Agroforestry Network

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AGROFORESTRY AND WATER FOR RESILIENT LANDSCAPES

Agroforestry can improve local water cycles and increase farms' control over and access to fresh-water. Trees are crucial components in local, as well as global water cycles. By incorporating trees in agricultural land, it is possible to improve food production systems and meet water needs without adversely affecting neighbouring or downstream water users. This brief focuses on the role of trees for increased water security on smallholder agroforestry farms in the tropics, and opportunities to adopt agroforestry as a landscape restoration practice to make degraded lands more resilient to the consequences of climate change while reducing greenhouse gas emissions.

Water in landscapes can have both positive (food production, etc.) and negative (floods, erosion etc.) repercussions to climate change. Throughout history, humans have transformed the global water flow, which has had an enormous impact on ecosystems and the services they generate. Unsustainable land-use and climate change have effects on the availability of water, both locally in terms of water quantity and quality and regionally in terms of changes in precipitation. Access to freshwater, for human consumption, agriculture and industry, is an increasing global challenge and many people are suffering from both water and food insecurity. Globally, agriculture accounts to 70% of freshwater use (UN Environment 2019) and is a driver of many other environmental challenges (Molden 2007) and is therefore one of the most important factors in today's water and climate challenges.

Low-income countries are facing immense challenges related to water use and food production, while also being vulnerable to the effects of climate change. In Africa, for example, the situation is likely to worsen drastically in the coming years, due to a combination of the expected doubling of the population by 2050 (UN Population Division 2017); an expansion of drylands and an exceptionally high rainfall variability in many locations, that is expected to worsen with global warming (IPCC 2012); and an agricultural sector that is 95% rainfed (FAOSTAT 2010). To avoid a hunger crisis, the continent needs major investments to transform its agricultural sector.

To improve the productivity and resilience of land and water resources we need to aim for productive, multifunctional landscapes and good governance considering human rights for a more equitable distribution of water. Agroforestry practices can support the livelihoods of people, produce raw materials, strengthen biodiversity and maintain the water cycle.

Fredrick Odhiambo, Kenya. Photo: Elin Larsson.

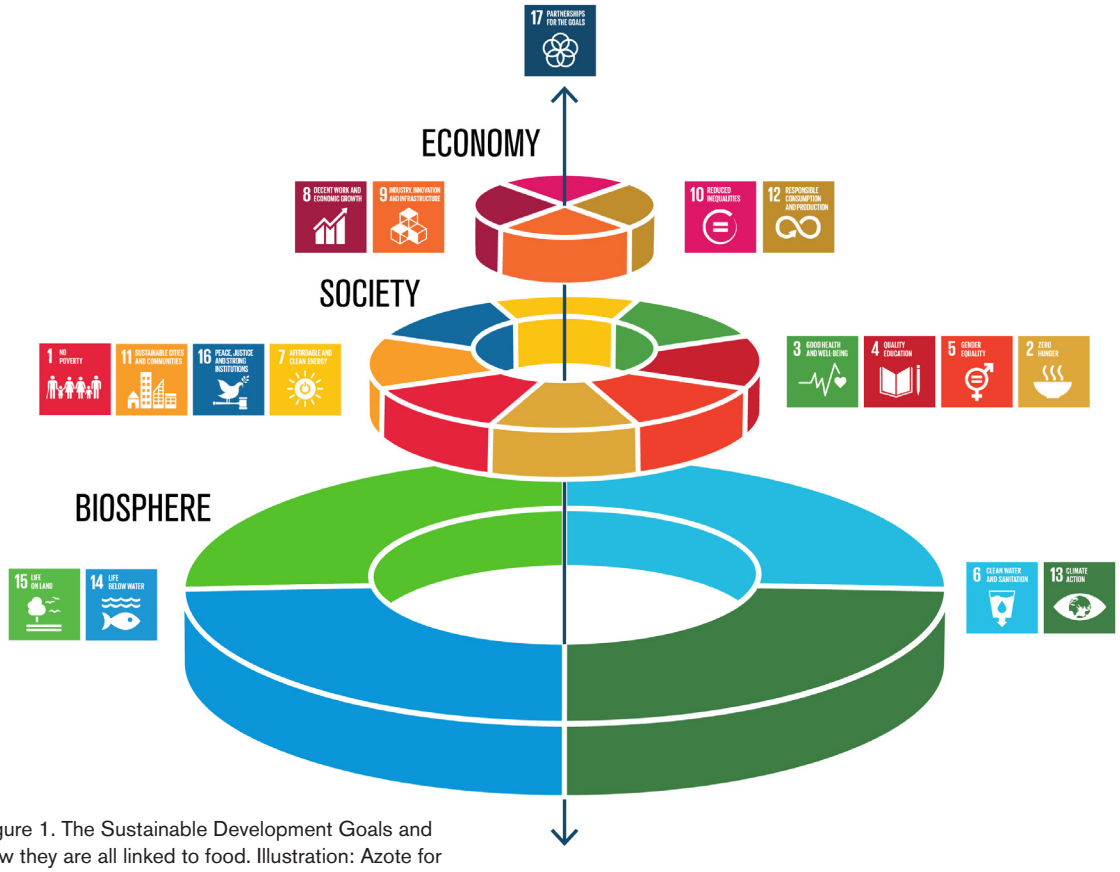

Figure 1. The Sustainable Development Goals and how they are all linked to food. Illustration: Azote for Stockholm Resilience Centre, Stockholm University

AGROFORESTRY AND WATER CONTRIBUTE TO THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Sustainable development goals (SDGs) related to water, restoration and sustainable land management practices, such as agroforestry, form the basis for achieving the SDGs related to economic and social goals (Figure 1). Most of the SDGs and targets are dependent on SDGs, and to deliver on the 2030 Agenda it is urgent to observe the role that water plays in achieving the SDGs (SIWI 2019). Agroforestry practices can contribute significantly to both water security and to several of the SDGs, not least SDG 6 on Clean Water and Sanitation, but also SDG 2 on Food and Nutritional Security, SDG 3 on Health, SDG 13 on Climate Action and SDG 15 on Life on Land (SIWI 2019, Agroforestry Network 2018).

TREES AND THE WATER CYCLE

Trees pull water from the ground and release it into the atmosphere as vapor through their leaves in a process called transpiration, which influences local temperatures and rainfall locally and across the globe. Water cycles operate at multiple scales; from global and regional, down to catchments. Trees have a key function in these hydrological cycles (Figure 2).

Tree transpiration suports moisture recycling. The hydrological process contributes to local rainfall, atmospheric humidity and cloud cover (Keys et al. 2016), as well as cross-continental transport of atmospheric moisture that can influence water availability in remote downwind locations (Ellison et al. 2017). Deforestation reduces transpiration and can disrupt the movement of water in the atmosphere, which can have huge impacts on rainfall, both locally and in distant locations (Debortoli et al. 2017, Spracklen & Garcia-Carreras 2015).

Trees and other vegetation cover regulate water flows in various ecosystem processes. Trees also influence the soils

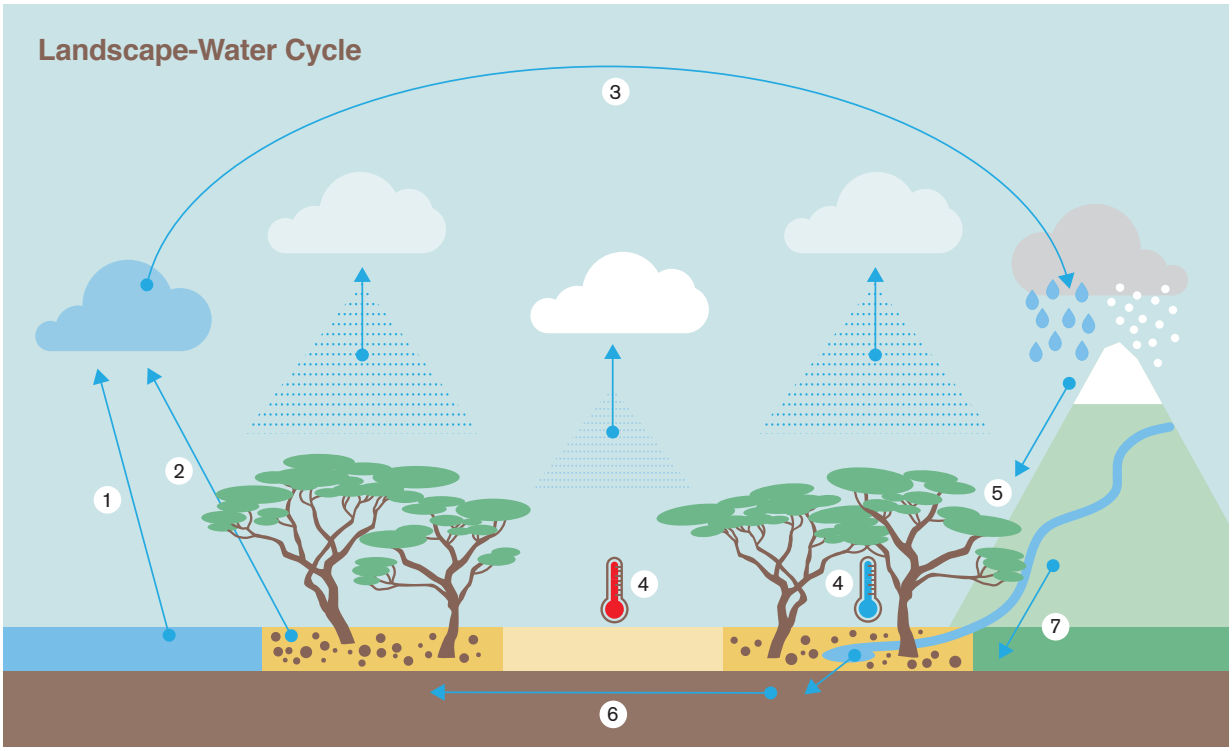

Figure 2. How trees and forests affect the landscape-water cycle: 1) Precipitation recycling at regional and continental scale 2) Cloud formation triggered by humidity and bio-particles 3) Atmospheric moisture transport 4) Local and global heating and cooling 5) Fog/cloud moisture that is intercepted by the trees and the forest floor 6) Infiltration and groundwater recharge 7) Flood moderation

ability to capture, store and release water, as organic matter from trees can help soil to hold water and improve soil structure and porosity (Benegas et al. 2015). Loss of tree cover, following e.g. conversion from forest to agricultural land, can result in soil degradation, reduced soil organic carbon and degraded soil structure (Nyberg et al. 2012). By adopting sustainable agricultural and landscape management practices – such as agroforestry – it is possible to regulate and improve water flows.

AGROFORESTRY IS WATER WISE FARMING

The trees in agroforestry provide numerous water-related ecosystem services that are crucial to agriculture (van Noordwijk et al. 2019), for instance, regulation of water flows, and improved soil fertility and water quality (leading to less erosion). Trees also provide shade for crops, as well as for humans and livestock. By adopting an agroforestry practice, i.e. integrating trees, crops and/or livestock on the same plot of land, smallholder farmers can increase the supply of water needed on the farm and its surroundings, while also reducing the amount of water lost as surface runoff.

In sub-Saharan Africa, agroforestry has proven to increase crop yield while maintaining the delivery of ecosystem services, such as water regulation, erosion control, and soil fertility (Kuyah et al. 2019). A major challenge for agroforestry in arid areas is to identify management practices that optimize water use, such as species selection and pruning (Ong et al., 2007). The trees in an agroforestry farm affects water movement through the soil, and research shows that a moderate to intermediate tree cover on degraded land can improve groundwater recharge (Ilstedt et al. 2016). In arid areas, trees can improve the infiltration and contribute to deep soil and groundwater recharge (Bargués-Tobella 2020).

MORE FOOD PER WATERDROP

A sustainable and diverse agroforestry practice can increase farmers' control over the availability of water. By adopting a 'water productivity' perspective, that means growing more food with less water, it is possible to increase the amount of agricultural output (crops, trees, livestock) produced per unit volume of water consumed (Lundqvist & Unver 2018, Gordon et al. 2008). Water

Case study:

RAINFED-IRRIGATION CONTINUUM AND UPSTREAM – DOWNSTREAM INTERACTIONS

Rainfed and irrigation systems at a landscape or watershed scale are interdependent units, although we give them different names to simplify management. In the central rift valley in Ethiopia, rainfed agriculture is common. Currently the dryland systems, including the valley floor of the rift valley, faces several major risks and uncertainties. The rainfed production system is highly vulnerable to climate variability and extremes (such as highly variable rainfall, long dry seasons and recurrent droughts and floods).

The Ethiopian rift valley rainfed systems are in many parts degraded and water stressed, and efforts are needed to improve water management to build resilient landscapes. This has resulted in farm-level supplemental irrigation development through solar-driven pumps (Haileslassie et al. 2020). The introduction of effective and sustainable management of water for agriculture in the rift valley landscape, through agroforestry and other water wise landscape management approaches, have supported the recharge of shallow groundwater (Fig 3a och 3b). This presents an opportunity to practice irrigated agriculture in the middle and lower parts of the rift valley by ensuring a continuum of rainfed irrigation for sustainable agricultural production at the landscape scale.

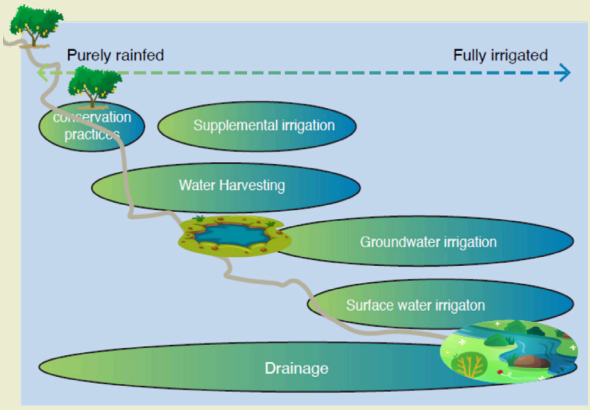

Figure 3a: Graphic illustration of the rainfed and irrigation continuum across landscapes.

Figure 3b: Partial view of Lake Hawassa catchment with people settlement, their agricultural land and different agricultural practices

productivity can be improved by increasing productive water flows (for example from increased tree transpiration) while reducing unproductive losses of water, such as soil evaporation (Molden 2007). There are many management strategies that can significantly increase the water productivity of an agroforestry farm, for example by using drought tolerant trees and crop varieties, and by combining trees and crops with complementary resource uses in both time and space (Boelee 2013).

AGROFORESTRY, WATER AND CLIMATE CHANGE

Climate change is affecting the hydrological cycles upon which the natural and human environments entirely depend. As the Earth keeps getting warmer, competition over water resources increases, as well as extreme rainfall events and flooding (IPCC 2012). It is probably through water that we will experience some of the strongest effects of climate change. Improved water efficiency is key to reducing carbon emissions from agriculture. Without adaptation, climate change may depress growth in global agriculture yields with up to 30 percent by 2050 (GCA, 2019).

Smallholder farmers in many parts of the world are already experiencing changes in rainfall patterns (IPCC 2019). This reduced ability to predict precipitation and access to water is affecting farm productivity and people's health. Measures to ensure that everyone has access to sustainable water and sanitation services are critical to climate change adaptation. Agroforestry offers solutions that can contribute to both climate change mitigation and adaptation, while also contributing to increased water security. One example is improved fallows, an agroforestry practice where trees are planted in rotation with cultivated crops,

that have the potential to improve soil moisture and enrich the soil, while mitigating climate change through carbon sequestration (Partey et al. 2017).

AGROFORESTRY FOR LANDSCAPE RESTORATION

Agroforestry practices can transform degraded or less-productive lands and support the hydrological cycle, for instance by regulating the supply of water, improving soil health and controlling erosion. Restoring degraded landscapes is becoming increasingly important, and sustainable agroforestry practices have a central role to play in this development.

Forest and landscape restoration (FLR) is a long-term restoration process that has gained extensive attention internationally in recent years. Most FLR opportunities are in the form of mosaic restoration where agroforestry plays a critical role (FAO 2017). The main focus of FLR is twofold; to regain ecological functionality while also enhancing human well-being across deforested or degraded forest landscapes. Compared to other restoration practices included in FLR, agroforestry is particularly effective in restoring biodiversity and ecosystems while also delivering food and income (FAO 2017).

Agroforestry can contribute to international commitments for landscape restoration, such as the Bonn Challenge, The New York Declaration of Forests, The Governor's Task Force and Africa 100, not the least as part of FLR management plans. There is potential for these commitments to contribute to the SDG targets, and to the Paris agreement targets. Integration of water resource management is needed for the processes to be successful in restoring resilient, productive landscapes.

WATER GOVERNANCE

Agroforestry practices can increase water security. However, good water governance is crucial to ensure equitable access to water resources. It has increasingly been recognised that good water governance should take a human rights-based approach (HRBA) (Grönwall & Danert, 2020). Many countries recognize the right to a healthy environment as a constitutional or statutory right including the right to clean water that is free from toxic wastes or pollution.

The way we manage our water has a major impact on the lives of individuals, societies, and nature. Agroforestry can contribute to improved water security, while at the same time enhancing food security, improve nutrition, hygiene, human and ecosystem health and socio-economic development. In the face of existing and increasing global water scarcity (UN Water 2018) it is of utmost importance to adopt resilient and sustainable agriculture water management practices, such as agroforestry.

Agroforestry plays a critical role in Forest and landscape restoration (FLR)

RECOMMENDATIONS FOR POLICY AND PRACTICE

- Incorporate sustainable agroforestry practices into national policies and strategies to contribute to water security, climate action and enhanced resilience of people and ecosystems.
- Enhance water security and numerous other ecosystem services by supporting the implementation of agroforestry practices.
- Support improved water productivity through the implementation of agroforestry practices and better information about opportunities to use limited water resources for better nutrition.
- Promote agroforestry in forest and landscape restoration (FLR) to support the targets in both the Paris Agreement and the SDGs, not least the targets for water, food and climate action and contribute to international commitments for landscape restoration, such as the Bonn Challenge and Africa 100.
- Include agroforestry practices in the rainfed-irrigation continuum in landscapes to support recharge of groundwater in upstream areas for downstream irrigation.
- Use a human rights-based approach in water governance to improve stakeholder engagement, capacity building and the implementation of landscape approaches that support the relationships between livelihoods, agroforestry and water security.

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Tanzania. Photo: Elin Larsson.

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