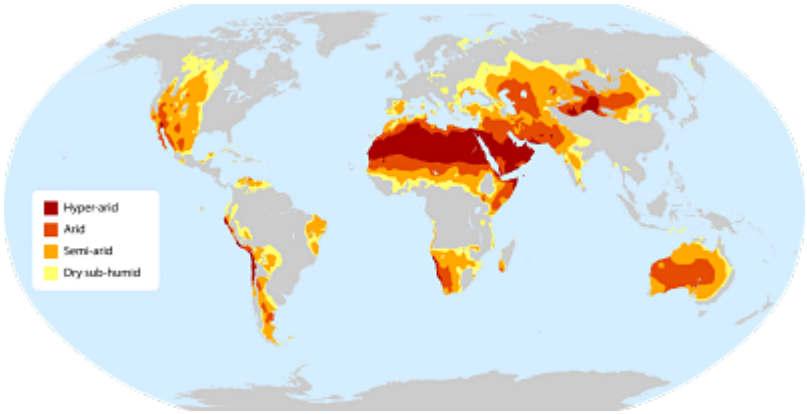
Dryland Forests & Agrosilvopastoral Systems

Basic knowledge

Welcome to the module on dryland forests and agrosilvopastoral systems. This module highlights the importance and vulnerability of dryland forests and agrosilvopastoral systems and provides guidance on their sustainable management, protection and restoration. It provides basic and more detailed information, as well as tools, cases and practical experiences.

Drylands are characterized by a scarcity of water, which affects both natural and managed ecosystems and constrains the production of livestock as well as crops, wood, forage and other plants and affects the delivery of many environmental services. The United Nations Environment Programme (UNEP) defines drylands according to an aridity index (AI), which is the ratio between average annual precipitation and potential evapotranspiration; drylands are lands with an AI of less than 0.65. UNEP's classification system subdivides drylands on the basis of AI into hyper-arid lands, arid lands, semi-arid lands and dry subhumid lands. Drylands are found in most of the world's biomes and climatic zones and constitute 41 percent of the global land area.



The world's drylands and subtypes. Prepared using spatial data from UNEP-WCMC (2007).

On the basis of satellite data, FAO has estimated that one-fifth of global forest cover is located in drylands. Forests covered about 13 percent of drylands in 2012, mostly in dry subhumid areas, but at least 3 percent of the world's dryland forests were lost between 2000 and 2012. These figures do not include non-forest wooded lands and other tree-based systems, even though these play key roles in many dryland systems.

More than elsewhere, forests and agrosilvopastoral systems in drylands play crucial economic, social and environmental roles, including by improving the environmental sustainability and resilience of wider landscapes. Dryland forests and agrosilvopastoral systems harbour species that are particularly well adapted to extreme ecological conditions and provide essential goods and environmental services. If well managed and properly valued, dryland forest and woodland ecosystems can help alleviate poverty and contribute to the food security and sustainable livelihoods of 2 billion people worldwide. Dryland forests and agrosilvopastoral systems are important for the very poor, providing a source of food and other essential materials in periods of food insecurity, such as during dry seasons or in the wake of natural disasters and war. More generally, forests and trees in drylands are essential for sustaining rural livelihoods. In Africa, for example, 320 million people depend on dryland forests and woodlands to meet many of their basic needs, including medicinal supplies and woodfuel.

Dryland forests and agrosilvopastoral systems face serious threats, including degradation, fragmentation, deforestation and desertification. Various interrelated factors are driving these threats, such as climate change and climate-related disasters; policy and socioeconomic factors that lead to resource overharvesting; a lack of technical capacity; and a lack of understanding of the importance and vulnerability of dryland forest and woodland ecosystems.

Sustainable management of dryland forests and agrosilvopastoral systems

The management and conservation of dryland forests and agrosilvopastoral systems often require different approaches to those suited to humid forests. The biodiversity of dryland forests and woodlands, and the physiological adaptations of species that allow their survival in dry conditions, are assets that should be identified, studied and used as tools to underpin sound management practices.

Many dryland forests and agrosilvopastoral systems are degraded or threatened by degradation, and management actions therefore often involve restoration (see the Forest Restoration and Rehabilitation module) aimed at reversing degradation processes and increasing the contributions of forests and associated landscapes to livelihoods, land productivity, environmental services and the resilience of human and natural systems. In dryland forests and other dryland ecosystems dominated by trees and shrubs, the re-establishment of trees and other species (such as grasses and shrubs) can restore protective and productive ecological functions. Integrated landscape-scale approaches to the restoration, protection and management of dryland forests and agrosilvopastoral systems have the greatest chance of success.

Drylands forests and agrosilvopastoral systems contributes to SDGs:


1
NO
POVERTY
2
ZERO
HUNGER
12
RESPONSIBLE
CONSUMPTION
AND PRODUCTION
15
LIFE
ON LAND

In more depth

Choosing the best management strategy

The management of dryland forests and agrosilvopastoral systems can involve a wide range of actions, such as those aimed at protecting the resource from water and wind erosion, fire, over-grazing and other threats; biodiversity conservation; the re-establishment of vegetation cover through assisted natural regeneration (ANR) or planting; and the production of wood, woodfuel and non-wood forest products. Overall, the management of dryland forests and agrosilvopastoral systems aims to maintain or enhance ecological integrity and support human well-being. Such management usually has multiple economic, social, environmental and cultural objectives and will involve trade-offs to balance socioeconomic demands and environmental outcomes.

Dryland forests and agrosilvopastoral systems comprise diverse natural resources (e.g. plants, wildlife and soil and water resources) and land uses (e.g. pastoral and agricultural lands, forests, protected areas and urban areas) that together constitute a mosaic that should be managed holistically. Forests and trees play essential roles in many dryland landscapes, but their health and capacity to provide goods and environmental services are influenced by many external factors. A lack of coordination among the agriculture, forest, energy and other sectors often means that different institutions treat different components of land management separately, increasing the likelihood of conflicts over land use and undermining resource sustainability. Participatory landscape and land-use planning and visioning processes should be undertaken through equitable processes of dialogue and (if necessary) negotiation to obtain stakeholder agreement on the landscape mosaic of habitat types and land uses best-suited to environmental and socioeconomic conditions.

The management and restoration of dryland forests and agrosilvopastoral systems are best integrated with other priorities and processes, such as poverty-reduction strategies, land-use plans, infrastructure development and subsidy schemes. Creative mechanisms to secure collaboration among disparate ministries and institutions can be applied to integrate and coordinate interventions in drylands and to engage land-users in restoration and sustainable land management. Landscape approaches should be people-centred: promoting integration among institutions is always challenging, but rural people are often the best “integrators” because they instinctively adopt landscape approaches to their land management.

Using management plans

Management (as opposed to uncontrolled access to and use of forests and woodlands) is essential for facilitating the expansion, regeneration, growth and functional utility of forests and trees in drylands and the human activities essential for conservation and sustainable development. Effective management plans address the threats to and pressures on natural resources while also facilitating access to the many benefits of those resources.

Overly detailed management plans should be avoided, however: the imposition of unnecessarily onerous demands can be counterproductive, acting as barriers to rural communities. Prescriptive legal requirements, time-consuming and inflexible registration processes, and complex requirements for management plans, when imposed as prerequisites for community-based management, can hinder local users in making management choices that reflect their unique needs and conditions. Simple management planning approaches that fit local needs and capacities have been used successfully in many places and should be encouraged.

Recognizing and protecting land tenure and land-use rights

The absence of secure rights to natural resources, such as land access and management rights and the right to generate income or otherwise benefit from natural resources, is a major constraint on investment in sustainable management and restoration activities in drylands. Uncertainty on rights and unclear regulations can reduce interest in sustainable management among local actors, who do not wish to invest time and resources in restoration activities (for example) if there is no guarantee they will be allowed to use the resources when the land becomes productive.

Secure land tenure, therefore, is fundamental to achieving sustainable forest management (SFM) in drylands. It can be a major incentive for stakeholders to engage in and commit to long-term efforts to achieve SFM.

SFM proponents should carefully assess the tenure situation prior to management planning and implementation. A valuable resource for this is FAO’s Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security, which provides guidance on the recognition, respect and safeguarding of legitimate tenure rights. FAO’s Reforming Forest Tenure: Issues, Principles and Process sets out ten principles for reforming forest tenure that address, among other things, social equity; customary rights and systems; tenure security; and good governance (see also the Forest Tenure module).

Integrating sustainable grazing management practices

Unplanned grazing can damage vegetative cover and cause land degradation. Grazing management involves an iterative and adaptive process for determining grazing strategies, mainly because the timing and distribution of rainfall can be highly variable. The continuous monitoring of livestock productivity and range condition and productivity, and learnings from experience and practice, can help ensure suitable grazing management responses to changing climatic and socioeconomic circumstances. The appropriate numbers and types of stock, and the best management practices for livestock grazing, are highly context-specific and should be carefully matched with the landscape under management.

If well-controlled, grazing can be used as a management tool to increase the vigour of mature perennial grasses. For example, grazing can extend the longevity of plants and promote the fragmentation of decaying, over-mature plants by encouraging basal bud activation, new vegetative and reproductive tiller formation, and seed and seedling production. The positive impacts of grazing arise from the effects it has on species composition and litter accumulation.

In some regions, rangelands are burned to replace old dry grasses with re-sprouting young grasses that are more palatable to livestock. These fires can also be damaging, however, and improved grazing schemes might help in avoiding the production of dry long grasses, thus minimizing the need for fire.

Using integrated fire management

The observed increased frequency of fires in many drylands is likely due to a number of factors, including human-induced causes (such as land clearing for agriculture and pasture, negligence and lack or poor management practices), climate change, and an increase in the frequency of drought and heat waves. Fire can be used in dryland management in a variety of ways, ranging from traditional burning practices to highly specialized modern techniques. The frequency, location and intensity of fire have implications for biodiversity in some ecosystems. A lack of appropriate land management, however, may lead to the accumulation of fuels in landscapes and a consequent increase in high-intensity fires, producing homogenous or fire-prone landscapes. Fire management, therefore, should be part of integrated land management strategies (see also the Vegetation Fire Management module).

Protecting against soil and water erosion

Soil management is essential for preventing erosion and maintaining fertility in drylands. Soil erosion is one of the main threats to drylands worldwide, and protecting soils from additional water and wind erosion is often a critical first step in restoration. A range of measures can also be taken to conserve soil organic matter, recycle nutrients and maintain soil fertility, including the following:

- **Controlling wind erosion** – measures include primary fixation, which is the mechanical stabilization of sand masses by slowing their speed and movement or preventing the formation of such masses; and biological fixation, which is the installation and protection of permanent vegetation cover.
- **Maintaining soil fertility** – measures for maintaining soil fertility include the integration of leguminous trees and plant species in farming systems, composting, and the minimization of burning.
- **Controlling erosion caused by rainfall** – rainfall can cause various types of erosion, such as sheet, rill and gully, the latter being the most severe. The key to controlling erosion caused by rainfall is to reduce the velocity and volume of runoff, which can be done by increasing vegetation cover and the use of cross-slope barriers, such as tied ridging on contours and permanently vegetated contour bunds.
- **Using vegetative strips in farmland** – the establishment of strips of unploughed land on which trees, shrubs and grasses form permanent, often cross-slope barriers to slow runoff is an effective measure for improving water infiltration, preventing wind desiccation and erosion, limiting the loss of soil nutrients, creating microclimatic conditions conducive to vegetation growth, and enhancing biodiversity in croplands.

Managing natural regeneration for restoration

It is usually less expensive and more efficient to promote natural regeneration than to plant seedlings or pursue other re-vegetation strategies, provided there are mature trees and other species in or close to the restoration area. Depending on the tree species, the closest mature trees should be no more than 50–100 m from the restoration area. ANR is the deliberate protection of degraded land from pressures to allow natural processes of forest succession with the aim of re-establishing healthy, resilient and productive ecosystems. The process usually takes at least three years and can take up to 20 years, depending on the extent of degradation, the soil condition, the species, and the availability of seeds.

ANR may be difficult to implement in the absence of protection against pressures exerted by other land uses, especially in highly populated areas. Uncontrolled grazing can have a major influence, but the temporary exclusion of animal grazing can lead to the rapid recovery of soils and former vegetation. In the Tigray region of Ethiopia, for example, exclosures in place for more than two decades have allowed the

restoration of significant areas of degraded land.

Farmer-managed natural regeneration (FMNR) is the practice of "actively managing and protecting non-planted trees and shrubs with the goal of increasing the value or quantity of woody vegetation on farmland". In FMNR, farmers select and protect the healthiest, tallest and straightest stems of native trees and shrubs sprouting from stumps or roots on ploughed and grazed land. They remove unwanted stems and side branches to reduce water competition and to facilitate the growth of selected stems, which can quickly produce woodfuel and fodder. FMNR may also involve protecting and managing seedlings growing spontaneously from seedbanks in the soil and contained in livestock manure and bird droppings. The planting of seedlings may be incorporated in FMNR management practices to enrich existing vegetation, especially when coppicing stems are sparse and the soil seedbank is poor.

The main costs associated with FMNR are the time it takes farmers to protect and prune the regrowth and those associated with promoting and teaching FMNR practices (where this is necessary). FMNR is simple to implement and can be scaled up quickly, provided that latent seeds and living tree stumps and roots are present at the site.

A key lesson gained from diverse experiences in FMNR is that property rights to trees are essential if farmers and communities are to protect them. Equally important is the need to transfer land rights and authority to local communities to enable them to access and use the natural resources they are protecting.

Seeding and planting for restoration

Planted forests managed for the production of wood or non-wood forest products in drylands can help communities raise their standard of living while also restoring degraded lands and contributing to sustainable development. If poorly designed and managed, however, planted forests can have negative impacts on people, the environment and biodiversity. It is important, therefore, to adequately plan any planting scheme.

Relevant stakeholders, including local communities, should agree on planting objectives and locations before a planted forest is established. There may be hotspots in the landscape (e.g. where runoff occurs) where the planting of appropriate species will have an optimal impact on degradation (and those species can then spread by natural means), thus reducing costs and increasing benefits.

Other important aspects to take into consideration when choosing a planting strategy for restoration in drylands include the following:

- **Producing high-quality planting material** – well-managed nurseries play important roles by producing planting material with optimal potential to thrive in dry conditions. It is also important to choose the most efficient and cost-effective regeneration methods.
- **Choosing planting period and density** – the best time for planting in drylands is when the soil has sufficient water to satisfy the needs of seedlings in their first few months. Planting density should be determined by the availability of water resources and according to species used.
- **Using water in dry conditions** – assisted watering should be limited to specific periods of water stress in the first two years after planting, and it should only be considered if the benefits (monetary or otherwise) justify the substantial cost. Techniques for collecting and conserving water include micro-water harvesting, floodwater harvesting, capturing air moisture, using treated wastewater (see the Using Treated Wastewater in Forestry and Agroforestry in Drylands module), and rooftop and courtyard water harvesting.

See the Forest Reproductive Material and Forest Restoration and Rehabilitation modules for more guidance on the selection of suitable species and genetic material for restoration.

Sustaining management and its benefits for people

Trees and forests are essential for the lives of people in drylands, helping to meet basic needs for food, medicine, energy, fodder and many other materials. Families, communities and indigenous peoples own or manage more than 30 percent of the world's forests, including drylands. They have a demonstrated capacity to manage their forests sustainably and to restore them, but they have generally received little policy attention from national governments and international agencies.

Economic and financial viability is a necessary condition for all stakeholders if they are to invest in and allocate sufficient resources for restoration and sustainable management. Local authorities usually only agree to allocate funding when the benefits to a community are significantly greater than the costs (of all types).

Improving the income opportunities derived from forest and tree products is one way of providing incentives for local stakeholders to participate in dryland restoration and management. For example, small-scale forest product enterprises can support livelihoods by broadening local income opportunities. To be successful in the long term it is important that such enterprises integrate economic viability

and social and environmental sustainability and provide equitable, gender-balanced benefits. A tool designed to assist in such integration is Market Analysis and Development, known as MA&D, which has been developed as a participatory approach to capacity development and to assist local communities, farmers and producers in developing income-generating enterprises while conserving forest and tree resources. See the Market Analysis and Development of Forest-based Enterprises module for more information on this tool.

The planning of restoration and management activities in drylands should be linked to or integrated with business planning. For example, species and varieties with commercially important traits could be used in restoration, where appropriate.

The development of small and medium-sized enterprises can be facilitated by microloans, which have been shown to lead to rises in family income in rural areas, as well as by supportive structures such as certification schemes and networks of producers and buyers.

Monitoring as an essential part of sustainable management

Monitoring, preferably conducted in a participatory way, involves the systematic collection and analysis of data over time to determine whether conditions have changed relative to the situation before an intervention (the “baseline” or “reference” case) and whether planned management interventions have had the desired (or unexpected undesirable) effects.

A wide range of tools and methods is available for monitoring and assessing various aspects of drylands. Globally, the scale at which such tools and methods are being applied is insufficient, however, and there are gaps in the comprehensiveness and integration of existing monitoring and assessment programmes as well as a lack of capacity to implement them.

Monitoring is especially important in drylands given the many gaps in knowledge about dryland forest and tree management. Information gathered through monitoring can be used in planning and management at specific sites, as well as in generating lessons for scaling up interventions.

There is potential for building on existing monitoring and assessment methods and tools and for developing new methods that integrate remote sensing and local participation. For example, FAO has developed a customized version of the open-source Collect Earth tool for the monitoring and assessment of land use and land-use change in drylands. It uses freely available high-resolution imagery to obtain detailed biophysical assessments, such as tree-cover assessments in areas with low (e.g. less than 10 percent) tree cover.

Further learning

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