate resilience solutions, new forms of climate knowledge production and use for policy-making.

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Find out more:
Clarke et al. (2017) Regional/local scale CCIAV applications (IMPRESSIONS Deliverable D3C.2);
Hölscher et al. (2017) Adaptation and mitigation pathways, and synergy mechanisms between them, for the case studies (IMPRESSIONS Deliverable D4.2).

Both available from www.impressions-project.eu.