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Climate-smart forestry for climate resilience

Adaptive forest management and a replicable roadmap from Soria, Spain

In the province of Soria, Spain, forests have become a living laboratory for climate change adaptation, showing that anticipatory, knowledge-based, and flexible forest management can turn climate threats into opportunities.

Key Learnings

- **Adaptive forest management strengthens resilience to climate hazards**: Adjusting forestry practices to local climate risks, such as thinning trees to reduce fire risk during heatwaves, improves forest health and makes them more robust against the impacts of climate change.
- **Well-designed adaptation brings multiple benefits**: Beyond boosting resilience, the interventions have improved biodiversity, soil stability, and habitat quality, while reducing wildfire risk. They've also helped revitalise rural economies through sustainable activities like grazing and mushroom harvesting, showing how adaptation can support both nature and communities.
- **Private investment can drive climate-resilient forestry**: Businesses can play a key role in supporting adaptive forest management by investing in projects that both address climate risks and deliver environmental and social benefits.

About the region

Soria is a province located in the eastern part of the autonomous community of Castilla and León, in north-central Spain. Covering an area of approximately 272 km², Soria is one of the least densely populated provinces in the country, with a population of around 90,000 inhabitants (2024). Soria features a diverse landscape with mountains, plains, and the Duero River – one of the major Spanish rivers. Cold winters and mild summers characterise Soria's climate. Increasingly hot temperatures, leading to forest fires are one of the climate threats the province is facing.

Climate Hazards

Extreme Heat, Droughts, Wildfires, Water Scarcity

Sector

Forestry

Key system

Ecosystem and Nature-Based Solutions,

Land use and Food Systems

Figure 1: Castilla and León region, Spain. Image Credit: Britannica.

Climate Threats

In a context of increasing climate uncertainty, forests across southern Europe face mounting pressures: rising temperatures, erratic rainfall patterns, storms, aggravating biodiversity loss, and the social vulnerability of rural forested areas. In the Castilla and León region, where large, forested landscapes like those in the province of Soria are central to local livelihoods and ecosystems, climate change is already causing longer and more intense droughts, increased fire risk, declining water availability, and shifts in species distribution. In 2022, a devastating wildfire swept through the region after a prolonged drought and extreme heat, burning almost 66,000 hectares.

Figure 2: Soria Forest Landscape. Image Credit: FSC Espana.

Climate-smart forestry enhances resilience

In response, a comprehensive forest management approach places climate adaptation at the core of forest planning by combining climate analysis tools, technical training, participatory processes, and innovative financing mechanisms. This scalable model supports climate-resilient forest management across 200,000 hectares of public and private land in the Soria province, as part of the Castilla and León region of Spain. Fifteen pilot forest areas (ten public, five private) function as test facilities to generate practical knowledge and tools to replicate climate-smart forestry in other Mediterranean regions. Climate-smart forestry is a management approach that maintains healthy forests under climate change. The forests reduce climate impacts, store carbon and generate an income for local communities. A technical reference guide co-developed between the LIFE Soria ForestAdapt project team and local foresters helps integrate climate adaptation into forest management planning, offering operational and deliberative guidance tailored to real-world forest conditions.

From theory to practice – Adaptive Forest Management supporting Climate Resilience

A **technical guide for forest planning** incorporates climate adaptation into official management instruments, which public forest managers, private forest owners and regional authorities can use. Rather than offering a rigid set of prescriptions, the guide proposes a six-step process to support technical staff in integrating climate adaptation into forest management at the forest stand level. The six steps involve:

1. **Assessing the current forest conditions:** Evaluating the existing state of forest stands, including species composition, age structure, health status, and productivity levels.
2. **Analysing climate vulnerabilities:** Identifying potential climate-related risks such as increased drought, pest outbreaks, or fire susceptibility that could impact forest health and productivity.
3. **Defining management objectives:** Establishing clear goals that incorporate climate adaptation, such as enhancing biodiversity, improving soil conservation, and maintaining ecosystem services.
4. **Developing adaptive management strategies:** Designing and implementing practices that promote resilience, including species diversification, mixed age stands, and soil conservation techniques.
5. **Implementing concrete management actions:** Carrying out the planned adaptive measures in the field, ensuring they align with the defined objectives and address identified vulnerabilities.
6. **Monitoring and adjusting adaptation measures:** Continuously monitoring the outcomes of implemented actions and adjusting management practices as necessary to respond to changing climatic conditions and to consider new information.

The pilot forests in Soria province helped embed concrete adaptive measures into existing plans. These included assisted natural regeneration, reduced stand densities to improve water resilience, selection of drought-tolerant species, structural diversification, and the integration of livestock grazing as a fire prevention strategy. These on-the-ground practices show that adaptive forestry is feasible across diverse landscapes and institutional settings.

A series of training sessions informed more than 30 public and private technicians about up-to-date forest management techniques to build climate-smart forests, supporting a common ground for adaptive forest management and fostering a culture of anticipation, flexibility, and "no-regret" decisions.

Biodiversity benefits of well-designed adaptation

Well-designed adaptation measures have **multiple environmental co-benefits**. In the pilot areas, the interventions towards adaptation improved biodiversity and ecological connectivity, stabilised soil, restored habitat quality, and significantly reduced wildfire risk. Forests under adaptive management also showed better plant health and a gradual recovery of abandoned silvo-pastoral systems, combining forestry with animal grazing and preserving traditional landscapes and their associated species. In parallel, diversifying forest uses, such as beekeeping, grazing, or mushroom harvesting, boosted rural resilience and strengthened local economies in alignment with the EU Green Deal and the Sustainable Development Goals.

Climate investment through the "Zero Solutions" model

Zero Solutions is a portfolio of investment opportunities for companies to support verified climate and conservation actions. These include *FireZERO*, *PassivityZERO*, and *EmissionsZERO*, each offering a credible pathway for businesses to compensate for emissions and contribute to resilient forest landscapes. For instance, they can support afforestation and reforestation actions, support agroforestry or collaborate with local stakeholders.

In the pilot case of **Villaciervos,** a partnership between companies, local authorities, and livestock herders led to the establishment of silvo-pastoral firebreaks, reducing fuel loads, enhancing biodiversity, avoiding carbon emissions, and revitalising the rural economy. It demonstrates that climate finance can drive local conservation and development goals while ensuring transparency and credibility by aligning financial resources with clearly defined conservation objectives and involving multiple stakeholders.

Climate tools for strategic forest management

Digital tools, such as the ForestAdapt Tool and FITOCLIM are powerful tools to facilitate strategic decision-making and climate-adapted forest management.

- The ForestAdapt Tool maps the future climatic suitability of nine key tree species (pines, oaks, beeches, and junipers) under various IPCC emission scenarios up to 2100, supporting decisions on reforestation, species selection, and long-term planning.
- FITOCLIM provides dynamic plant health analyses that help forest managers anticipate structural and compositional shifts in vegetation and plan for them accordingly.

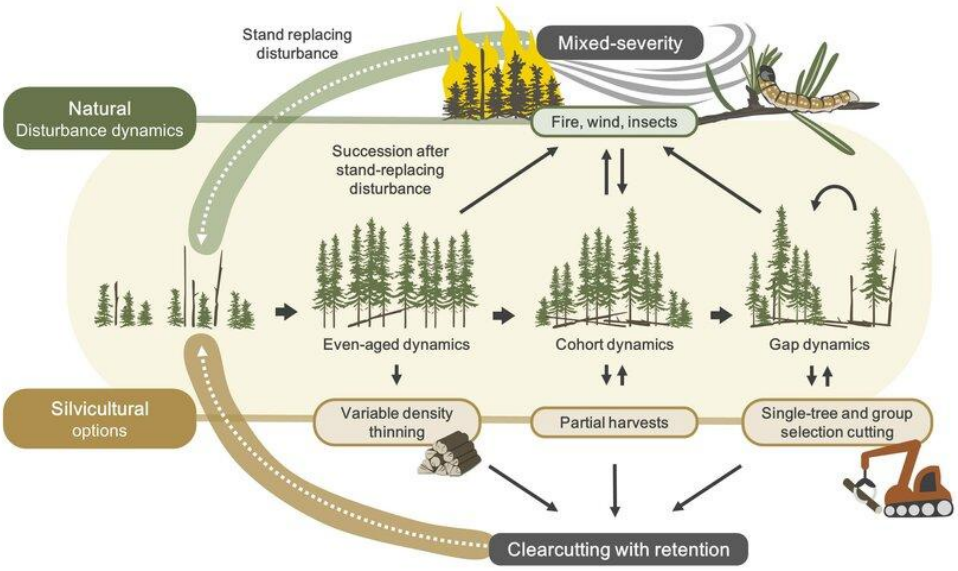

Figure 3: Example of Forest Management Options. Image Credit: Miguel Montoro Girona.

Together, these tools offer risk and opportunity maps at the forest level, helping to prioritise intervention areas, select climate-resilient species, and tailor measures such as canopy diversification, thinning, or adaptive rotations.

This climate-informed planning framework is essential to avoid maladaptive decisions, which are decisions that have a beneficial climate adaptation intention but cause the opposite outcome, and to ensure resource efficiency.

From pilot to policy – Enabling systemic change

The interventions have already influenced public forest policy in Castilla and León and contributed to updating national technical standards, such as the UNE 162002:2023 norm, describing sustainable forest management with respective criteria and indicators. The national authorities integrated the climate criteria developed into PEFC and FSC sustainable forest certification schemes, ensuring wider application and uptake across Spain and potentially beyond.

Beyond providing tools and standards, the project has helped mainstream climate adaptation in territorial planning, policy dialogue, and professional practice. It has created the conditions – data, capacity, partnerships, and confidence – needed to embed climate adaptation in forest managers' day-to-day decisions.

A replicable path to forest resilience

With a modest €1.5 million budget, the climate change adaptation activities have exceeded expectations. The interventions offer a pragmatic, science-based model for managing forest ecosystems under climate change – they not only protect biodiversity and ecosystem services but also create rural jobs, enhance governance, and build long-term resilience as they contribute to sustaining local, forest-dependent livelihoods.

"As a reference province in forest management at a national level, […], we want to continue working on improving our management and lead the way to manage our forests with the disturbing climate change that haunts us.",

José Antonio Lucas Santolaya, Head of the Territorial Service for the Environment of the Regional Government of Castilla and León

Summary

Adaptive forest management can transform climate threats into opportunities by enhancing forest resilience, biodiversity, and rural livelihoods. Flexible, knowledge-based forestry practices tailored to local risks like drought and wildfires strengthen climate resilience. Through a six-step adaptive planning guide, 15 pilot sites implemented measures such as thinning, species diversification, and firebreaks. These actions improve ecosystem health, reduce fire risk, and revitalise local economies. Supported by digital tools and innovative financing models like “Zero Solutions,” the actions bridge science and practice, influencing regional policy and national standards. With modest funding, the measures create a replicable model for climate-smart forestry that aligns with EU climate goals and offers a roadmap for other Mediterranean regions.

Further information

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