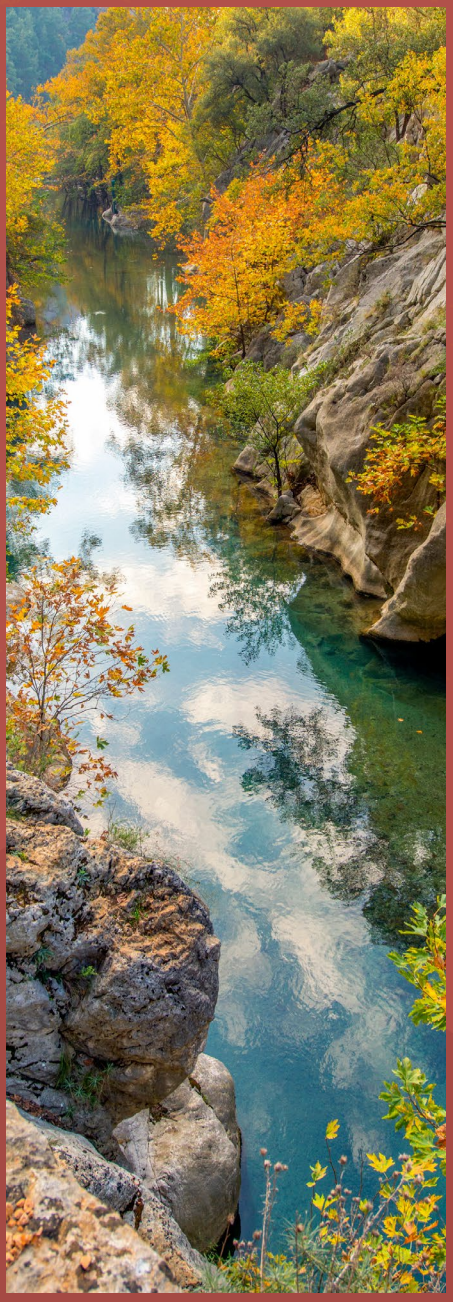

10 case studies

Actions for the resilience of Mediterranean landscapes

2026

EFI

Diputació Barcelona

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Diputació Barcelona

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Cover photos: Adobe Stock

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Fires


Drought


Floods


Soil degradation


Environmental management

INTRODUCTION

There are very few areas in the world where landscapes have been so profoundly shaped by traditional land management practices, resulting in a variety of cultural landscapes that harbour a rich diversity of species and ecosystems. Over the centuries, civilisations and communities have transformed Mediterranean landscapes in response to social change and climate variability, while maintaining their resilience. However, the speed and intensity of these changes in recent decades is unprecedented. The Mediterranean basin is one of the regions of the world experiencing the most rapid warming and the greatest decrease in precipitation, which exacerbates climate-related disturbances. In recent decades, populations have become increasingly urbanised, especially in North African countries and the Middle East, while cropland and grasslands have shrunk, especially in mountainous areas of Europe.

As in the past, Mediterranean communities must adapt their increasingly vulnerable landscapes, but today the urgency is greater than ever. These landscapes and their associated cultural land management practices must be able to withstand, recover and transform in response to climate-related stresses and shocks, while taking into account climatic and socio-political uncertainties. Building resilience into these systems is no longer optional, but essential.

This document describes **10 case studies** from Mediterranean countries in Europe, North Africa and the Middle East that maintain or improve the **resilience of agricultural, forestry and agroforestry systems** to hazards such as fire, drought, floods, soil degradation or environmental degradation caused by previous inadequate management. Most of these measures are not very complex, but require profound changes in land management and governance.

This document is addressed to land managers responsible for promoting sustainability. The actions presented here have been implemented by authorities, local and regional agencies, and NGOs, often with the support of research centres. By their nature, these are municipal or supra-municipal actions that can be replicated elsewhere in the Mediterranean. These are not actions that can be carried out in isolation on a single farm by its owner. The actions presented in this document need a promoter who knows how to surround himself/herself with other bodies that complement his/her capacities and competencies.

Each action is described following the same structure: the local **context**, the **challenge** faced, how its **technical, administrative and financial implementation** has been carried out, and how it meets the four **requirements for success**: how it is integrated with other actions of the same promoting organisation, how its continuity is ensured, what specialised resources have been needed for its implementation and what collaboration with other organisations has been necessary to reach its full potential.

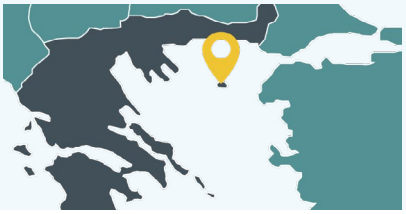
Case studies from the Mediterranean and beyond*

- Lebanon
- Cyprus
- Greece
- Italy
- France
- Morocco

**The map only shows the eight case studies with specific geographic locations. The remaining two cases are international tools of cross-cutting application and are not represented on the map.* Source: EFIMED

1. Traditional agro-pastoral management as a model of resilience

Terra Vita certification has revitalised the agro-pastoral system on Lemnos, which combines biodiversity conservation, valorisation of local products and alignment with agri-environmental policies.



Context

Lemnos, in the North Aegean, is an island of 477 km² with plains and hills. Its 16,411 inhabitants (2021) are distributed in a single municipality made up of four municipal units and more than forty hamlets. Its territorial matrix is agro-pastoral, with a predominance of arable land (33.9%) and pasture or low vegetation (33.8%), with no recorded forest masses and with characteristic thermo-Mediterranean scrubland habitats.

The rural system is organised around the mandras, dry stone enclosures that integrate the shepherd's dwelling, the sheepfolds and the associated farmland, with dimensions adapted to the carrying capacity and the size of the associated plots. Management is usually vested in family units headed by a kehaghia, who is responsible for livestock management, annual crop and grazing planning, and guardianship of tangible and intangible heritage. Farms are mixed and are based on cereals and fodder for herd self-feeding, with crops such as "Lemnos" barley, durum wheat, legumes and vines, together with a recent increase in fodder species.
Sheep and goat farming is predominant, more present in the west, while the central-eastern part maintains a more agricultural profile. Local products are supported by a PDO that reinforces their identity and enhances their value.

Landscape of the island of Lemnos. @Dodouras © MedINA (Mediterranean Institute for Nature and Anthropos).

Location
Lemnos Island, North Aegean, Greece

Stakeholders

Project implementation - Mediterranean Institute for Nature and Anthropos (MedINA).

Implementation of measure - Operational body under MedINA: Land Stewards Network (LSN).

Other agencies involved
Public universities, research centres, national environmental NGOs, certification bodies, national accreditation body, international philanthropic foundations, public environmental fund and public authorities.

Type of measure
Management

Type of financial incentive
through certification

Economic sector
Agriculture

Resilience to
Drought, fires

Challenge

The agro-pastoral system on Lemnos faces low economic viability, migration, pressure from imported products and climate change, which has led to the abandonment of traditional practices and the loss of local varieties and breeds. Land degradation is due to changes in land use, fires and overgrazing, together with the abandonment of rain-fed agriculture and the expansion of degraded scrubland, which fragment the mosaic, reduce vegetation cover and increase erosion. Practices such as stubble burning aggravate soil loss and functional desertification. Intensification with foreign breeds improves production in the short term, but reduces quality, increases costs, lowers resilience and compromises the authenticity of local products. Only 500-700 indigenous sheep remain.

How is the agro-pastoral mosaic and the functionality of the mandras system - including landraces, local breeds and semi-natural elements - while maintaining and/or improving economic viability, containing erosion and water scarcity, to be preserved in the face of abandonment and intensification?

Solution

To respond to these challenges, in 2020 the Mediterranean Institute for Nature and Anthropos (MedINA), a Greek NGO dedicated to the conservation of natural and cultural heritage, created a Standard of Good Agro-Pastoral Practices based on local knowledge and field evidence, implemented through the Land Stewards Network (LSN), a voluntary network of farmers and producers that emerged in the Terra Lemnia project (2017-2022). This project investigated traditional agricultural practices and their relationship with biodiversity, and facilitated structuring of the standard into five blocks: crop management; input reduction and sustainable use of resources; livestock management and grazing; conservation of (semi-)natural elements; and maintenance/restoration of mandras, with the combination of mandatory and optional criteria.

The standard resulted in the "Terra Vita - Agricultural Tradition and Biodiversity" certification, applied under the supervision of an agronomist and monitored by a digital register (geographical database and application). It aims to conserve biodiversity, soil and landscape, and to provide technical evidence to guide the Greek Ministry of Agriculture in adapting CAP eco-regimes and agri-environmental measures to the Aegean context.

Pros

- Conservation of biodiversity and the traditional agro-pastoral landscape.
- Recovery of landscape elements: terraces, dry stone walls and local varieties.
- Strengthening economic viability with certification.
- The introduction of a digital monitoring system (geodatabase and mobile app) reinforces traceability, transparency and adaptive management of the mandras.
- Promotion of participatory governance through formal networks.
- Facilitation of alignment with CAP policies and eco-schemes.

Cons

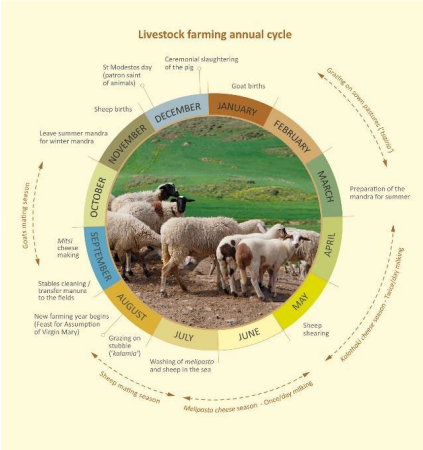
- Initial dependence on external funding.
- Reduction of labour force due to migration and rural ageing.
- Administrative complexity in managing the standard and audits.
- Limited local technical capacity prior to the project, with need for external support.
- Risk of abandonment if there are a lack of sufficient financial incentives or continuity of support.

The Terra Lemnia project filled three gaps: the lack of local technical structure, the need for scientific rigour provided by universities, NGOs and research centres, and the absence of financial resources, solved by the MAVA Foundation (Strategy M6, 2017-2022). After its establishment on Lemnos, the Terra Vita certification was transferred to Kythira. It has been operational since 2021 in Lemnos (12 farmers and 2 food producers) and in Kythira (36 farmers from 2 cooperatives), and continues under the MedINA "Terra Graeca" / "Let it Grow" programmes.

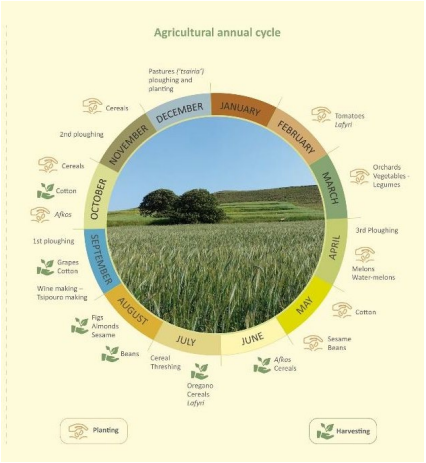
Traditional Mandra in Fakos. @Dimopoulos © MedINA (Mediterranean Institute for Nature and Anthropos).

Technical implementation

The LSN implements Terra Vita certification on farms that meet the mandatory and 60% of the optional criteria, under the supervision of an agronomist and with registration and verification through the geographical database and the application. Certification is in line with the functioning of the mandra system and incorporates its spatial organisation and the annual cropping and grazing calendar. In agriculture, rotations, polyculture, fallow, reduction of agrochemicals, organic fertilisation, reduced tillage and use of local varieties are applied; and in livestock, rotational grazing, own forage production, use of stubble and maintenance of local or adapted breeds. The farms conserve semi-natural elements, restore sheepfolds and create small ponds to reinforce the functionality of the mosaic and reduce the risk of fire.



The certification defines operational and performance indicators in five groups (crops; inputs and fertilisation; livestock and grazing; natural and semi-natural elements; built heritage and water), assessed through digital records, field verification and external audits. Following Terra Lemnia, farms maintain the system on an annual basis, establishing baselines, recording practices and undergoing agronomist visits and independent verifications to ensure traceability and continuous improvements in soil, biodiversity and landscape. The process combines self-declarations, field validation and annual audits within a defined schedule of controls.



Traditional Mandra in Fakos. @Dimopoulos © MedINA (Mediterranean Institute for Nature and Anthropos).

Administrative and governance implementation

MedINA, responsible for the Terra Lemnia methodological framework, converted the Good Practice Standard into the "Terra Vita - Agricultural Tradition and Biodiversity" certification, of which it is the holder and technical reference body. The governance of the system is based on the voluntary participation of farms and on digital tools that organise the registration of practices, verification and annual audits. LSN, coordinated by MedINA, facilitated the adoption of the standard and the implementation of monitoring protocols, in order to consolidate a stable operating model.

Following Terra Lemnia, MedINA maintains and updates the system, supporting farmers and reinforcing cultural and agrobiodiversity aspects through heritage files and local variety registers. Terra Vita identifies producers who meet the standard through agronomist verification, digital records and external audits, with additional technical support in specific areas. In 2025, certification is still active on Lemnos and Kythira, where group certification reduces costs and facilitates short supply chains.

Financial implementation

The MAVA Foundation financed the initial impulse and methodological basis of the system within its M6 Strategy (2017-2022), which facilitated the development of the Good Practice Standard, the monitoring tools (geographical database and application), the certification system and an operational network supervised by an agronomist, as well as training the twelve pilot farmers who were initially certified. In parallel, the "Terra Vita - Agricultural Tradition and Biodiversity" certification generated market value for Lemnos and Kythira products, with a certification fee assumed by MedINA and paid directly to the accredited bodies through core and external funding. In 2023, the "Terra Graeca - Small Farm to Market" programme reinforced the adoption of traditional practices, expanded the number of certified producers and financed the 2024 and 2025 certifications.

After Terra Lemnia, the continuity of the system is supported by funding from the Green Fund, the support of two additional foundations and its integration into the MedINA strategy through "Terra Graeca - Sustainable Food Systems" and, from 2025, "Let It Grow - Sustainable Food Systems".

These mechanisms, together with Terra Vita certification itself, facilitate access to responsible markets, alignment with eco-schemes and the consolidation of sustainable practices, providing the necessary technical and operational support to maintain the annual registration-verification-certification cycle and its coherence with public policies.

Ancient mandra in Tsimandria. @Katsaros © MedINA (Mediterranean Institute for Nature and Anthropos).

Requirements for success

Integration

MedINA, initially through the LSN, has integrated the certification system into its strategy, projects and daily operations, using the criteria and indicators as a basis for admission, monitoring and certification of farms. The application and the geographical database are routinely used to record practices, while the agronomist manages annual control cycles. The certification closes this cycle by verifying compliance and its annual renewal conditions the right to use the Terra Vita seal.

The system ensures traceability, guides technical assistance and supports continuous improvement. Integration now also includes an increasing focus on alignment with eco-schemes and agri-environmental measures.

Terra Vita certification seal. © MedINA (Mediterranean Institute for Nature and Anthropos).

Continuity

Following the Terra Lemnia project, MedINA turned certification into a permanent operational procedure, supported by diverse funding and its integration into the organisation's strategy. Continuity is supported by the involvement of farmers and cooperatives in the registration of practices, by the work of the agronomist as the person responsible for supervision and liaison with the certification body, and by subsequent programmes such as "Let it Grow - Sustainable Food Systems", which reinforce its projection and alignment with the CAP eco-schemes. The University of the Aegean maintains the geographical database, thus consolidating the stable operation of the system.

Specialisation

During Terra Lemnia, technical expertise was ensured through a consortium of universities, research centres and NGOs that provided the methodology, indicators and monitoring protocols, as well as the technical development of the geographical database and application. In the subsequent phase, specialisation is maintained through the MedINA team, supported by successor projects and the continued use of digital tools to ensure traceability and technical coherence.
For specific jobs, MedINA uses external professionals such as graphic designers or marketing specialists.

Collaboration

The implementation of the criteria and indicators, monitoring/certification and digital tools is managed by MedINA through the LSN, in close collaboration with farmers and herders (registration in the application) and with the designated agronomist (field verification). This cooperation extends to local cooperatives and associations and authorities, both local (support and collaboration in the continuity of the project) and national (through the Green Fund and coherence with agricultural policy), ensuring compatibility with rural development policies and farm-to-table approaches.
At the same time, the certification system and the network of producers are designed for replicability in other Aegean territories, in order to maintain verifiable management and traceability criteria that facilitate their alignment with public frameworks and their territorial scaling.

Acknowledgements

The authors would like to thank Rigas Zafeiriou of MedINA for his contributions to this text.

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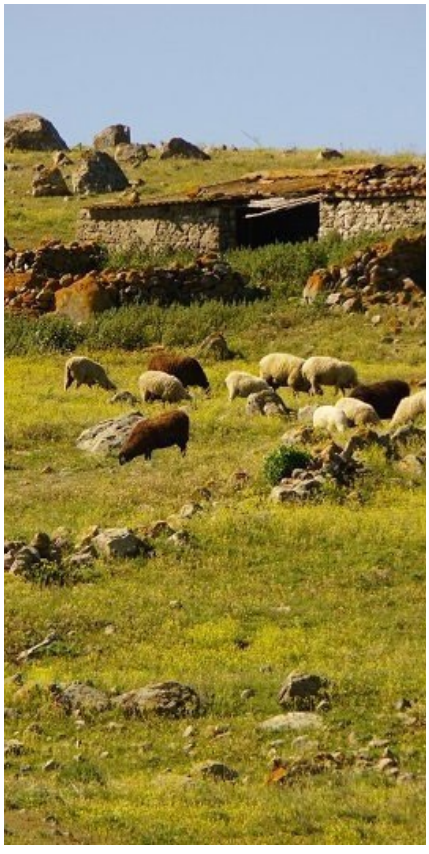


2. TreesAdapt: Platform for forest- and tree-based climate adaptation

TreesAdapt is a platform that promotes climate adaptation through forests, trees and agroforestry, combining science and local action to strengthen capacity in the face of climate change.

Context

Climate change is intensifying its impacts on forest and agroforestry ecosystems, with heat waves, droughts, floods and other extreme events already affecting forests, woody crops (coffee, cocoa, latex, etc.) and their value chains. Because of their longevity and structural function, trees are sensitive indicators of these impacts; at the same time, they constitute a key ecological infrastructure to buffer their effects on agriculture, water, cities and the most vulnerable populations. Forests and trees reduce temperature extremes, mitigate heat stress on people, crops and livestock, regulate the water cycle through infiltration, evapotranspiration and flood control, and protect soils and watercourses from erosion. They also provide food, fodder and livelihoods, especially in developing contexts.

In a scenario of rising temperatures and altered precipitation, the dependence of rural and urban communities on these systems is increasing, making the adaptation of forest and agroforestry ecosystems to maintain the resilience of landscapes and the societies that depend on them an urgent need.

Location
International implementation tool

Stakeholders

Project implementation - International research organisation: Centre for International Forestry Research and Global Agroforestry (CIFOR-ICRAF).

Other agencies involved
Public universities, research centres, national environmental NGOs, certification bodies, national accreditation body, international philanthropic foundations, public environmental fund and public authorities.

Type of measure
Management

Economic sector
Agroforestry, Forestry

Resilience to
Drought

Forage function of trees in silvopastoral systems in semi-arid regions. Khejri, Churu district, Rajasthan, India. V.P. Singh © World Agroforestry Centre CC BY-NC-SA 2.0.

Challenge

Climate change intensifies pressures on forests and agroforestry systems, compromising their ability to maintain essential services and affecting millions of people who depend on them. Although adaptation is urgent, obstacles remain, such as the lack of practical tools, the dispersion of knowledge and the risk/fear of applying inappropriate measures. The challenge is to articulate available knowledge, strengthen capacities and coordinate action so that ecosystems and communities can adapt effectively to an increasingly variable climate.

So **how do we articulate, at local, national and global levels, the knowledge, tools and actors needed for forests, trees and people to adapt together, inclusively and evidence-based, to a rapidly changing climate?**

Solution

TreesAdapt is an international platform driven by CIFOR-ICRAF that promotes effective climate adaptation in trees, forests and agroforestry systems through multi-level cooperation and joint knowledge creation. Created by the Centre for International Forestry Research and Global Agroforestry (CIFOR-ICRAF, an international research organisation on sustainable forests and agroforestry systems), the initiative integrates science, local knowledge and practical tools to support countries, institutions and communities throughout the adaptation cycle - from identification of vulnerabilities to assessment of measures - and foster context-specific decisions to avoid inappropriate adaptations. Through collaboration between governments, research centres, the private sector and communities, and by promoting the participation of minority groups, TreesAdapt aims to strengthen the ecological, social and economic resilience of landscapes and facilitate the coherent integration of tree systems into climate adaptation strategies.

Technical implementation

The technical implementation of TreesAdapt operates as a framework for cooperation between science, public policy and local action that translates the principles of the platform into concrete adaptation measures. Its approach to forests and trees is organised along four lines of action:

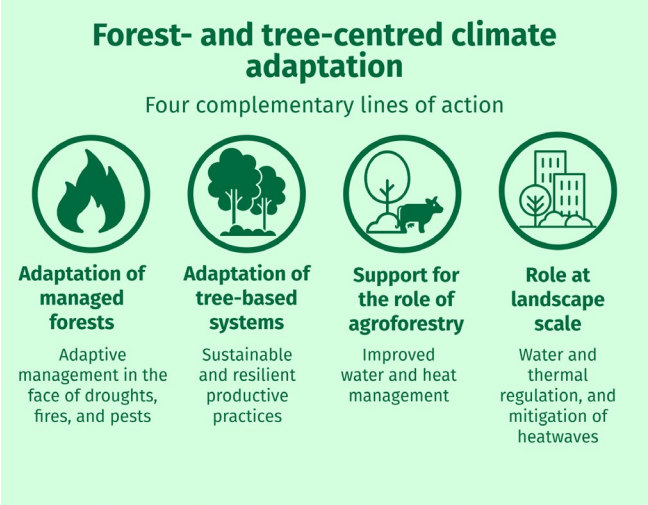
Pros

- Strong institutional integration, ensuring continuity and strategic coherence.
- Multi-scale approach, connecting science, policy and local action for practical application.
- Broad collaboration, generating synergies between international agencies, governments and local actors.
- Robust scientific basis, backed by decades of applied research.
- Knowledge transfer, through tools, methodologies and practical guides that facilitate its implementation in the field.
- Facilitation of alignment with CAP policies and eco-schemes.

Cons

- Complexity of coordination, where its global and multi-sectoral nature requires demanding institutional management and constant communication between regions.
- Impact is difficult to measure, as it functions mainly as an integration framework.
- Dependence on external funding, which may affect the continuity of some actions.
- Regional inequality, due to differences in technical capabilities and available resources.
- Limited local visibility, prioritising global coordination over local needs.

- Adaptation of managed forests through adaptive management;
- Adaptation of tree-based systems and their value chains;
- Support for agroforestry, silvopastoralism and on-farm trees to strengthen agricultural and livestock resilience; and
- Promoting the regulatory role of forests and trees at landscape scale, including in the urban environment.



Four action lines for forest and tree-based climate adaptation. Photo: Produced by author / Carlos Serrano Duque.

From these lines, TreesAdapt deploys four operational components:

1. Generation and synthesis of scientific, technical and traditional knowledge to guide decisions and avoid maladaptation.
2. Development of methods and tools to assess risks, vulnerabilities and adaptation options, as well as to monitor results.
3. Mobilisation of actors through intersectoral and multi-scalar dialogue to build context-specific solutions and coordinate action with national and international policies.
4. Capacity building through training, exchange and the creation of institutional and financial environments that enable the implementation and scaling up of measures.

Technical and operational components of TreesAdapt. Photo: Produced by author / Carlos Serrano Duque.

Across the board, the platform maintains a continuous learning and feedback loop that updates knowledge, improves methods and adjusts strategies according to changing conditions. Together, TreesAdapt turns international cooperation into evidence-based, inclusive and coordinated adaptation actions, strengthening the resilience of ecosystems and communities and linking science, policy and land management.

Administrative and governance implementation

TreesAdapt is structured as an international platform coordinated by CIFOR-ICRAF, bringing together governments, international agencies, research centres, universities, civil society and the private sector through a flexible partnership model with strategic, technical and financial roles. Central coordination

is responsible for operational planning, knowledge management and the articulation of thematic working groups. It is composed of experts, public institutions, local communities, private actors and international networks that bring coherence across scales.
Governance is based on principles of transparency, participation and multi-level cooperation, in order to connect global adaptation agendas with national and sectoral frameworks, and aligning adaptation, mitigation and restoration. Decision-making is consensual and combines the technical leadership of CIFOR-ICRAF with the contribution of regional and national partners, supported by stable communication, coordination and accountability mechanisms.

TreesAdapt also maintains operational links with other international initiatives and platforms (e.g. the Global Adaptation Network or the Global Landscapes Forum) to avoid duplication, generate synergies and expand its advocacy and funding capacity. Overall, this administrative and governance structure provides legitimacy, continuity and effectiveness, in order to consolidate TreesAdapt as a lasting space for cooperation between science, public policy and local action.

Financial implementation

TreesAdapt's funding relies on a cooperative and progressive model based on voluntary contributions from partners - financial, technical or in the form of staff - reflecting its character as an international partnership platform. CIFOR-ICRAF coordinates economic management with criteria of transparency and results orientation, in an open framework that allows for the incorporation of new partners and funding mechanisms as the initiative grows.

Agroforestry systems favour a more efficient use of natural resources and help to reduce the effects of climate change on the agricultural landscape. Example of integrated agroforestry in rice fields, Sri Lanka. DKNG Pushpakumara © World Agroforestry Centre.

The resources mobilised are mainly allocated to the four operational areas mentioned above: knowledge generation, development of methodological tools, institutional coordination and capacity building, thus ensuring technical and administrative sustainability and avoiding duplication.
In addition, TreesAdapt leverages public and private investment to support tree, forest and agroforestry-based adaptation, in order to strengthen the connection between science, policy and climate finance.

Overall, the platform operates through a flexible, collaborative and scalable financial system designed to sustain long-term cooperation and ensure continuity of adaptation actions in diverse contexts.

Requirements for success

Integration

TreesAdapt is integrated into the daily work of CIFOR-ICRAF as an operational framework that connects research, policy and action on the ground. It does not act as a stand-alone project, but guides and coordinates the mainstreaming of adaptation into restoration, agroforestry, governance and value chain programmes. Its implementation is supported by shared methodologies - vulnerability assessment, adaptation guidelines and planning tools - that are applied in field teams and regional projects. Coordination between programmes and feedback from

local results ensure coherence between science and practice, enabling tree-based adaptation to become a natural part of the day-to-day activities of CIFOR-ICRAF and its partners.

Continuity

The structural integration of TreesAdapt into CIFOR-ICRAF, where it functions as a permanent framework for work on tree-based adaptation, ensures its continuity. Its development does not depend on a single project or one-off funding, but on continuous cooperation between scientific programmes, regional centres and international partners. Partnerships with FAO, the Global Centre on Adaptation, or the Consultative Group on International Agricultural Research (CGIAR), a global agricultural research partnership for food security, provide technical and financial stability, ensuring the constant updating of methodologies and the geographical expansion of its actions. In this way, TreesAdapt maintains a sustained flow of knowledge, technical support and shared learning that facilitates intervention continuity beyond project cycles.

Specialisation

TreesAdapt draws on CIFOR-ICRAF's scientific and technical expertise in adaptation, restoration and agroforestry. The platform brings together decades of experience in research on resilient forests, trees and production systems, translating the knowledge generated into tools, guidelines and methodologies that are applicable in the field. Its interdisciplinary approach combines ecology, forest management, governance and economics, strengthening the capacities of local teams and institutional partners.
This consolidated technical base allows for the development of robust, replicable adaptive solutions aligned with international climate and forest policies.

Collaboration

TreesAdapt is based on a multi-scale collaboration that connects research centres, public administrations and international networks. CIFOR-ICRAF encourages cooperation between regional teams, scientific programmes and technical partners, promoting the exchange of data, methodologies and learning. The platform works together with organisations such as FAO, the Global Centre on Adaptation and the CGIAR to articulate efforts, share experiences and broaden the territorial scope of actions. This collaborative approach ensures coherence between levels of governance and strengthens collective capacity to drive tree-based adaptation in different geographical contexts.

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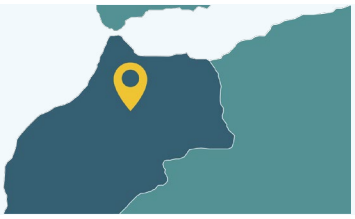
3. Ifrane Model Forest: silvopastoral co-management and cedar resilience

The Ifrane Model Forest promotes co-management between communities and forest administration to reduce overgrazing and reverse cedar decline, consolidating a model of social forestry.



Context

The Ifrane National Park area in the Moroccan Middle Atlas, created in 2004 and expanded in 2008 to 125,000 ha, covers altitudes up to 2,409 m and a forest matrix dominated by Atlas cedar, with about 114,500 ha representing about 85% of the country's cedar forest. This forest system coexists with high altitude pastures and stands of kermes oak that support key water and pastoral functions. The province of Ifrane, where a large part of the park is located, has 160,904 inhabitants, a population density of 49 inhabitants/km² and a high poverty rate (31.1%), in a socio-economic context dependent on natural resources.

The territory faces two main pressures: the progressive decline of the cedar forest, closely linked to water stress and recurrent droughts affecting mainly limestone soils and sunny slopes, and the degradation of resources due to overgrazing and extraction of fuelwood and fodder under subsistence conditions. Although the core of the Middle Atlas remains relatively stable, the ecological margins show increasing vulnerability under the combination of climate change, human pressure and historical overexploitation effects. High livestock stocking limits pasture and forest regeneration, favours soil compaction and reduces regrowth capacity, while domestic dependence on fuelwood intensifies pressure on timber resources. All this compromises the natural recovery of the ecosystem.

Location
Ifrane National Park, Ifrane Province, Fès-Meknès, Morocco

Stakeholders

Project implementation - Ifrane Model Forest / Ifrane Model Forest Association.

Other agencies involved - National Water and Forestry Agency, forestry associations, livestock associations, local and state administrations
National Water and Forestry Agency, silvopastoral associations, livestock associations, local and state administrations.

Type of measure
Multiple (Management, Governance)

Economic sector
Agroforestry, forestry

Resilience to
Environmental management, drought

View of a cedar grove from a pasture in Ifrane National Park. Reda Abouakil. CC BY-SA 3.0.

Challenge

The central problem is not an isolated threat, but the persistent mismatch between the ecohydrological capacity of the system and the actual intensity of uses. Repeated droughts raise cedral mortality/regeneration thresholds (with greater vulnerability at ecological boundaries and in specific areas such as exposed sunny areas), while pastoral cycles and domestic fuelwood/forage extraction hinder grass and sapling recovery and accelerate soil loss, narrowing the restoration window and reducing both mosaic functionality and water availability.

In this context, **how can silvopastoral uses and resource extraction around the Atlas cedar be readjusted, alleviating water and soil pressure and restoring the mosaic, without compromising local livelihoods?**

Nomadic settlement in the cedar groves of the Ifrane National Park. Reda Benkhadra. CC BY-SA 4.0.

Solution

To reverse the pressures, the territory shifted from open use of resources to a co-management system that manages silvopastoral management and favours the regeneration of cedar. Since 2007, silvopastoral associations have been set up in the Ifrane National Park, in order to initiate a model of co-management between pastoralists and forest administration promoted by the National Agency for Water and Forests (Agence Nationale des Eaux et Forêts). This model was consolidated through local silvopastoral management agreements and contracts that adjusted loads and schedules, established temporary closures with compensation ("social forestry"), delimited sensitive areas and prioritised natural regeneration - proven to be effective after excluding grazing - reserving planting for situations with no regeneration capacity.

Pros

- Inclusion in international networks that provide methodological, financial and peer-to-peer exchange support.
- Consolidation of co-management with 11 legally constituted silvopastoral associations, which carry out rotations, crop breaks and pasture improvements.
- Significant reduction of energy pressure through implemented measures.
- Diversification of production with lavender and saffron as high-value crops.
- Stable scientific-academic support in ecophysiology and monitoring of the decline of *Cedrus atlantica*.
- Institutional support that ensures a legal and logistical framework.
- Recurrent international cooperation.

Cons

- Dependence on external funding for key lines.
- Cedar decline aggravated by water stress and recurrent drought, with localised mortality.
- Persistence of overgrazing in areas not covered by silvopastoral associations or outside forest areas where grazing is prohibited.
- Natural regeneration effective in potential areas, but limited in margins, requiring more costly targeted planting.
- Socio-economic pressure on rural communities dependent on forest and energy resources.

The system incorporated participatory monitoring to adapt decisions on the ground. In 2011, the Ifrane Model Forest was created, a local multi-stakeholder governance platform integrated into the International Model Forest Network, covering the provincial level (357,300 ha) with the Ifrane National Park as its territorial core. Its main function is to integrate communities, forest administration and other stakeholders to coordinate and scale up these measures across the province.

Technical implementation

To reverse cedar regression and resource degradation, the National Agency adopted a co-management approach that mandated silvopastoral use through grazing exclusions with offsets, rotations, strategic watering and pilot plantings of native grasses. Since 2007, these measures have been integrated into the Ifrane National Park Management Plan through silvopastoral partnerships.

Technical implementation is supported by 11 silvopastoral partnerships that transformed former open uses into planned rotations, improved forage capacity and reduced pressure on the forest. The Model Forest, together with the National Agency, reinforced this management through a planted cedar corridor and exclusion areas that favour natural regeneration, reserving targeted planting for areas without resilience. Following the 2022 fire, targeted reforestation was implemented and preventive infrastructure was improved.

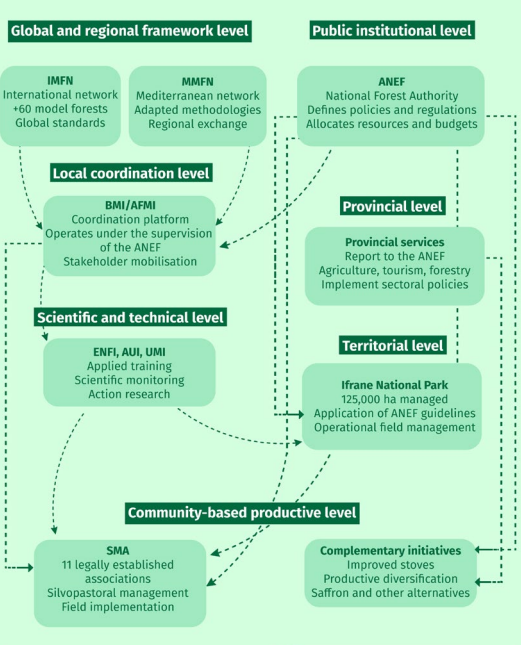
The diversification of production incorporates lavender and saffron as alternatives compatible with biodiversity, and the reduction of domestic pressure on biomass is supported by efficient ovens and cookers, as well as solar thermo-siphons. Overall, the Model Forest integrates rotational grazing, natural regeneration, post-fire restoration, productive diversification and energy efficiency, consolidating an operational package that strengthens the functionality of the cedar forest and improves rural livelihoods.

Saffron flower and the process of obtaining the premium saffron. © courtesy of International Model Forest Network / Ifrane Model Forest.

Administrative and governance implementation

The Ifrane Model Forest functions as a platform for concertation at landscape level within the International Network and the Mediterranean Model Forest Network, providing it with a common framework for participatory governance and learning between territories. At the institutional level, the National Agency - together with the Ifrane National Park - acts as the main public partner and frames the implementation on the ground, while the Model Forest coordinates with the relevant provincial

services. Technical and scientific support comes from the National School of Forestry Engineers, Al Akhawayn University and Moulay Ismaïl University, which provide applied training and monitoring of the interventions. At the community-production level, the 11 silvopastoral associations implement planned rotational grazing, exclusions for natural regeneration and pilot plantings in partnership with the National Agency. The scheme is complemented by energy efficiency measures promoted by the National Agency (improved ovens and cookers) and by diversification initiatives compatible with conservation, such as saffron. All of this is articulated through annual plans coordinated by the Model Forest with the forest administration and the National Park, ensuring traceability and operational coherence. Together, this multi-level architecture - international and Mediterranean network, forest administration, park, universities and community associations - supports a stable, replicable co-management model adapted to the ecological and social challenges of the Middle Atlas.



Governance structure and levels of coordination of the Ifrane National Park.

Financial implementation

The financial sustainability of the Model Forest is based on a combination of international funding, national public resources and local in-kind contributions. At the international level, Natural Resources Canada channels support through the International Network and the Mediterranean Model Forest Network for restoration, governance and capacity building actions in Ifrane (2024-2025), while the FAO "Paris Agreement in Action" project is funding the 25 ha pilot site starting in 2023. At the national level, the National Agency provides resources for the energy efficiency package through the distribution of improved cookers and ovens. Locally, silvopastoral associations contribute labour, monitoring of exclusions and support for planting, a key part of the co-management model. In productive diversification, the lavender programme - financed by the Critical Ecosystem Partnership Fund - implemented some 27 ha and provided equipment and training to cooperatives, while the saffron pilot is progressing as an internal Model Forest action. Overall, this multi-level financial scheme supports restoration, silvopastoral co-management, productive diversification and energy efficiency in the Ifrane Model Forest territory.

Requirements for success

Integration

In day-to-day practice, the Model Forest operates through annual plans developed by the Model Forest Partnership and validated by the National Agency and the National Park, which guide implementation on the ground. The silvopastoral associations apply rotations, exclusions and cultural care within their routines, while the National Agency and the National Park integrate these actions into their regular management. Participatory monitoring - regeneration, areas managed and fuelwood consumption - adjusts interventions each season. Thus, the Model Forest functions as a continuous cycle of planning, implementation, monitoring and adjustment that is fully integrated into communities and management.

Continuity

The Model Forest operates under continuous management through annual plans coordinated by the Model Forest Association, implemented in the field by the silvopastoral associations and institutionally framed by the National Agency and the National Park, with technical support from universities. Its support combines the FAO project (25 ha since 2023), the 2024-2025 funds channelled by the International Network and the Mediterranean Model Forest Network (funded by Natural Resources Canada), public support from the forest authority - including the distribution of improved stoves/ovens - and in-kind contributions from the associations. Each campaign prioritises regeneration and restoration, integrates energy efficiency measures with verified reductions in fuelwood consumption and maintains productive diversification with lavender and saffron.

Specialisation

The Model Forest operates with a core team of specialists: community-based silvopastoral management technicians who organise rotations and exclusions; forest restoration specialists from FAO's "Paris Agreement in Action" project, plantation managers, and energy efficiency technicians who introduce improved ovens and cookers. Production diversification includes specialists in aromatic plants in the lavender programme and technicians from the Model Forest in the saffron pilot. Scientific support comes from universities, whose studies of forest ecophysiology guide the selection of techniques and sites.

Collaboration

The Model Forest operates as a platform for multi-scale collaboration. At the international level, it is integrated into model forest networks that facilitate technical exchange and funding. At the scientific-academic level, it collaborates with universities and forestry schools for applied research on cedar and training of professionals. In international cooperation, it participates in climate and restoration programmes that provide funding and expertise. On the production side, it works with donors and NGOs to introduce high-value crops and aromatics. And at the local level, it articulates co-management agreements between the forest administration, the park and community associations to reconcile cedar conservation and livelihoods, acting as a Mediterranean node for validation and replication of solutions.

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4. Forest and Landscape Restoration in the Shouf Biosphere Reserve

Since 2012, the Shouf Reserve has been applying a forest and landscape restoration approach that integrates governance, adaptive management and circular economy to restore ecosystems and prevent fires.

Context

The Shouf Reserve in Lebanon, declared a biosphere reserve by UNESCO in 2005, covers some 500 km² in core, buffer and transition zones. It combines relict cedar forests with an agrosilvopastoral mosaic (oaks, pines, terraces and pastures) now altered by the colonisation of abandoned terraces, which increases the continuity of the fuel. Migration due to land degradation and lack of employment favoured the expansion of quarries, dispersed construction and the loss of cultural practices and local governance. The abandonment of terraces reduced water retention and accelerated erosion, while secondary vegetation accumulated biomass and increased fire risk. Uncertain tenure and lack of management generate conflict and weaken management, and the arrival of refugees and additional livestock increases overgrazing and habitat fragmentation. Agricultural intensification and the impact of quarries increase the overall vulnerability of the territory.

Fires are a structural threat: the burning of agricultural residues in autumn and the continuity of scrubland, resprouts and secondary pinewoods facilitate ignition and spread, especially on the road network and peri-urban areas. These dynamics make the Shouf a priority landscape for reducing fire risk and preserving the functionality of its ecological mosaic.

Mixed cedar and hardwood forest in the Shouf Biosphere Reserve. © courtesy of Shouf Biosphere Reserve.

Location
Shouf Biosphere Reserve, Shouf/Aley, Lebanon

Stakeholders

Project implementation - Public administration, Ministry of Environment of Lebanon: Designated protected area management committee; and NGOs: Al-Shouf Cedar Society.

Other agencies involved - Municipalities, private landowners, land users (herders and farmers), research centres, international cooperation agencies
Municipalities, private landowners, land users (herders and farmers), research centres, international cooperation agencies.

Type of measure
Governance

Type of financial incentive
Biomass and composting value chain, community microfinance (small loans), compensation in the form of technical support

Economic sector
Forestry

Resilience to
Fires, land degradation

Challenge

All this occurs in a territory that supplies water and basic ecosystem services to 28 municipalities, so the challenge is simultaneously environmental and socio-economic. So, in that context: **How can the agrosilvopastoral mosaic of the Shouf Reserve be redeveloped and managed while creating local employment linked primarily to biomass management and restoration, while at the same time safeguarding the ecological functions and water services of the landscape?**

Anthropic pressures on the Shouf landscape: agricultural abandonment (left), uncontrolled urbanisation (centre) and quarrying (right). Shouf Biosphere Reserve and Pedro Regato © courtesy of Shouf Biosphere Reserve

Solution

The application of the forest and landscape restoration approach in the Shouf Reserve proposes participatory planning at the landscape level that redirects land use and prioritises environmental and socio-economic benefits simultaneously. The strategic lines focus on several actions that aim to: reduce vulnerability to fire through preventive fuel management on roadsides and interface zones, replace agricultural burning with local valorisation of biomass into briquettes and compost to create employment and affordable energy, restore terraces and dry stone walls, and reactivate agricultural uses, including higher value species/crops, in order to stabilise soils and break fuel continuity, and regulate grazing to control regrowth, favouring functional mosaics and ecological connectivity.

Pros

- Recovery of soils and terraces, improving water retention.
- Strengthening ecological connectivity and biodiversity.
- Fire risk reduction through biomass management.
- Local employment generation with briquette and compost plants.
- Promotion of participatory and multilevel governance.
- Facilitation of replication and scaling thanks to standardised protocols.

Cons

- High initial dependence on external funding.
- Requirements for strong institutional coordination.
- Risk of abandonment if there is a lack of continuity of resources.
- Presence of tensions due to population pressure and overgrazing.
- Difficulty in applying rules in a context of unclear land tenure.

This initiative was led by the Designated Protected Area Management Committee (a governmental committee under the Lebanese Ministry of Environment) that manages protected areas and coordinates, among others, the Al-Shouf Cedar Society (a Lebanese NGO that manages the Shouf Reserve), municipalities and the Mediterranean Mosaics programme. In terms of governance, the plan promotes local agreements and regulatory adjustments (such as restrictions on burning or enabling selective thinning), together with training and awareness-raising for landowners and crews, and monitoring with ecological and socio-economic indicators to sustain and scale up measures.

Technical implementation

Since 2012, the Shouf Reserve has consolidated a forest and landscape restoration approach based on multi-level governance coordinated by the Cedar Society, which includes municipalities, private landowners, farmers, herders and technical teams. The model is built on three pillars: participatory planning, an integrated soil-water-plant technical package, and adaptive management through indicators of survival, erosion, connectivity and biomass utilised.

The implementation is structured along three lines. In forest restoration, native plant production is standardised, connectivity between cedar groves is strengthened through species combinations, high mountain slopes are diversified, tree islands are planted in degraded pastures, and quarries, wetlands and riparian forests are rehabilitated in collaboration with private landowners. In agriculture, terraces are recovered through the reconstruction of dry stone walls and the reactivation of traditional crops, conserving hedges and rocky elements to control erosion and maintain connectivity. In fire prevention and circular economy, fuels are managed on roadsides and urban-forest interface, with biomass going to the Kfarfakoud briquette plant and complemented by the Baadarane composting plant.

Examples of traditional dry stone terraces in the Shouf Biosphere Reserve. Shouf Biosphere Reserve and Pedro Regato © courtesy of Shouf Biosphere Reserve.

The package operates under an adaptive management cycle that combines ecological monitoring, technical-economic evaluation and annual adjustment, allowing for scaling up interventions and replication of the approach through the sequence "Partnership Building + Pilot Fieldwork → Replication".

Administrative and governance implementation

The administrative implementation of the restoration approach in the Shouf Reserve is coordinated by the designated protected area management committee, a body appointed by the Ministry of Environment under the Protected Areas Framework Law. This law defines its structure, functions and the appointment process of its members. The Committee brings together local authorities, NGOs - with the Cedar Society as lead manager - and resource users, and has an executive committee to coordinate activities and oversee the management team responsible for the day-to-day work. This framework ensures participatory and multi-level governance.

The management process combines participatory planning and mapping, standardised technical protocols as outlined in the guidelines of the landscape and forest restoration approach, capacity building for local stakeholders and dissemination tools, together with adaptive management based on landscape and operational indicators. In parallel, local co-management mechanisms and agreements with private landowners are in place to implement pilot interventions that facilitate the adoption of practices such as thinning, pruning and the use of biomass.

The circular economy aspect is articulated through the operation of two plants initially promoted by the Shouf Reserve: the Kfarfakoud briquette plant, currently managed by the Farah Social Foundation, and the Baadarane composting plant, operated by a private company and aimed at waste management and

the supply of natural fertilisers. In both cases, the Shouf Reserve maintains continuous accompaniment and offers additional support when needed.

Financial implementation

The financial implementation of forest and landscape restoration in Shouf combines seed capital, local co-financing, market returns and other sources within a circular scheme managed by the Committee. The initial phase (2012-2016), funded by Mediterranean Mosaics/MAVA, allowed for the design of the approach, standardisation of protocols and production of native plants, and was later consolidated with contributions from the European Neighbourhood and Partnership Instrument, the Italian Agency for Development Cooperation, FAO, the World Food Programme and the Lebanese Reforestation Initiative, which supported participatory planning, pilots and training.

Agreements with municipalities and landowners provided logistics and maintenance, along with microfinance for green businesses linked to non-timber forest products, tourism, biomass and terraced agriculture. The Committee currently manages funds from the Ministry of Environment, the reserve's own income and international donations. In the early days it was necessary to incorporate economic incentives to overcome the reluctance of some landowners to invest in improving the environment.

Cutting briquettes at the Karkafoud plant. © courtesy of the Shouf Biosphere Reserve - Sarah Nasrallah and NOWLEBANON.

The economic return comes from the Kfarfakoud briquette plant - which transforms biomass and pomace into bioenergy - and the Baadarane composting plant - whose compost is returned to terraces - closing the circular economy and sustaining the operation. The whole cycle is managed with an adaptive approach based on technical indicators that guide resource allocation and territorial scaling.

Requirements for success

Integration

In the Shouf Reserve, the Cedar Society, in coordination with the Committee, integrates the planning → design → implementation → monitoring → cost-benefit assessment → adjustment → replication cycle into the annual operation. The prioritisation of interventions (micro-basins, dry wells, dry stone sections, restoration of terraces, tree islands and connectivity between cedar groves) is defined through participatory workshops with municipalities, landowners and users. Actions are organised into recurrent works and management campaigns, while monitoring - survival, stability of works, functional hectares and diesel replacement - is incorporated into the regular inspections. The cost-benefit assessment guides the reallocation of resources each year towards the most efficient techniques, closing a cycle of adaptive management that facilitates the replication of successful measures in new areas of the reserve.

Continuity

In the Shouf Reserve, the forest and landscape restoration approach has evolved from pilot projects to ongoing management by being integrated into the permanent agenda of the Cedar Society, coordinated by the Committee. The annual planning, implementation, monitoring and adjustment cycles are part of regular operations and are consolidated as a standard procedure.

The sustainability of the system is supported by international funding, local contributions from municipalities and landowners and returns from the circular economy, jointly managed by the Cedar Society and the Committee. These resources are aimed at supporting the local population and sustaining biomass recovery and composting initiatives, ensuring continuity and replicability beyond one-off projects.

Composting operations at the Baadarane plant in the Shouf Biosphere Reserve. Shouf Biosphere Reserve and Pedro Regato © courtesy of Shouf Biosphere Reserve.

Specialisation

During the project phase, the Shouf Reserve relied on external expertise from universities, research centres and aid agencies to provide the scientific knowledge and training needed for nursery protocols, micro-basin techniques and ecological indicators. In the ongoing management phase, the expertise lies with the technical teams of the Cedar Society and the Committee, which have integrated these methodologies into their daily operations. These teams - supported by local brigades and municipal staff - supervise plantations, micro-basins, terrace restoration and biomass management, with capacity for monitoring, annual adjustment and replication in new sites, thus transforming the initial scientific basis into applied technical competence within the day-to-day management of the reserve.

Collaboration

In the Shouf Reserve, the Cedar Society, overseen by the Committee, coordinates restoration with municipalities, farmers, herders and private landowners, who participate in planning and facilitate access and maintenance through various agreements. The local brigades operate under this coordination, integrated into the Committee's governance framework. The reserve also maintains a stable collaboration with the Ministry of Environment and international programmes that provide technical and financial support, as well as a continuous exchange with Italian teams specialising in biomass. This set of partnerships ensures operational continuity, technical coherence and replicability of the model.

Acknowledgements

The authors would like to thank Kamal Abou Assi of the Al-Shouf Cedar Society - Shouf Biosphere Reserve for his contributions to this text.

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5. Annual land preparation for fire risk reduction in Bonorva

The municipality of Bonorva applies an annual land preparation model based on diagnosis, simulation and selective treatments to reduce fuel continuity and limit the spread of fires.

Context

Bonorva, in the Sardinian hinterland, is located in a territory highly affected by fires, with a mosaic of agricultural areas, pastures, scrubland and scattered forest stands that generate a high fuel continuity. This structure, together with open areas exposed to the wind, conditions the spread of fire and increases the vulnerability of sensitive areas such as Mariani Park.

The urban core and scattered settlements are partially inserted into this mosaic, creating critical points at the forest-urban interface. In recent years, the municipality has experienced large-scale fires that have affected homes and infrastructure, in addition to the operational complexity of the wind farm, where aerial vehicles cannot operate.

Panoramic view of Bonorva. © Gianni Careddu, CC BY-SA 4.0.

Location
Bonorva, Sardinia, Italy

Stakeholders

Project implementation
Specialised technical agency: Fire Use and Analysis Group of the Forestry Corps (Forestry and Environmental Monitoring Corps).

Other agencies involved
Scientific institute, regional forestry agency, local administration.

Type of measure
Management

Economic sector
Forestry

Resilience to
Fires

The local regime is characterised by recurrent and rapidly spreading fires, driven by summer dryness and open topography. Technical analysis by the Forestry Corps and the Forestry Agency highlights that fuel accumulation and connectivity account for the wide spreads observed, especially in the St. Lucia Plain.

Although a robust extinguishing system is in place, Sardinia continues to face extreme fires. In Bonorva, the structural factors of the landscape and settlement pattern show that risk cannot be managed through emergency response alone. The technical documentation emphasises the need to anticipate the local regime and act on the fuel before each summer season.

Challenge

Recent fires exhibit more intense and extensive fire behaviour than in previous decades, a pattern consistent with the so-called fire exclusion paradigm, according to which continued suppression favours more destructive future fires. Fuel build-up and extreme weather conditions are driving large fire scenarios that exceed conventional firefighting capabilities. In addition, many decisions are still focused on the emergency, when the land requires prior interventions that modify the fuel structure and reduce its connectivity before the critical period.

The challenge is not only to reduce biomass, but also to reorganise the land through strategic actions that limit the spread and protect the most exposed areas, especially the forest-urban interface. This calls for a structural, sustained, preventive approach based on technical diagnostics.

So, **how can this growing risk pattern be transformed into a robust preventive strategy that, based on technical analysis and advanced simulation, can reduce the potential for spread and effectively protect the most vulnerable areas of the municipality?**

Solution

The solution applied in Bonorva consists of establishing an annual and replicable model of land preparation aimed at reducing the horizontal and vertical continuity of fuel in strategic points of the municipality, through the combination of prior diagnosis, propagation simulation and execution of mitigation actions.

The methodology is based on a detailed study of the landscape, the fire regime and local vulnerabilities to identify several critical areas of the municipality and then to optimise interventions using the SWS (Sardinian Wildfire Simulator), a modelling system that simulates the spread of fire in real time to identify the areas where treatments best reduce the risk, ensuring the maximum preventive effect with the minimum treated surface area.

On this basis, selective treatments are designed and implemented, such as prescribed burning of scrubland and grasses, widening of the road network as lines of defence, fuel partitioning under the wind farm and creation of firebreaks in sensitive areas, creating a more compartmentalised and manageable landscape in the event of fires.

Pros

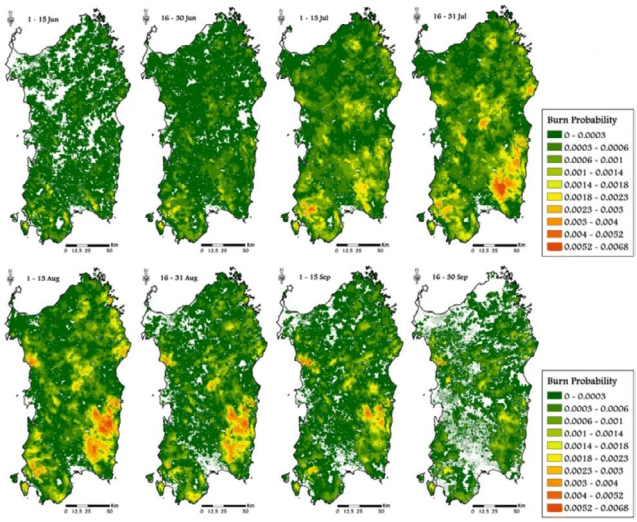
- Conservation of biodiversity and the traditional agro-pastoral landscape.
- Recovery of landscape elements: terraces, dry stone walls and local varieties.
- Strengthening economic viability with certification.
- The introduction of a digital monitoring system (geodatabase and mobile app) reinforces traceability, transparency and adaptive management of the mandras.
- Promotion of participatory governance through formal networks.
- Facilitation of alignment with CAP policies and eco-schemes.

Cons

- Initial dependence on external funding.
- Reduction of labour force due to migration and rural ageing.
- Administrative complexity in managing the standard and audits.
- Limited local technical capacity prior to the project, with need for external support.
- Risk of abandonment if there are a lack of sufficient financial incentives or continuity of support.

This preventive approach is reinforced by the complementary use of advanced remote sensing and modelling tools (such as the S²IGI satellite system) to improve hazard prediction, vegetation condition monitoring and action planning under different scenarios.

All of this is part of a public strategy aimed at the creation of passively safe territories, consistent with the paradigm shift towards anticipating risk through structural actions on fuel, rather than relying exclusively on response during the emergency. Beyond the concrete actions, the case of Bonorva is the first full application of an operational methodology designed as a reference framework for the annual planning of land fire preparedness, conceived to be replicable and transferable to other municipalities that are at high risk.



Example of fire probability prediction using simulators such as SWS. © Salis, M., Ager, A.A., Alcasena, F.J. et al. Analyzing seasonal patterns of wildfire exposure factors in Sardinia, Italy. Environ. Monit. Assess. 187, 4175 (2015). https://doi.org/10.1007/s10661-014-4175-x, CC BY.

Technical implementation

The technical implementation is structured in a sequence of analysis, planning and execution adapted to the Bonorva territory. The process begins with a municipal diagnosis that characterises the landscape, topography, climate, fuels, wildland-urban interface and fire regime, with the identification of critical points where fuel continuity favours rapid spread. Based on this diagnosis, intervention hypotheses are formulated and evaluated using the SWS simulator, facilitating analysis of the propagation and comparison of the effect of different treatments. The simulations optimise the technical design, achieving maximum risk reduction with minimum surface area intervention. On this basis, strategic actions such as prescribed burning in the forest-urban interface, selective road widening, fuel sectorisation under the wind farm and the creation of firebreaks and silvicultural treatments in key areas are carried out.

The S²IGI satellite system complements the process by providing near real-time information on ignitions, short-term spread, meteorological hazards and mapping of fuels and burnt areas, facilitating adjustment of the design and timing of actions. Overall, the methodology combines territorial diagnosis, advanced simulation and selective fuel treatments to generate a more compartmentalised landscape and reduce the likelihood of high intensity fires.

Administrative and governance implementation

The administrative and governance dimension ensures that technical actions are developed with continuity, coordination and legal backing. The process is articulated on the basis of the methodological framework defined by the Fire Analysis and Use Group of the Forestry Corps, in coordination with the Bioeconomy Institute of the National Research Council, the Regional Forestry Agency for Territorial and Environmental Development of Sardinia and the Municipality of Bonorva. The Forestry Corps carries out analysis, surveillance and preventive coordination functions, while the Forestry Agency manages operational implementation on the ground.
The role of the municipality is key, as prevention requires intervention on private land and in peri-

urban areas. To this end, the City Council can pass an ordinance declaring the need for risk mitigation and authorising prescribed burning and other treatments on private plots, ensuring the legal basis and annual continuity of interventions. Governance also includes active community involvement through communication, training and awareness-raising actions, which are essential to strengthen the understanding of risk and the social acceptance of measures.

This strategy is aligned with the Italian Civil Protection framework, which recognises these actions as structural prevention, facilitating their integration into regular municipal planning and their replicability. Bonorva's experience shows that the model is only scalable if specialised public bodies take over planning and preventive implementation on a permanent basis at the municipal level, supported by stable regional frameworks, qualified professionals and local operators, with technical bodies exercising training, support and monitoring functions.

Financial implementation

The financial implementation of Bonorva's model is based on optimising public spending, redirecting resources from extinguishing to structural prevention at the municipal level. In the initial phase, the methodological development and pilot implementation were undertaken by the Forestry Corps and the National Research Council with their own resources, integrating prescribed burning into the regular training of operators and without clearly distinguishable additional costs.

For generalisation, the model distinguishes between planning and implementation. The complete study of a typical rural municipality, including diagnosis and simulation, can be carried out by qualified professionals at an estimated cost of €10,000-15,000, while the annual implementation of preventive actions requires around €20,000 per municipality. At regional level, planning and implementation in the 100 most at-risk municipalities would involve an initial investment of approximately 1.5 million euros and an annual cost of around 2 million euros, compared to an annual expenditure on extinguishing of around 100 million euros.
The viability of the model is based, therefore, on a strategic reorientation of resources through stable regional frameworks, rather than on increased public spending.

Requirements for success

Integration

The preventive methodology applied in Bonorva is integrated into the ordinary functioning of the institutions responsible for the territory by being organised as an annual cycle that is aligned with the usual fire risk assessment and planning procedures. The tasks of territorial analysis, simulation and definition of interventions are part of the regular functions of the technical services, which enables them to be implemented without creating parallel structures or extraordinary arrangements.

Prescribed burning, fuel treatments and strategic actions are also incorporated into the preventive work that forestry agencies carry out each season, acting as a programmed extension of existing practices. This continuity is reinforced by the recognition of these interventions as structural prevention in the Italian Civil Protection framework, which allows local governments to integrate them into their annual pre-fire season planning and ensures their stability over time without the need for exceptional mechanisms.

Continuity

Following initial implementation, the continuity of the process at Bonorva is ensured because the methodology is conceived as a preventive cycle to be repeated every year before the period of highest risk. This design establishes that the study of the territory, the updating of the propagation scenarios by means of the simulator and the programming of interventions are carried out on a recurring basis, making it possible to adjust the actions according to the evolution of the fuel, the vegetation and the conditions of each campaign. Likewise, the recognition of these measures as structural prevention within the framework of Italian Civil Protection reinforces their integration into ordinary municipal planning, making it easier for fuel reduction and land preparedness to be maintained in a stable manner over time and not depend on one-off actions or extraordinary devices.

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Specialisation

The preventive methodology in Bonorva requires specialised technical profiles in all its phases. Territorial analysis requires expertise in spatial analysis, fire dynamics and model development, tasks undertaken by the Fire Analysis and Use Group of the Forest Service and the Bioeconomy Institute of the National Research Council. Preventive planning requires trained technicians to operate the SWS simulator, with skills in modelling, risk analysis and scenario interpretation. The execution of prescribed burns, fuel treatments and strategic actions is carried out by operational teams with specific training in fire use and safety, belonging both to the Regional Forestry Agency for Territorial and Environmental Development of Sardinia and to the forestry corps itself, which reinforced their capacities through training and updating of protocols.

Finally, the use of the S²IGI satellite system requires specialised profiles in remote sensing, advanced data processing and dynamic fire simulation, linked to Nurjana Technologies, the Bioeconomy Institute and the School of Aerospace Engineering of the University of Rome La Sapienza.

Collaboration

The implementation of the preventive methodology in Bonorva is based on close collaboration between the specialised agencies that developed the approach and the local administration in charge of its application. The Fire Analysis and Use Group of the Forestry Corps provides the technical design of the methodology and the operational capacity to execute prescribed burns and fuel treatments; the Bioeconomy Institute of the National Research Council contributes with the development of the propagation simulator and scientific support; and the Regional Forestry Agency for Territorial and Environmental Development of Sardinia participates in the planning and execution of the actions on the ground. For its part, the Bonorva City Council provides the local implementation framework and makes the necessary provisions to allow the works to be carried out in private areas by issuing a municipal ordinance. This combination of technical, scientific and administrative capacities ensures that the process can be implemented consistently and continuously in the municipality.

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The authors would like to thank Franco Casula of the Forestry and Environmental Monitoring Corps of the Sardinia region for his contributions to this text.

6. Hydrological-forestry restoration of the Metsovitikos torrent

The Greek Forestry Service restored the Metsovitikos torrent through torrential corrections and massive reforestation, reducing erosion and flooding, and restoring vegetation cover.

Context

In the mountains of Greece, the prolonged combination of recurrent fires and overgrazing degraded large basins, leading to vegetation loss, intense erosion and the formation of highly active torrents that, since the mid-20th century, have caused flooding and damage to agricultural areas and settlements. The Metsovitikos basin in the Pindo exemplified this problem: steep slopes, fragile lithologies and unsustainable human uses (illegal logging, fires, hillside cultivation and overgrazing) left a severely degraded territory, with landslides and sediment transport threatening the local population. Current studies confirm that these dynamics persist and that Mediterranean mountain ecosystems remain highly vulnerable to erosion, a risk accentuated by the increasing frequency of extreme events associated with climate change. Recent storms in central Greece have shown that the lack of headwater intervention significantly increases the risk of flooding in the plains.

Challenge

The Metsovitikos basin had chronic slope instability, accelerated soil loss and a torrential regime resulting in recurrent flooding with impacts on crops, populations and infrastructure. The fragility of the physical environment (flysch, steep slopes, high intensity rainfall) and anthropic uses (fires, logging, overgrazing) amplified the problem in a context without effective soil conservation measures.

Currently, the increased frequency of extreme events and the lack of maintenance in many hydrological works reactivate these risks and stress territorial resilience, making a comprehensive and sustained approach over time necessary.

The key question is: How, in the current climatic and socio-economic scenario, can the protection of headwaters against erosion and flood risk be ensured?

Location
Metsovitikos Stream, Metsovo, Epirus, Greece

Stakeholders

Project implementation - National public administration in charge of forest management, conservation and restoration: Greek Forestry Service

Other agencies involved - Local Forest Service unit: Metsovo Forestry Office.

Type of measure
Management

Type of financial incentive
Local public procurement

Economic sector
Forestry

Resilience to
Flooding

View of Metsovo and its surroundings. Dimitris Kiriakakis. © Unsplash.

Solution

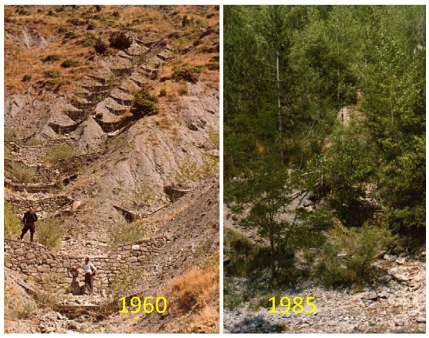
To reverse the pressures, the territory shifted from open use of resources to a co-management system that manages silvopastoral management and favours the regeneration of cedar. Since 2007, silvopastoral associations have been set up in the Ifrane National Park, in order to initiate a model of co-management between pastoralists and forest administration promoted by the National Agency for Water and Forests (Agence Nationale des Eaux et Forêts). This model was consolidated through local silvopastoral management agreements and contracts that adjusted loads and schedules, established temporary closures with compensation ("social forestry"), delimited sensitive areas and prioritised natural regeneration - proven to be effective after excluding grazing - reserving planting for situations with no regeneration capacity.

The system incorporated participatory monitoring to adapt decisions on the ground. In 2011, the Ifrane Model Forest was created, a local multi-stakeholder governance platform integrated into the International Model Forest Network, covering the provincial level (357,300 ha) with the Ifrane National Park as its territorial core. Its main function is to integrate communities, forest administration and other stakeholders to coordinate and scale up these measures across the province.

Technical implementation

The Metsovitikos project was designed by the Forestry Service in 1955 and approved in 1960, while the Metsovo Forestry Office prepared the detailed planning and implemented the actions throughout the basin. Engineers and rangers delineated priority sections and designed field works on the unstable flysch, and local crews constructed an extensive torrent correction network that included more than a thousand stepped dykes, seventy gabion walls, phyto-technical works, small weirs and consolidation dykes. These infrastructures reduced flow energy, retained sediment and stabilised slopes and riverbeds. Subsequently, the Metsovo Office coordinated a massive reforestation with 1.8 million seedlings on more than 500 ha, concentrated on the points most likely to be successful, so that the vegetation would consolidate the effects of the works and increase infiltration.

The office documented the process through comparative photographic series in the 1960s and 1980s, which showed a marked increase in vegetation cover, increased water retention and a clear reduction in peak flows compared to the initial state. This approach becomes relevant in the context of the



Evolution of the Metsovitikos ravine: from severe erosion (1960) to forest recovery (1985). © courtesy of the General Secretariat for Forests and Natural Environment of Greece.

Pros

- Reduction of destructive phenomena: less erosion, more water retention and reduction of peak flows.
- Exemplary technical documentation: comparative photographic series showing results.
- Local recruitment.
- Positive socio-economic impact: temporary employment for local crews in a mountain region.

Cons

- Lack of maintenance and follow-up due to reduced long-term funding.
- Dependence on public resources: without stable allocations, infrastructure functionality declines.
- Initial conflicts with local herders.
- Technical limitations identified in subsequent studiesthe phytotechnical works alone did not provide absolute protection against extreme events.

recent hydro-meteorological events in central Greece, where events such as storm Daniel in 2023 showed extreme rainfall, failure of hydrological defences and severe impacts on low-lying areas, reinforcing the need to maintain and upgrade headwater works. Scientific literature on the Pindo confirms the high susceptibility of the area to erosion and highlights the value of tools such as NDVI and RUSLE for prioritising interventions and monitoring the evolution of degradation, complementing the technical management of basins such as the Metsovitikos.

Evolution of the torrential correction works in the Metsovitikos ravine: from the initial state to the restored state. © courtesy of the General Secretariat for Forests and Natural Environment of Greece.

Administrative and governance implementation

The restoration of Metsovitikos took place within a clearly hierarchical administrative structure: the Forestry Service acted as the representative of the State and assumed institutional responsibility for the project, while the Metsovo Forestry Office acted as the implementing territorial unit. The Forest Service conceived the project in 1955, approved the final plan in 1960 and set technical guidelines and resources, while foresters supervised implementation and the field office organised field execution. Within this framework, rangers took over the operational control and photographic documentation, and local crews carried out the work and logistics.

The grazing ban was essential to protect the plantations, in a context of high tensions between herders and the Forest Service over the impact of overgrazing and the use of fire. At the same time, subsidies were offered to replace goats with sheep to facilitate regeneration, and efforts were made to meet the population's need for fuelwood, although the harsh conditions led to a process of depopulation in the 1960s. However, the hiring of local labour for the works provided significant income for the communities.

The photographic series taken by the rangers were archived in the local office as evidence of the progress of the project. In terms of governance, the Metsovo Office estimated that about 90% of the original plan was implemented, but reduced funding in the 1990s and the absence of maintenance since 2000 weakened the functionality of some of the works and contributed to the loss of technical knowledge at all levels of the Forest Service. Overall, the project combined decision and approval at the central level, implementation and operational management in Metsovo, technical supervision by Forest Service staff and documentary custody at the Metsovo Office, with good initial results and subsequent deterioration associated with lack of resources.

Financial implementation

The project was fully financed and budget managed by the Forestry Service, which provided the appropriations for planning, technical management, local labour, procurement of materials and supply of plants from forest nurseries. The Metsovo Office acted as the executing unit for the expenditure: it

processed temporary contracts, organised logistics and haulage, structured the crews and programmed the planting campaigns according to the approved annual budgets. The financial flow followed a top-down scheme: the central level defined guidelines and allocations, while Metsovo planned the work phases - first channel and slope corrections, then revegetation - certified the completed work and sent the necessary reports for the release of payments. Spending was concentrated in three main blocks:

- Torrential correction works
- Reforestation
- Technical services (staking out, direction, control and photographic follow-up)

In the 1990s, the reduction of resources allocated to the Forest Service cut back on maintenance, leaving essential routine interventions unprovided for, which affected the functionality of some of the works. Overall, the financial model combined centralised multiannual planning with decentralised implementation and payments, effective during the new construction phase but vulnerable when conservation budgets decreased.

Requirements for success

Integration

The Metsovo Forestry Office integrated the restoration of the Metsovitikos into its regular operations by means of an annual programme that combined riverbed and slope work phases with planting campaigns. It assigned engineers to day-to-day coordination, rangers to field control and local crews with stable shifts for implementation, so that the tasks were incorporated into the regular responsibilities of the staff. The project was also absorbed into the office's administrative circuits: contracting, procurement of materials, nursery management and payment processing were carried out through the usual procedures, while progress reports and certification of work were sent periodically to the central level. The photographic archive was kept as official follow-up documentation. In this way, restoration was managed as a continuous activity rather than as a one-off intervention, with regular cycles of planning, execution and reporting that were sustained as long as the budget was available.

Continuity

Evolution of the torrential correction works in the Metsovitikos ravine: from the initial state to the restored state. © courtesy of the General Secretariat for Forests and Natural Environment of Greece.

After about 90% of the original plan was implemented, the restoration of Metsovitikos was left without maintenance due to reduced funding from 1990-2000, which deteriorated part of the infrastructure and led to loss of know-how in a context of increasing incidence of extreme events. Recovery involves reactivating programmes and rebuilding capacity by training staff, updating methods and adapting designs - including higher dykes or small reservoirs with added fire utility - together with

continuous monitoring. In support of this, demonstration projects financed by European programmes such as LIFE or INTERREG are envisaged to ensure a full cycle of planning, implementation, maintenance and evaluation. Along these lines is the "Aqua Montis" programme, on mountain hydrology, with a budget of 90 million euros to strengthen environmental and forest resilience. It was initially implemented in Thessaly and designed and supervised by the Directorate General for Forestry and Forestry Environment, with plans to extend it to other regions.

Specialisation

The project integrated forestry engineering expertise for design, planning and technical direction from conception to plan approval and deployment (Forestry Service) and for the translation of that design into operational programming, staking and day-to-day coordination in the field (Metsovo Forestry Office). Rangers undertook the operational field control and official documentation (comparative photographic series at checkpoints). Local crews carried out the manual work and logistics. In parallel, the central level of the Forest Service ensured budget approval and spending guidelines, and the Metsovo Office managed procurement, supplies and payments.

Collaboration

The Metsovitikos project was sustained in a close collaboration between levels of the Forest Service and the local community - the crews hired by the Metsovo Forestry Office. This contracting made it possible to have a stable workforce and to coordinate shifts and tasks with the technical management and rangers over the years until funding stopped. In the recent dissemination phase, entities such as ELGO-DIMITRA (Greek Agricultural Organisation, national agroforestry research and training) have contributed to the recovery and valorisation of the experience, opening up the possibility of new demonstration projects to reintroduce these techniques with European participation and co-financing to ensure a stable cycle of implementation, maintenance and monitoring.

Acknowledgements

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7. Post-fire hydrological restoration in the Melini-Arakapas basins

Hydrological restoration in Melini-Arakapas installed small gabion dykes to reduce erosion and runoff after the fire, protecting vulnerable infrastructure and basins.

Context

The municipalities of Melini and Arakapas are located in a mountainous area of inland Cyprus, characterised by steep slopes, a dense network of small watercourses and a high susceptibility to erosion when the vegetation cover is lost. In this type of Mediterranean basin, vegetation plays a fundamental role in water regulation and in protecting the soil from heavy rainfall.

The fire that occurred in the area in 2021 caused the complete elimination of vegetation in large areas, leaving unprotected land that was highly vulnerable to erosion and had a severely reduced water retention capacity. Following the fire, the Republic of Cyprus Water Development Department (WDD) identified immediate hydrological impacts: increased surface runoff due to the absence of vegetation cover, increased risk of flooding in watercourses and rivers, and high erosion rates capable of mobilising large volumes of sediment during rainfall events.

This dynamic increased the risk of infrastructure obstruction (especially sewers and water crossings in the road network), with possible damage due to overflows. Similarly, sediment transport from burned areas threatened to reduce the usable volume of reservoirs, affecting their storage function and the quality of water for human consumption.

The Cyprus flood risk analysis and planning documents describe that flood events are intensified in steeply sloping, degraded or deforested basins. This general framework of hydrological risks provides the technical context necessary to understand the magnitude of the problems triggered by the 2021 fire.

Location
Melini-Arakapas, Larnaca/ Limassol, Cyprus

Stakeholders

Project implementation - Water management authority: Cyprus Water Resources Development Department.

Other agencies involved Government department responsible for forestry, technical experts and academics specialising in risk and disaster management.

Type of measure
Management

Economic sector
Agriculture

Resilience to
Drought, fires

View of Arakapas and surroundings. © Xaris333, CC BY-SA 4.0.

Challenge

After the Melini-Arakapas fire, the burned basins were exposed to extremely rapid and difficult-to-control hydrological dynamics. The technical documents highlight that even small basins can generate sufficient flows and sediment inputs to cause significant damage, due to the combination of bare surfaces, steep slopes and an almost immediate response of the terrain to rainfall events. This sensitivity makes the area a critical point where any storm can trigger erosion processes and transport of materials that exceed the capacity of the infrastructures located downstream, putting roads, sewers and strategic reservoirs for the supply of drinking water at risk.

In this scenario, where the hydrological response is accelerated and the reaction window is minimal, the essential challenge is: **How can immediate and effective action be taken to prevent the first rainfall events from triggering irreversible damage in a highly reactive burned basin, before there is any natural recovery or scope for larger-scale interventions?**

Solution

Following the fire, the WDD and the Cyprus Forestry Department opted for a solution based on small in-stream retention infrastructures: the construction of small dykes and retention ponds in series using gabions (structures made of wire mesh boxes filled with rock) directly on the beds of watercourses, prioritising the upper basin areas with steep slopes and higher erosion potential.

These structures act as "energy and sediment pools": they attenuate peak flows during rainfall events, retain materials washed down from the upper basin and, therefore, reduce the risk of clogging of infrastructure and the Kalavasos reservoir, and, when suitably positioned, promote groundwater recharge. Sites are selected using a geographic information system (GIS), combining a digital elevation model and satellite images, burned area boundaries, road network, registered watercourses and state land, setting a minimum size of 0.3 km² tributary basin and defining a set of 66 potential locations, of which 37 are prioritised for rapid actions immediately after the fire.

Pros

- Reduction of sediment transport due to the retention of materials in the ponds generated by the gabions.
- Attenuation of peak flows, reducing the risk of flooding downstream.
- Protection of road and drainage infrastructures, avoiding obstructions due to dragging.
- Preventing the clogging of reservoirs, maintaining their useful volume and water quality.
- Possible contribution to aquifer recharge when the location favours infiltration.
- Rapid implementation in vulnerable headwaters using local materials and existing access.

Cons

- Location limitation, as they can only be installed on registered waterways or state land.
- Accessibility restrictions, by avoiding the use of off-road machinery in burnt areas.
- Dependence on accurate targeting of small basins and steeply sloping sections.
- Need for early monitoring after the first rains to assess whether they need to be reinforced or extended.

In the framework of the Cyprus Flood Risk Management Plan, this main solution is complemented by other natural water retention measures, such as off-channel side ponds, controlled flooding of agricultural or forest land in flood plains and headwater terraces, all of which are designed as green infrastructure to manage floods, protect reservoirs and improve water management in degraded or burned basins.

Technical implementation

The technical implementation starts with a detailed hydrological characterisation based on digital terrain models and the 1 m horizontal resolution LIDAR-derived hydrographic network. This analysis makes it possible to identify the sections with the highest erosive energy and to select, according to the WDD criteria, the intervention points from the threshold of 0.3 km² of contributing basin. The combination of this information with the mapping of slopes and the boundaries of the public water domain leads to an initial identification of 66 candidate sites, later reduced to 37 priority points through field visits and inter-institutional coordination. These points coincide with headwater areas and steeply sloping watercourses where the Flood Risk Management Plan indicates greater danger due to accelerated erosion and reactive flows. Small gabion dykes are built directly on the bed, using local rock and a staggered arrangement that generates micro-deposits capable of retaining sediment and reducing the energy of the flow. This configuration progressively decreases erosion and moderates the peak flows characteristic of burned basins.

To complement this, the technical documents take into account other viable actions (lateral ponds connected by landfills and terrace systems at headwaters) that are applicable only where accessibility, relief and soils allow, and avoiding the entry of machinery outside the existing road network. Together, these measures form a technical strategy based on simple structures, local materials and an implementation adjusted to the topography and the degree of post-fire degradation, consistent with the hydrological assessment criteria of the Cypriot state.

Retention works with gabions in channels affected by the Arakapas fire. Kostas Aristeidou, © courtesy of the Ministry of Agriculture, Rural Development and Environment of Cyprus.

Administrative and governance implementation

After the Melini-Arakapas fire, institutional coordination fell to the WDD (under the Ministry of Agriculture, Rural Development and Environment), which defined the priorities, led the initial assessment and established the administrative procedure for organising urgent interventions. To ensure a coherent response, the WDD convened field visits with relevant departments, including the Department of Forestry (also under the same ministry, which facilitated joint management), as well as other agencies with responsibilities for watercourse, land and post-fire management. External experts also participated in these visits, including Professor Efthymios Lekkas (geologist specialising in the assessment and management of geological and atmospheric natural disasters) and other Cypriot natural hazards specialists, creating a technical coordination space where priorities were discussed

and principles for action in the affected watercourses were agreed upon. With this agreed framework, governance was structured through centralised direction in the WDD and coordinated implementation with the Department of Forestry integrating its functions within the common scheme. This working model facilitated a rapid institutional response aligned with the competencies of each agency, while ensuring that actions were carried out only on state-owned land and registered waterways, in accordance with the criteria defined during the initial coordination phase.

Financial implementation

The hydrological restoration works carried out after the Melini-Arakapas fire are fully financed from the national public resources of the Republic of Cyprus, channelled through the WDD, the competent authority to finance flood protection works when resources are available. In this case, the interventions are part of the Flood Risk Management Plan, which establishes the prioritisation criteria and technical-economic evaluation procedures that allow funds to be allocated to measures considered critical for reducing runoff, erosion and sediment transport in vulnerable basins. The WDD finances technical planning, preliminary studies, site selection through GIS analysis, the construction of gabion dykes and retention ponds, as well as machinery, materials, labour and site supervision. Implementation is further supported by in-kind contributions - technical staff, specialised assistance and monitoring - provided by the public departments involved in the project and the experts convened during the field visits.

Accumulation of materials in the gabion dam from the upper part of the basin. Kostas Aristeidou, © courtesy of the Ministry of Agriculture, Rural Development and Environment of Cyprus.

The Programme of Measures of the Flood Risk Management Plan incorporates a stable mechanism of state funding that facilitates the development of post-fire restoration works and structural protection measures, prioritising those with greater efficiency and cost-effectiveness. Overall, hydrological restoration in Melini-Arakapas is supported by a national public funding scheme, led by the WDD and reinforced by inter-agency technical cooperation.

Requirements for success

Integration

The actions carried out in Melini-Arakapas are integrated into the Flood Risk Management Plan. The retaining structures installed after the fire are part of the set of runoff protection and management measures included in the Programme of Measures of the Flood Risk Management Plan, which includes interventions in watercourses, mountain areas and burnt areas.
Their location on registered watercourses and state land, as well as the prioritisation of headwaters and steep slopes, is in line with the methodological criteria defined in this plan for the selection of actions. Thus, these interventions do not constitute an isolated action, but are part of the national strategy for flood risk reduction and sustainable basin management.

Continuity

The actions implemented after the Melini-Arakapas fire are conceived as initial measures within an ongoing risk management process, rather than as one-off interventions. The technical document states that, after the priority installation of small ponds and gabion dykes in the headwaters to respond immediately, a next phase of more extensive actions is planned, including larger reservoirs and complementary works in the middle and lower areas of the basin, the implementation of which will depend on the hydrological response observed during the first episodes of rainfall. This staggered approach coincides with the logic of the Flood Risk Management Plan's Programme of Measures, which structures interventions in successive cycles and establishes the need to evaluate the effectiveness of the first actions before moving on to more complex measures. It also envisages the possibility of incorporating additional practices such as lateral ponds, controlled flooding of agricultural or forestry land and retention systems in degraded areas, consolidating an operational continuity aimed at improving the resilience of the basin in the medium and long term.

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Specialisation

The intervention developed in Melini-Arakapas is characterised by a high degree of technical specialisation, derived from the direct involvement of agencies with specific competences in hydrology and forest fire management. The WDD provided the necessary expertise in runoff analysis, erosion and prioritisation of actions in watercourses, while the Forestry Department contributed with its operational knowledge of burned land, access, soil stability and post-fire behaviour. In addition, the process integrated the input of external experts specialised in natural disasters whose participation strengthened the technical quality of the risk diagnosis and management, as well as the selection of solutions. This combination of capacities (hydrological, forestry and risk management) resulted in a specialised approach capable of identifying critical areas and designing the necessary interventions.

Collaboration

The implementation of the criteria and indicators, monitoring/certification and digital tools is managed by MedINA through the LSN, in close collaboration with farmers and herders (registration in the application) and with the designated agronomist (field verification). This cooperation extends to local cooperatives and associations and authorities, both local (support and collaboration in the continuity of the project) and national (through the Green Fund and coherence with agricultural policy), ensuring compatibility with rural development policies and farm-to-table approaches. At the same time, the certification system and the network of producers are designed for replicability in other Aegean territories, in order to maintain verifiable management and traceability criteria that facilitate their alignment with public frameworks and their territorial scaling.

8. Restoration of traditional micro-dams in Kythira

The recovery of traditional dry-stone hydraulic structures preserves heritage and improves water catchment, enhancing resilience through integrated water management.

Context

Stone micro-dams, present on small Mediterranean islands since Minoan times, were built across torrents to reduce the slope, regulate the flow and create small pools (loutses in Greek) used for irrigation, livestock supply and flood control.
On Kythira, a Greek island with a dry Mediterranean climate (530-540 mm/year of rainfall), moderately hilly terrain, about 3,600 inhabitants and low population density, these structures offered a local and low-cost solution to seasonal water and heavy rainfall events.

In addition to their hydraulic function, they contribute to the recharge of aquifers, generate micro-wetlands and reduce soil erosion, thus constituting a model of sustainable water management suitable for island environments. Integrated into the group of river control works, they are less resistant to flooding than concrete micro-dams, but stand out for their adaptation to the landscape and the environment. The work of the Mediterranean Institute for Nature and Anthropos (MedINA), a Greek NGO dedicated to the conservation of natural and cultural heritage, has enabled the revalorisation of this practice in territorial resilience and climate change adaptation initiatives, strengthening cooperation between institutions and local communities in the face of increasing water pressure.

Location
Kythira, Attica, Greece

Stakeholders

Project implementation -
NGO: Mediterranean Institute for Nature and Anthropos (MedINA).

Other agencies involved
Local foundations, local administrations, community management bodies, local associations, local businesses, volunteers and local tourist bodies.

Type of measure
Management

Economic sector
Forestry

Resilience to
Flooding

Coastal panorama of southern Kythira. @Ingo Mehling. CC BY-SA 3.0.

Challenge

Mediterranean islands face a double water stress: water scarcity during long dry periods and torrential rainfall events that generate flash floods and accelerate soil erosion. This imbalance, intensified by climate change, jeopardises the availability of water for irrigation and livestock supply, compromises aquifer recharge and degrades riparian ecosystems. This is compounded by the structural vulnerability of many traditional water infrastructures, which require constant maintenance and may be inadequate in the face of extreme flows. The lack of systematic monitoring and coordination mechanisms between local users, administrations and technical bodies also makes it difficult to guarantee the safety, durability and efficiency of these works.

The central question is: How can traditional micro-dams be strengthened, maintained and adapted to remain an effective tool for water management, conservation and resilience to climate change in Mediterranean territories?

Solution

In 2020, MedINA and the KIPA Foundation, a local Greek organisation dedicated to culture and sustainable development, reintroduced traditional stone micro-dam construction in the Karavas stream (north of Kythira) as green infrastructure aimed at recharging aquifers, reducing flood risk and enhancing biodiversity in a semi-arid Mediterranean riparian environment. With the participation of the local association "Portokalia", organisations from the island and volunteers, micro-dams were erected using local stones and traditional techniques that slow down the flow, form small ponds and favour infiltration and the supply of water for domestic gardens.

In addition to their hydrological benefits, these structures contribute to mitigating erosion, creating microhabitats and reinforcing the cultural link with ancestral water management practices, integrating into new forms of community governance promoted by MedINA. The micro-dams were also incorporated as points of interest in the Kythira Trails network, accompanied by ethnographic stories about the five most emblematic structures, accessible on the network's app to raise awareness among visitors and hikers.

Pros

- Heritage conservation with restoration in its original form, following the local architecture and reusing the existing stones.
- Improved water catchment with direct benefit on water recharge and irrigation systems.
- Broad institutional and community collaboration.
- Mobilisation of local resources with materials provided by local companies, reinforcing social ownership and reducing external costs.

Cons

- Limited hydraulic effect against impermeable micro-dams, as they generate backwater, generally localised, with flow acceleration as it passes through the structure.
- They require maintenance and follow-up, and post-work monitoring and/or control must be established to evaluate results.
- Reliance on local stakeholders and volunteerism.

Construction of a micro-dam in the Karavas ravine (Kythira), thanks to the participation of neighbours from the community. @Zafeiriou © MedINA (Mediterranean Institute for Nature and Anthropos).

Technical implementation

MedINA, together with KIPA and the local association "Portokalia", extended the traditional micro-dam network of the Karavas stream by building 26 new structures along a 1.6 km stretch. The team used local stone laid by hand using traditional stacking and reinforcement techniques to ensure stability without the use of heavy machinery. Under the scientific guidance of MedINA and the supervision of local stonemasons, the works were designed to respect the hydromorphological dynamics of the stream and minimise environmental impacts, while volunteers provided most of the manual effort. The serial arrangement of these micro-dams reduced the effective slope of the channel, created small temporary ponds and progressively dissipated the energy of the flow, reducing erosion, retaining fine sediments and favouring the regeneration of nearby agricultural soils. The resulting ponds increased infiltration and recharge of the aquifer, as well as providing water points for home gardens.

These stepped structures - built entirely of local stone - generated temporary pools that increase the heterogeneity of the habitat for riverine and migratory fauna, and integrate naturally into the landscape. From the outset, MedINA and its collaborators recognised the inherent limitations of this technique (lower resistance to extreme floods, need for maintenance and greater vulnerability to scour) and opted for small and numerous micro-dams instead of conventional dykes, valuing their cultural and environmental integration in small-scale ravines such as those of Karavas.

Administrative and governance implementation

Performance was managed through a system of local co-governance. MedINA proposed the idea, planned the intervention, processed permits, drew up the technical specifications and undertook the technical and financial coordination. The KIPA Foundation provided financial support, mobilised the actors (associations and citizens), promoted collaboration with the authorities and aligned the intervention with the cultural and hiking objectives of the Kythira Trails project. The local community was actively involved in both decision-making and implementation, providing volunteers, materials and logistical support, including ensuring continuity through maintenance and supervision of the micro-dams.

Water accumulation behind a micro-dam in the Karavas ravine (Kythira). @Zafeiriou © MedINA (Mediterranean Institute for Nature and Anthropos).

The municipality and the Household Property Management Committee institutionally supported the project, and the association "Portokalia" played a key role in raising awareness and organising the work. A Memorandum of Understanding formalised this collaboration, articulating an administrative implementation based on combined funding, institutional support and community participation within an integrated framework of water management, landscape restoration and territorial resilience.

Financial implementation

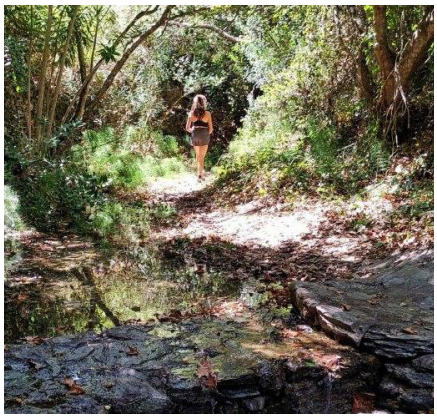
The intervention was part of Kythira Trails, a joint project of MedINA, KIPA, the Municipality of Kythira and the Kythira and AntiKythira Domestic Property Management Committee, and funded by MedINA through the MAVA Foundation, KIPA and the European CLLD programme. Launched in 2017, this programme combines international, European and local funding for landscape conservation and sustainable development on the island.

The restoration with stone micro-dams carried out in 2020 was driven and financed by MedINA and KIPA, reinforced by in-kind contributions from local businesses and volunteer labour from residents and associations. In the framework of Kythira Trails, the construction and signposting of trails was mainly financed by MedINA resources and complemented by municipal funds in cooperation with KIPA, reflecting the integration of European, national and local resources in a common territorial management strategy.

Requirements for success

Integration

In Kythira, MedINA integrated the stone micro-dams into the day-to-day management through a system of inspection and maintenance by local users and volunteers, who check the structures after heavy rainfall events. The use of local stone and the simplicity of construction makes it easy for maintenance to be undertaken on a communal basis. To reinforce this model, systematic monitoring with ecological, chemical and hydrological indicators is recommended, as well as clarifying consumption needs in order to properly size the works. The integration of the project into the Kythira Trails programme makes it possible to take advantage of a multi-sectoral structure for financing, management, awareness-raising and fund-raising that reinforces its long-term continuity.



Example of a micro-dam integrated into the landscape in Kythira. @Zafeiriou © MedINA (Mediterranean Institute for Nature and Anthropos).

Continuity

The continuity of the project in Kythira is based on the simplicity and low cost of the stone micro-dams, built with local materials and easy to maintain by the users themselves, who carry out regular inspections after heavy rainfall events. Long-term sustainability is supported by awareness-raising actions - such as publications, educational activities and local outreach - and the continued involvement of volunteers in maintenance. The success of the experience in Kythira facilitated its subsequent replication in three Cyclades islands (Paros, Ios and Sifnos) by MedINA and local partners, extending the reach of this methodology beyond the pilot island.

Specialisation

The restoration of the Karavas stone micro-dams involved dry-stone specialists who recovered the traditional practice of *deseis*, integrating the works into the local hydraulic system and restoring or rebuilding the structures according to traditional architecture and reusing the original stones. MedINA and KIPA took over the technical and administrative management, providing their expertise in

environmental and cultural projects. Given the heritage dimension of the intervention, MedINA's heritage specialists documented and preserved the historical and functional value of the micro-dams as elements of the trail network.

Collaboration

The project was supported by a broad network of collaboration involving scientific bodies, local administration, associations and volunteers for the coordination, logistical support and execution of the actions. Within the framework of Kythira Trails, this network was extended to the tourism sector: KIPA, the Tourism Office and the Municipality incorporated the rehabilitated micro-dams into route planning and visitor management, while businesses and tour operators supported signage, dissemination of best practices and trail maintenance. This joint approach linked tourism and conservation, enhanced the visitor experience and strengthened the conservation of the cultural landscape and the local economy.

Acknowledgements

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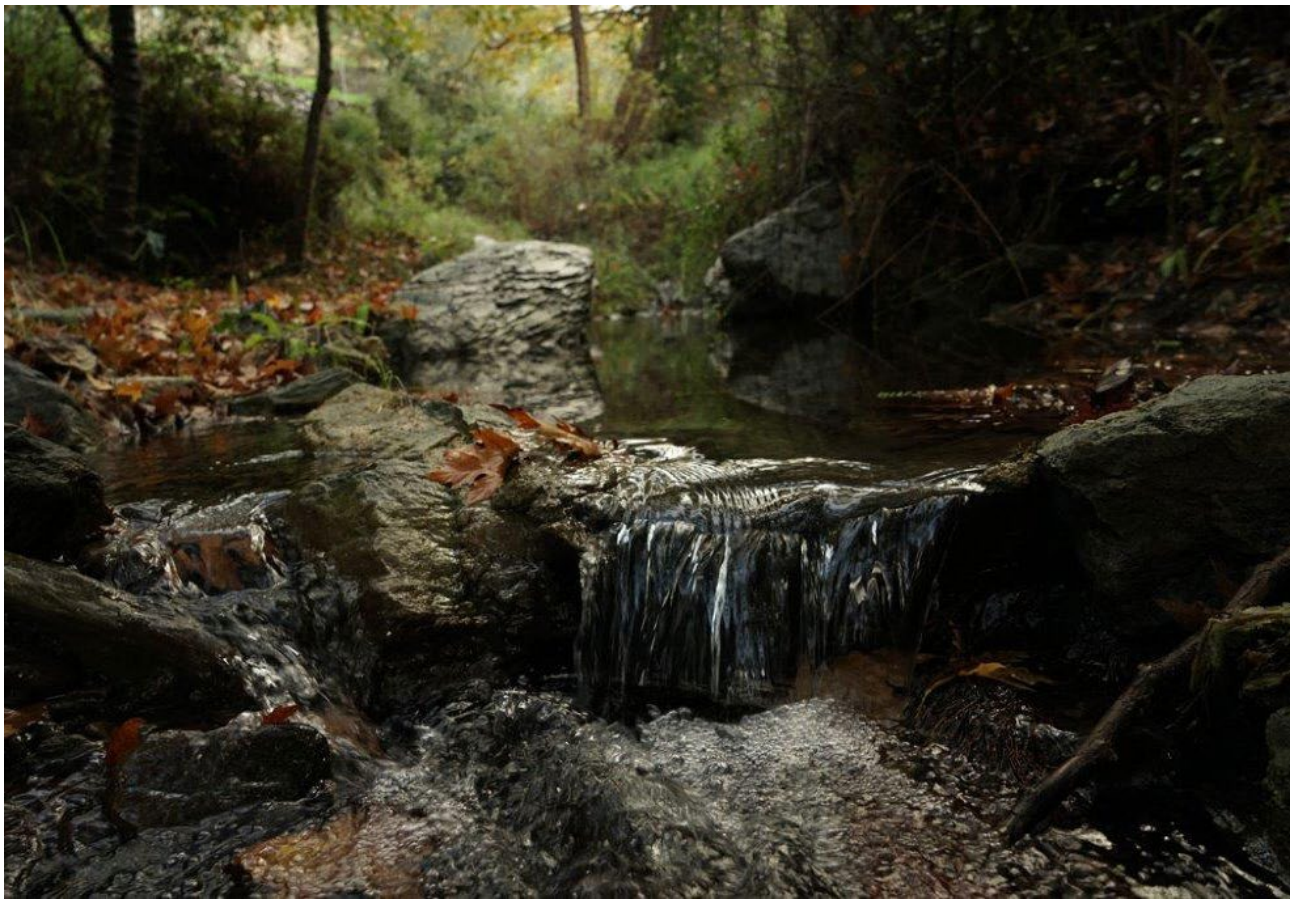
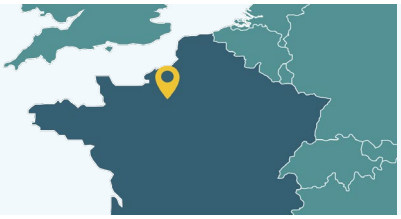


9. Grouped management in a fragmented massif: public-private coordination in Normandy

The project promotes concertation to explore grouped management in a massif with very fragmented tenure, identifying available stands and assessing the feasibility of joint actions.



Context

Forest ownership in Normandy is characterised by strong fragmentation, especially at the private level. Approximately 75% of the forest area is privately owned (about 328,000 ha), divided among about 90,000 owners, of which only about 9,000 own plots of 4 ha or more. The remaining 25% is under public ownership.

This structure has direct implications for forest planning. At the private level, the obligation to have an approved sustainable forest management plan applies only to properties of 25 ha or more, resulting in a coexistence of small plots with and without formal planning. Overall, it is estimated that only about 50% of the private forest area has an approved management document.

In contrast, the entire public forest area is managed under sustainable management plans. However, there are about 300 communal forest properties within the municipality that are not subject to the forestry regime. Even so, municipalities often show clear ambitions for the management and valorisation of their forests, which can act as drivers for joint management initiatives and involve the many small neighbouring private properties.

A representative example is the Becdal ravine, in the communes of Quatremare and Mesnil-Jourdain, where a 35 ha massif is spread over 38 properties, including 10 ha of communal land. This case illustrates the fragmentation of Norman forest ownership and the strategic role of the commune as an articulating element of forest management on the scale of the massif.

Location
Quatremare and Mesnil-Jourdain, Normandy, France

Stakeholders

Project implementation - Public technical body, forestry extension service: Centre National de la Propriété Forestière de France (CNPF) / Centre Régional de la Propriété Forestière de Normandie (CRPF).

Other agencies involved Private forest owners, municipalities (as public forest owners), Regional Union of Forest Collectivities.

Type of measure
Governance

Economic sector
Forestry

Resilience to
Management

Mosaic agroforestry landscape typical of the Normandy area. barskefranck. © Pixabay.

Challenge

Fragmented forest ownership and small plot sizes make forest management at the scale of the forest massif difficult. Many private landowners prioritise autonomy in decision-making and landscape and biodiversity conservation, limiting the adoption of collective approaches. From the institutional point of view, the existence of communal forests that are not subject to the forestry regime, together with the legal separation between public and private management established by the French Forestry Code, complicates the articulation of joint initiatives and access to planning and support instruments.

At the technical and economic level, the heterogeneity of the stands, the low volumes of mobilisable timber per plot and the diversity of species reduce the commercial interest of individual harvests, making it difficult to mobilise management without coordination mechanisms.

So, in that situation: **How can a coherent and grouped management process be articulated in a massif where regulatory constraints, divergent technical priorities and a low initial predisposition to cooperation coexist?**

Solution

The *Forêts Privées et Publiques - Essai de Gestion Groupée*project, launched in 2019, aimed to boost public-private sustainable forest management in Normandy. On the basis of a pilot experience of grouped management, it laid the foundations for a regional doctrine and developed common tools for consultation between municipalities, the French National Centre for Forest Ownership (CNPF), through the Normandy Regional Centre for Forest Ownership (CRPF), and private owners.

The project was articulated through a structured and shared work process, conceived as a stable consultation group to assess the feasibility of a grouped management of the forest massif. This process was carried out in several stages, including a forest inventory, a technical analysis of the forest and an individualised dialogue with each landowner. The work was based on a technical diagnosis and individualised sheets that facilitated the discussion of management options adapted to each situation.

Pros

- Encourages forest management in areas with very fragmented tenure, facilitating consultation between public and private actors.
- Generates accurate diagnoses per property.
- Mobilises wills even without a common legal structure.
- Creates a reusable technical basis.

Cons

- Legal barriers to joint management of community forest and private forest.
- Need for unanimity to deal with consultations.
- Small and heterogeneous volumes reduce economic viability.
- The absence of an agreement (municipal or private) may block enforcement.

Aerial view of the wooded massif of Quatremare and Mesnil-Jourdain. © IGN.

In this context, the two municipalities involved, owners of 10 of the 35 ha of the massif, have taken on the driving role of public landowners, with the aim of encouraging the gradual adhesion of small private landowners through a demonstrative approach. The joint work made it possible to identify stands with acceptance for intervention and to assess the possibility of grouping actions without compromising individual objectives. Although the small volumes of timber and the diversity of species made marketing difficult, the grouping made it possible to achieve a sufficient volume to attract buyers. The CNPF regional office in Normandy launched a call for the estimation of the volume and value of felling, which was subsequently validated by the landowners, and the process also clarified the role of the town council and the regulatory constraints of the communal forest.

The project constitutes a precedent at national level, as it is the first experience of public-private joint management of this kind in France. It is particularly relevant that the driving landowner is a municipality, an unusual and strategic situation in a region with about 300 community forests in similar contexts. In short, the solution implemented is based on the creation and dynamisation of a stable framework for consultation and support that facilitates the mobilisation of landowners, structures the technical information available and lays the foundations for future coordinated public-private interventions at the scale of the forest massif.

Technical implementation

The technical implementation is based on a detailed characterisation of the stand, through the analysis of stands, soils and climatic conditions (current and future) in order to assess the condition of the forest stands and the interest of different silvicultural options. This diagnosis makes it possible to identify the stands where conditions justify intervention.

On the basis of this analysis, the CRPF prepares individualised technical sheets for each landowner, which describe the characteristics of each stand and the management possibilities. These sheets are subsequently discussed in individual interviews, allowing the proposals to be adjusted to the expectations, constraints and objectives of each landowner.

From a technical point of view, relevant interventions are identified in stands affected by mortality or biotic attacks, as well as thinning in stands where landowners prioritise biodiversity. The proposals take into account the fragmented structure of the massif, the mix of species and the small mobilisable volumes per plot, which are determining factors for operational and economic feasibility.

In this context, the CRPF is considering the possible grouping of actions with the aim of improving the operational coherence and commercial interest of the whole. For this purpose, a technical estimate of volumes and values is made and sent to the owners for validation. As a result of this process, a development project is proposed that brings together four landowners and a total of 15 ha.

Plotting and structure of the property in the Quatremare and Mesnil-Jourdain massif. © courtesy of the Centre National de la Propriété Forestière.

Administrative and governance implementation

Administrative management is articulated through

a formal consultation process coordinated by the CRPF, which is in charge of contacting landowners, organising collective and individual meetings and gathering the necessary express agreement to move forward, ensuring a clear record of decisions and authorisations. The commitment shown by the municipality during the project made it possible to establish a calm and effective dialogue, favouring the mobilisation of private landowners.
This framework for exchange led to technical discussions and field demonstrations on forest management, in which the CRPF identified a clear willingness on the part of many landowners to conserve a high level of biological diversity.

The Regional Union of Forestry Collectivities (URCOFOR, a regional organisation that brings together and represents forestry municipalities) complements this work by providing institutional support to the municipality, particularly in matters of local public management and in the interpretation of administrative constraints specific to communal forests not subject to the forestry regime. This framework is further conditioned by the Forestry Code, which strictly separates public and private management and limits the possibilities for joint planning.

In this context, the process highlights that, in order to mobilise small landowners, it is key to rely on dynamic neighbouring landowners who act as real drivers of the process. In this Norman project, the originality lies in the fact that the driving landowner is the municipality itself, which introduces an innovative element with the potential to relaunch forestry at the scale of the forest, while at the same time identifying and documenting the legal difficulties associated with this type of grouped management initiative.

A central element of the procedure is the official consultation for the estimation of volumes and values of interventions, which can only be issued with the express agreement of all owners involved. In the case of the community forest, the lack of forest ownership is a structural constraint: without it, it is not possible to draw up a sustainable management document, to access public aid or to authorise forestry activities.

The procedures for joining the forestry regime are perceived by the municipality as demanding and lengthy, which has led to caution and considerable time for reflection. In this context, the CRPF sought to steer actions towards a financial balance between revenue and expenditure, avoiding recourse to subsidies and thus the need to join the forestry scheme. However, the absence of both such a designation and a specific management regulation for small public forests prevented the community forest from being given a formal management framework.
The lack of agreement during the project period finally prevented the planned intervention in the communal forest from being authorised, blocking the joint operation that required the participation of all the properties.

Financial implementation

The project had a total budget of €105,431, financed with €59,476 from the European Agricultural Fund for Rural Development (EAFRD, the European Union's main financial instrument for financing rural development policies under the Common Agricultural Policy) and €14,869 of funds from the Region.

These resources were used to cover the CRPF's technical support, consultation with landowners and local councils, the preparation of diagnoses and individualised technical sheets, and the general coordination of the process.

In terms of planned actions, the financial strategy was conditioned by the status of the community forest, which, not being subject to the forestry regime, is not eligible for subsidies and does not have a sustainable forest management plan. Consequently, the project was oriented towards a model based exclusively on the balance between income and expenses derived from the value of the timber, thus avoiding additional investments by the owners. The financial model is designed in such a way that the renovation of the stands does not require additional investments by the owners, beyond the income obtained from the felling.

To assess this feasibility, the CRPF prepared a technical and economic estimate of cutting volumes and values, which was sent to all landowners for validation. The grouping of actions was proposed as a way to improve profitability in the face of small and heterogeneous volumes; however, the lack of municipal agreement prevented authorisation of the intervention on the communal woodland, blocking the overall execution and the possibility of mobilising the planned income.

Requirements for success

Integration

If the grouped management had been implemented, the municipality would have integrated the lessons learned from the project into its thinking on community forest management and the implications of the forestry regime, and incorporating them into its regular decision-making. Joint management could have been incorporated into the normal functioning of the municipality by coordinating actions, using the technical tools developed as an operational reference and maintaining continuous dialogue with the landowners. Taken together, these tools would have facilitated the appropriation of the technical orientations that emerged during the project and laid the foundations for a possible future continuity, which did not materialise.

Continuity

In practice, the project was limited to a test phase and did not lead to operational continuity, although the main impediments to joint management were clearly identified. In the public sphere, the municipality is continuing its reflection on the forestry regime and the management of the communal forest, as the constraints identified show the need to reconsider its management options in the medium term. At the regional level, the results obtained contribute to the reflection on public-private management in fragmented contexts, offering lessons applicable to future initiatives of the CRPF and other communities. Although the actions were not implemented, the method proved to be able to mobilise owners and generate proposals, providing a starting point for new initiatives.

Specialisation

The project requires the participation of CRPF technicians with skills in forest inventory, stand analysis, soils and climate, which are necessary to diagnose the status of the stands and their future evolution under a changing climate, and to detect problems of mortality or biotic attacks. Based on these diagnoses, profiles are needed that are able to translate the technical information into individualised records and discuss them with the landowners, which requires knowledge of applied forestry, conservation criteria and field advisory skills.

In the economic valuation phase, specialists in volume estimation and timber valuation who are able to analyse species mixes and low volumes are required for the formal consultation sent to the landowners. Also in this regard, the CRPF guided the proposals to ensure economic balance by avoiding dependence on aid. Finally, the municipality receives specialised support (including URCOFOR) to interpret the technical and regulatory implications of the forestry regime and of the eventual participation in grouped actions, which requires knowledge of forestry law and public management.

Collaboration

The partnership is articulated through a consultation process led by the CRPF, which facilitates dialogue between the municipality, private landowners and URCOFOR, ensuring that all stakeholders have the necessary information and participate in decision-making. Individual interviews, group meetings and field demonstrations facilitate continuous and direct interaction between technicians and landowners, favouring trust building and clarification of expectations, especially in relation to biodiversity conservation and management of stands affected by mortality or biotic attacks.

The municipality plays a key role in collaboration by creating a climate of calm dialogue, which helps to mobilise owners and sustain the process, even in a complex regulatory framework for communal property. The partnership follows a voluntary process without a common legal structure, based solely on consultation and the trust generated during the partnership.

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10. "How are we doing?": Equity and strengthening territorial governance in multi-stakeholder forums

"How are we doing?" is a participatory monitoring tool for multi-stakeholder forums, used by their members to assess participation, decision-making and governance, and to agree on improvements.

Context

Multi-stakeholder forums bring together public administrations, local and indigenous communities, social organisations, NGOs and the private sector to discuss and coordinate decisions on the territory. They are valuable because they facilitate the articulation of sectors and levels of government and give a voice to historically excluded groups in processes that affect their rights and livelihoods. Its expansion is related to its potential to generate more inclusive and collaborative processes in the face of current socio-environmental and climate challenges.

However, the literature warns that bringing stakeholders together does not in itself guarantee equitable participation: without a design that explicitly addresses inequalities of power, representation and access, these spaces can reproduce them. To respond to this challenge, a number of initiatives have developed participatory reflective monitoring tools that enable forums to analyse their process, highlight equity gaps and adjust their planning on an ongoing basis, complementing existing administrative systems.

Given that these forums operate in landscapes with diverse interests and strong asymmetries, institutionalising practices of learning, equity and internal adjustment is essential if they are to truly contribute to fairer and more sustainable territorial governance.

Location
International application tool, implemented in Peru

Stakeholders

Project implementation
International non-profit scientific research organisation: Centre for International Forestry Research (CIFOR).

Other agencies involved
Public protected area management entities, protected area management committees, indigenous and/or minority organisations and rights advocacy, local and community associations.

Type of measure
Governance

Economic sector
Agriculture, Agroforestry, Forestry

Resilience to
Cross-cutting tool

Challenge

Preventing multi-stakeholder forums from reproducing inequalities involves addressing power dynamics that enable some stakeholders to dominate decisions, as well as representation gaps and access barriers that particularly affect women, local communities and indigenous peoples. This is compounded by the lack of internal participatory monitoring mechanisms, as existing systems tend to be external and administrative. The central challenge is to design context-sensitive processes with clear rules that address these asymmetries, rather than assuming that bringing stakeholders together ensures equal participation.

How, then, **can multi-stakeholder forums with a participatory, regular and context-sensitive mechanism be provide d that make inequalities visible, improve effective representation and guide management adjustments so that less powerful stakeholders can influence forum decisions?**

Solution

The "How are we doing?" tool is a participatory and reflective monitoring tool created for the members of a multi-stakeholder forum themselves to assess their functioning, identify gaps in participation, decision-making and governance, and to agree on improvements that will enhance the forum's effectiveness and legitimacy. It goes beyond measuring: it promotes joint learning and guides adjustments in the way work is done.

Its application combines three elements:

- Assessment of statements/indicators
- Guided reflection
- Definition of improvement actions.

It uses research indicators and other local indicators defined with the participants, and is developed in 3-4 hour sessions, recommended to be used at least once a year. It has been applied in territorial forums for agriculture, agroforestry and resource management, with institutional adaptations such as that of the National Service of Natural Areas Protected by the State (SERNANP) for natural protected areas committees in Peru; it has also been implemented in Indonesia, Kenya and can complement methodologies in developed countries.

The tool requires that the forum brings together its diversity of stakeholders, is facilitated, and that there is a willingness to implement changes resulting from the reflection. When applied in established multi-stakeholder spaces, it promotes representativeness, trust and continuity. The process follows a plan-act-monitor-reflect-adjust cycle and is structured in five stages:

1. Preparation: instructions, periodicity and voting method
2. Selection of statements
3. Voting
4. Reflection on key statements
5. Roadmap development: actions, responsible parties and deadlines

Pros

- Promotes equity in governance.
- Encourages participatory monitoring and reflective learning.
- Reinforces trust and transparency between actors.
- Improves the planning and adaptation of the multi-stakeholder forum.
- Brings institutional legitimacy.

Cons

- Can reproduce inequalities if there is no real participation.
- Requires a willingness to change on the part of organisers and participants.
- Requires skilled facilitation and a skilled secretariat.
- Requires time and resources (3-4 hour sessions + space, materials, travel and overnight stay, etc.).
- Loses its usefulness if there is no follow-up and integration into the action plan.

Participants collaborating in a working session of the multi-stakeholder forum. © courtesy of Vania Edith Martínez.

The results complement administrative monitoring systems and allow for comparison of future cycles. In short, the tool provides an internal, regular and context-sensitive mechanism to highlight inequalities, strengthen coordination and improve the governance of the forum from within.

Technical implementation

The tool requires two internal forum functions - facilitation and secretariat - designated only for the session. It is recommended that roles, balance gender and representation are rotated, and, in large groups or groups with asymmetries, to work in sub-groups with their own facilitation and secretariat. The facilitator guides the whole process: explains statements and instructions, leads the voting to ensure full participation, coordinates the choice of statements for reflection and moderates the in-depth analysis, as well as final production of the roadmap and the assignment of responsible persons. The secretariat documents the process: records attendance and votes, calculates averages, prepares reflection sheets, takes notes and completes the final summary and roadmap with actions, deadlines and responsible parties. The two roles are complementary, but their separation favours methodological rigour and transparency in the process.

In Peru, one of the main challenges was the initial lack of confidence of some groups, which was overcome through direct support and adaptations of the methodology resulting in fewer statements and working in sub-groups. CIFOR-ICRAF provides technical support and facilitates pilot sessions.

The tool works best when applied in forums that already operate as established multi-stakeholder spaces, where there is a basis for collaboration and the participants themselves validate the representation of all relevant sectors.

Administrative and governance implementation

The application of the tool requires an administrative structure that ensures equitable participation and coordination between the forum authority, technical-scientific support entities and public institutions in the territory. In Peru, SERNANP led the process and made the tool official through a ministerial resolution, establishing its annual use in the Management Committees of the 75 natural protected areas. The agency ensures pluralistic participation, convenes actors and provides logistical support and training for facilitators, while the deconcentrated offices implement the sessions under the supervision of the Participatory Management Unit.

Multi-stakeholder forum working session on the Peruvian case. © Vania Edith Martínez.

Although the Peruvian case shows formal institutionalisation, the tool can also be applied in informal contexts depending on the maturity of the group. CIFOR-ICRAF provides the technical-methodological support - design, training and local adaptation - and recommends a previous pilot application.

Each annual session generates a priority sheet and a work plan with responsibilities and deadlines, validated by the forum and used for accountability the following year.

In short, implementation is supported by an institutional framework, a national coordinating entity, territorial units trained

in facilitation, specialised technical support and standardised documentation and monitoring mechanisms.

Multi-stakeholder forum working session on the Peruvian case. © Vania Edith Martínez.

Financial implementation

The implementation of the tool does not require a large investment: it is sufficient to finance an annual 3-4 hour session and its preparation in stages. The main costs include training and facilitation, development and archiving of documents (worksheets, summaries, roadmap), printed or digital materials, translation where multiple languages are involved, and logistics of participation (especially transport and, in some cases, overnight stays to ensure the presence of all actors). There are operational variants with different costs: during COVID-19 an online version was adapted which reduces travel costs, but requires basic digital support.
The development and scaling up of the tool has been funded by international donors (Norwegian Agency for Development Cooperation, European Commission, IKI of the German Ministry of Environment, UK Ministry of Foreign Affairs, and CGIAR research programmes via CIFOR), which points to possible co-funding avenues for its adoption in public systems.

The coordinating authority should budget for logistics, training and annual implementation in all committees, with the integration of the tool into institutional planning, and the priorities identified can be used to mobilise new sources of funding at the local level.

Requirements for success

Integration

The tool is integrated into the annual functioning of the forum as an operational cycle that facilitates planning, monitoring, reflecting and readjusting the work. The coordinating authority convenes the session, ensures facilitation and secretariat, and in a single meeting the five steps are implemented with official formats that ensure traceability. The resulting summary and roadmap are incorporated into the work plan, defining tasks, responsibilities and deadlines.

In Peru, SERNANP institutionalised the tool, coordinates the adaptation of indicators through workshops, forms committees and facilitates its operational deployment. After each session, the secretariat consolidates the roadmap, which is integrated into the committee's annual plan, allowing it to adjust actions, identify gaps in representation and improve coordination with other actors.

Continuity

The continuity of the tool is ensured by integrating it as a recurrent mechanism within the annual cycle of the forum: its periodicity is scheduled, its stages are implemented with facilitation and secretariat support, and standardised records make it possible to compare cycles and feed into the next planning within the plan-act-monitor-reflect-plan scheme. Where there is an institutional mandate - as in Peru, where annual implementation is official - continuity is reinforced by formal timetables, designated officials, training and national dissemination. Adaptation to online mode and continuous updating of materials also makes it easier to maintain the cycle even with logistical constraints.

Specialisation

The implementation of the tool requires two core technical profiles (facilitator and secretary) and some ad hoc support. Also, depending on the context, specialised support may be required in some cases:

- Coordination/organisation of the forum to prepare the session (prior sending of the manual, copies and formats, definition of frequency), which anchors the tool in the operational calendar,
- Linguistic support (second facilitator or translator) when there are several languages,
- Facilitators trained through specific trainings.

Also, when customising indicators to the legal or operational framework of the forum and working with historically under-represented groups (e.g. indigenous women or minority groups), it is useful to have expertise in gender and inclusion and adaptive collaborative management to translate reflection into actual adjustments to the work plan.

Collaboration

To ensure the effective participation of all identified stakeholders, the experience in Peru shows that the main initial obstacle was the lack of trust in the process, even after the training carried out. To overcome these barriers, it is advisable to support the implementation with technical support from CIFOR-ICRAF, which can adapt the tool to the specific needs of each group and even facilitate the first sessions. This initial support is decisive for building trust, resolving methodological doubts and ensuring that the forum incorporates the tool as part of its regular operation.

In addition, it is key to frame the application of the tool within existing planning processes (e.g. by integrating it into the group's work cycles or land planning), so that the activity is not perceived as an external or additional exercise, but as a natural part of the forum's functioning.

Acknowledgements

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Author's note: At the time of writing, CIFOR-ICRAF was in the process of releasing a new version of the tool, which will be available at: https://www.cifor.org/toolboxes/tools-for-managing-landscapes-inclusively/

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