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Resilient FOOD SYSTEMS

Analysis of the impact of land use on ecosystem services in productive landscapes of 12 African countries

UN environment programme

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Contents

Acronyms

AFR100	African Forest Landscape Restoration Initiative
ARIES	Artificial Intelligence for Ecosystem Services
DATAR	Diversity Assessment Tool for Agrobiodiversity and Resilience
DeLUTAS	Decision-making for Land Use Trade-offs and Synergies
FAO	The Food and Agriculture Organization of the United Nations
GHG	Greenhouse Gas
GLI	Green Legacy Initiative
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
InVEST	Integrated Valuation of Ecosystem Services and Trade-offs
LSDF	Landscape Degradation Surveillance Framework
LUCI	Land Utilization Capability Indicator
MPAT	Multidimensional Poverty Assessment Tool
RAPTA	Resilience, Adaptation Pathways and Transformation Assessment
SDGs	United Nations Sustainable Development Goals
SHARED	Stakeholder Approach to Risk-informed and Evidence-based Decision-making
SHARP	Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists
SLM	Sustainable Land Management
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
WOCAT-LADA	Land Degradation Assessment in Drylands Mapping Tool

CHAPTER 1

Introduction

Land is at the centre of Africa's prosperity and the sustainability of livelihoods across the continent. The question of land use and land health relate not only to agriculture, which employs about half of the continent's workforce, but also to housing, urbanization, biodiversity, water and a number of other issues. Unsustainable land use practices and other pressures have been degrading land across Africa, with climate change an additional pressing threat to land health and the livelihoods that depend on it. The health of natural ecosystems is intimately linked with land use – poor land use has the potential to undermine ecosystems at the site of such activities, but can also have wider impacts through, for example, erosion or pollution. Land is thus an enormously valuable resource. At the same time, land is limited – there is only a given amount of land available and allocating it to a specific use, for example urban development, means that it's availability for other activities, such as agriculture or nature conservation, is constrained or eliminated. While opportunities for mixed land use do exist, there are inevitable impacts of certain forms of land use that may limit the opportunities for other uses and there are trade-offs with managing land for mixed use. This means that, as human pressures on Africa's available land increases, judicious decision making is required to manage competing demands, maintain the productive capacity of land, and balance trade-offs between various forms of land use.

Land use is the particular purpose to which land is assigned; it is the way that society makes use of land, often modifying it for specific purposes. The United Nations describes land use as arrangements, activities and inputs that people undertake in a specific land cover type to produce, change or maintain it (UN DESA 2003). This is distinct from the concept of land cover, or the biophysical attributes of the earth's surface (Lambin et al. 2001). In simple terms, land cover can be thought of as what is on the land (forests, grasslands, wetlands, buildings), whereas land use speaks to what the land is used for (agriculture, nature conservation, industrial use, etc). The concepts of land use and land cover are distinct yet related, as changes in land use typically result in changes in land cover, which in turn can have far-reaching implications for the health of ecosystems (Foley et al. 2005):

> **"Land-use activities—whether converting natural landscapes for human use or changing management practices on human-dominated lands—have transformed a large proportion of the planet's land surface. By clearing tropical forests, practicing subsistence agriculture, intensifying farmland production, or expanding urban centres, human actions are changing the world's landscapes in pervasive ways."**

It should be clear that land use change is intimately linked with the multiple sustainability crises facing humanity. The Global Land Outlook report, in a comprehensive assessment of global challenges and opportunities related to land management and sustainability, emphasised that **"Our ability to manage trade-offs at a landscape scale will ultimately decide the future of land resources – soil, water, and biodiversity – and determine success or failure in delivering poverty reduction, food and water security, and climate change mitigation and adaptation"** (UNCCD 2017). There is an ongoing and urgent policy debate around how to feed growing populations, provide access to economic opportunities, and manage the impacts of the food system on the health of ecosystems. A paradigm shift is needed to ensure the sustainability and resilience of food production systems in the face of climate change, the linked spread of pests and diseases, market disruptions and other shocks. The COVID-19 pandemic has added to the existing pressures on the sustainability and resilience of food systems. Countries across the world, including those in Africa, are now being called upon to refocus their development models to include addressing the repercussions of the pandemic, while at the same time responding to pre-existing challenges such as climate change, biodiversity loss and food insecurity.

This report explores the impact of changing land use on ecosystem services and productive landscapes in Africa. It has been developed under the **Resilient Food Systems programme**, one of three pilot programmes that form part of the Global Environment Facility's sixth replenishment cycle (GEF-6).[1] The Resilient Food Systems programme targets agroecological systems in the drylands of sub-Saharan Africa, where the need to enhance food security is directly linked to opportunities for generating local and global environmental benefits. Sub-Saharan African countries are seriously affected by environmental degradation and loss of ecosystems, resulting in persistently low crop and livestock productivity, as well as increased food insecurity for millions of smallholder farmers, with preponderant impacts on vulnerable groups such as women and youth.

The Resilient Food Systems Programme and the Sustainable Development Goals

SUSTAINABLE DEVELOPMENT GOALS

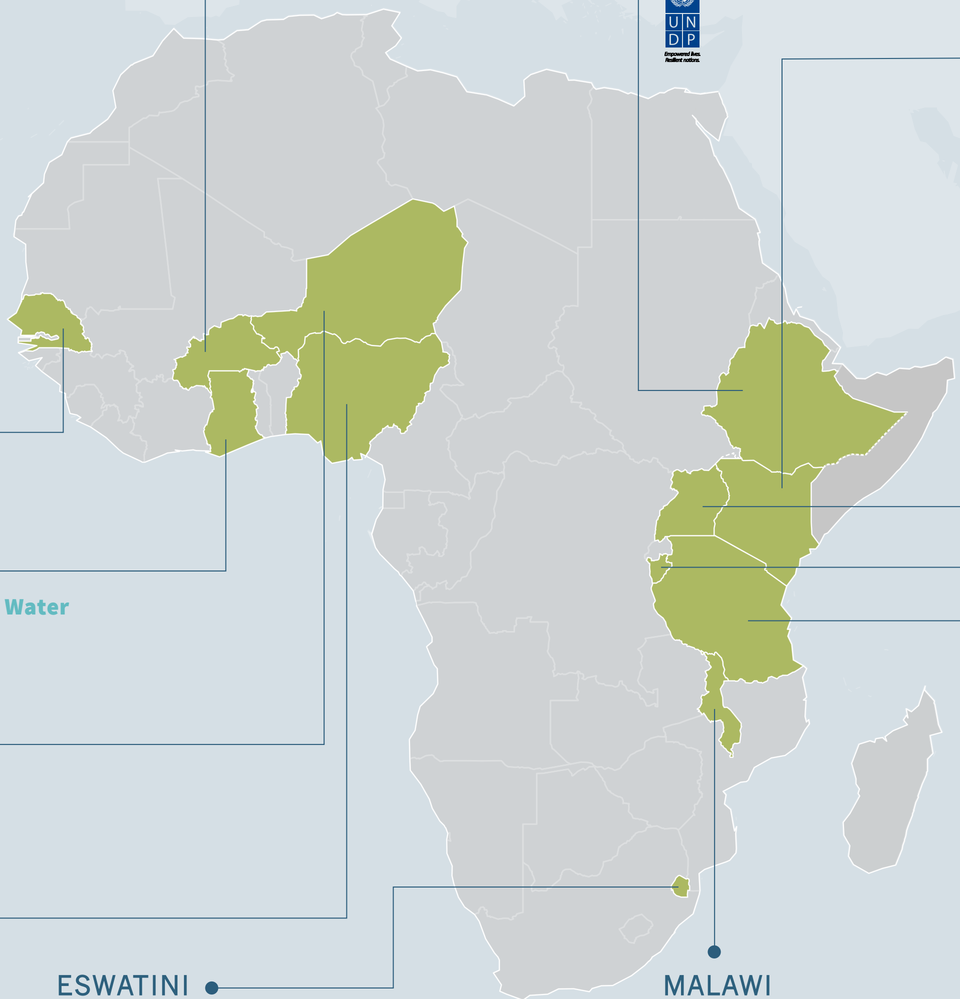
The Resilient Food Systems programme responds to several Sustainable Development Goals (SDGs), namely:

Geographically, the project focuses on 12 sub-Saharan African countries: Burkina Faso, Burundi, Eswatini, Ethiopia, Ghana, Kenya, Malawi, Niger, Nigeria, Senegal, Uganda, the United Republic of Tanzania.

1. The other two projects under the Integrated Approach Pilot Programme are Taking Deforestation out of Commodity Supply Chains and Sustainable Cities, see https://www.thegef.org/what-we-do/topics/integrated-approach-pilots

The Resilient Food Systems programme seeks to tackle major drivers of environmental degradation by advancing a holistic approach to enhancing agricultural productivity in smallholder systems, where food security is tied to agriculture and the health of ecosystems. A key part of this holistic approach is ensuring that gender and nutrition are mainstreamed throughout the project (CEDARE 2021). The project builds on existing efforts at national and regional levels to address various barriers pertaining to policy, institutions and knowledge in order to catalyse a shift towards safeguarding the natural capital, soil, water, and genetic resources that are important in ensuring resilience of agricultural livelihoods in the long term.

The design and implementation of the Resilient Food Systems programme is supported by specific partners in each of the participating countries. Coordination of project activities is fully supported by IFAD



BURKINA FASO
Participatory Natural Resource Management and Rural Development Project
IFAD Investing in rural people

ETHIOPIA
Integrated Landscape Management to Enhance Food Security and Ecosystem Resilience
UNDP

KENYA
Upper Tana-Nairobi Water Fund
IFAD Investing in rural people

UGANDA
Fostering Sustainability and Resilience for Food Security in Karamoja Sub-Region
UNDP FAO

SENEGAL
Agricultural Value Chains Resilience Support Project
IFAD Investing in rural people UNIDO

BURUNDI
Support for Sustainable Food Production and Enhancement of Food Security and Climate Resilience in Burundi's Highlands
FAO

GHANA
Sustainable Land and Water Management Project
THE WORLD BANK

NIGER
Family Farming Development Programme
IFAD Investing in rural people

NIGERIA
Integrated Landscape Management to Enhance Food Security and Ecosystem Resilience in Nigeria
UNDP

ESWATINI
Climate-Smart Agriculture for Climate Resilient Livelihoods
IFAD Investing in rural people

MALAWI
Enhancing the Resilience of Agroecological Systems
IFAD Investing in rural people

UNITED REPUBLIC OF TANZANIA
Reversing Land Degradation trends and increasing Food Security in degraded ecosystems of semi-arid areas of central Tanzania
IFAD Investing in rural people

The Resilient Food Systems programme is aligned with numerous African policy frameworks and objectives, including some frameworks that have emerged subsequent to the programme's launch. For example, the African Union Green Recovery Action Plan was launched in 2021 as an effort by African countries to address the impact of the COVID-19 pandemic on the continent. The Action Plan underscores that COVID-19 must be tackled in conjunction with pressing environmental challenges and calls for a clean and resilient recovery in Africa that will support employment and ensure that the continent effectively responds to the linked challenges of public health, prosperity and climate change. In this regard, it highlights critical areas of joint priority, including those directly addressed through the Resilient Food Systems programme, such as resilient agriculture, land use and biodiversity (African Union 2021).

The African Union Green Recovery Action Plan builds on existing work under various initiatives and strategic frameworks, including the Africa Adaptation Initiative, the Africa Renewable Energy Initiative, the Africa Blue Economy Strategy, the African Union Sustainable Forest Management Framework, the Pan-African Action Agenda on Ecosystem Restoration for Increased Resilience, the Comprehensive Africa Agriculture Development Programme, the Adaptation of African Agriculture Initiative, the African Climate Resilient Agricultural Development Programme, the Just Rural Transition initiative, the African Forest Landscape Restoration Initiative (AFR100), the Great Green Wall for the Sahara, Sahel and Southern Africa, the NDC Partnership, the Climate for Development in Africa programme, the three regional Climate Commissions (for African Island States, the Congo Basin, and the Sahel), and the African Union Climate Change and Resilient Development Strategy and Action Plan (AU Climate Change Strategy).

In addition to the above initiatives and strategic frameworks, an African Green Stimulus Programme was adopted through the African Ministerial Conference on the Environment in September 2021 to support the continent's overall post-COVID recovery programme, to contribute towards attaining Africa's Agenda 2063 targets, and to strengthen the continent's ability to achieve the SDGs. All these initiatives recognize the importance of integrated development as an approach that emphasizes the role played by ecosystems in ensuring food security and sustaining livelihoods.

This report has been developed in response to the demand by countries for support in improving decision making to address the impact of land use on the provision of ecosystem services under Resilient Food Systems programme component one: strengthening integrated institutional frameworks and mechanisms. In chapter two of this report, key concepts related to land use, natural capital and ecosystem services are introduced and broad global trends are outlined. Chapter three outlines the challenges and opportunities related to trade-offs and synergies in land use change, providing the framework for an assessment of regional trends in land use in Africa (chapter four) and specifically within the twelve Resilient Food Systems countries (chapter five). Chapter six reviews existing tools and frameworks for supporting land use decision making, while chapter seven offers a set of recommendations emerging from the analysis provided in the preceding chapters.


Photo: © Roshni Lodhia (NWF)

CHAPTER 2
Land Use, Natural Capital and Ecosystem Services

The concepts of natural capital and ecosystem services are closely related. Natural capital represents the value to society of all living and non-living resources; these natural capital stocks in turn generate a flow of benefits to humankind. The flows of benefits that humans derive from natural capital are referred to as ecosystem services. The Millennium Ecosystem Assessment (2005) identified four primary forms of capital – manufactured, human, social, and natural – highlighting that a society's natural capital is a key determinant of its wellbeing. Societies have applied manufacturing, human and social capital to available natural capital stocks such as fisheries, forests, water and land in ways that have increased productivity immensely and generated significant value for humankind. For example, agricultural land productivity increased 2.5 times between 1960 and 2000 as a result of mechanization, the use of chemical fertilizers and the development of new crop varieties (Steenwyk et al. 2022). The productivity of available land (natural capital) has thus increased significantly through the application of other forms of capital.

These gains have undergirded socio-economic development, allowing for societies to produce sufficient food even as the global population has swelled from 3 billion in 1960, to 6 billion in 2000, and over 8 billion today. Yet, as highlighted by the Millennium Ecosystem Assessment, humans are increasingly undermining the productive capability of ecosystems to provide the services that people desire.

For example, overfishing undermines the ability of marine ecosystems to provide food, while harmful agricultural practices reduce the long-term productivity of land and can undermine other key ecosystem services such as the provision of water, timber or flood control. The Global Land Outlook report highlights that land degradation and the subsequent loss of biodiversity leads to a reduction in many vital ecosystem services and thus greater food and water insecurity, as well as a decline in the resilience of ecosystem functions (UNCCD 2022a). At the same time, access to ecosystem services, including food production, continues to be shaped by unequal access and power disparities.

Ecosystem degradation **"has negative consequences for everyone, but generally impacts the vulnerable and poorest people most severely"** (UNCCD 2022a).

Enough food is produced today to feed the entire global population, with extra to spare. Indeed, it has been calculated that food production at current levels could support a global population of 10 billion people, yet famines continue to occur and hundreds of millions of people are food insecure. This underscores the importance of taking into account differences in power and access when considering governance and decision-making processes.

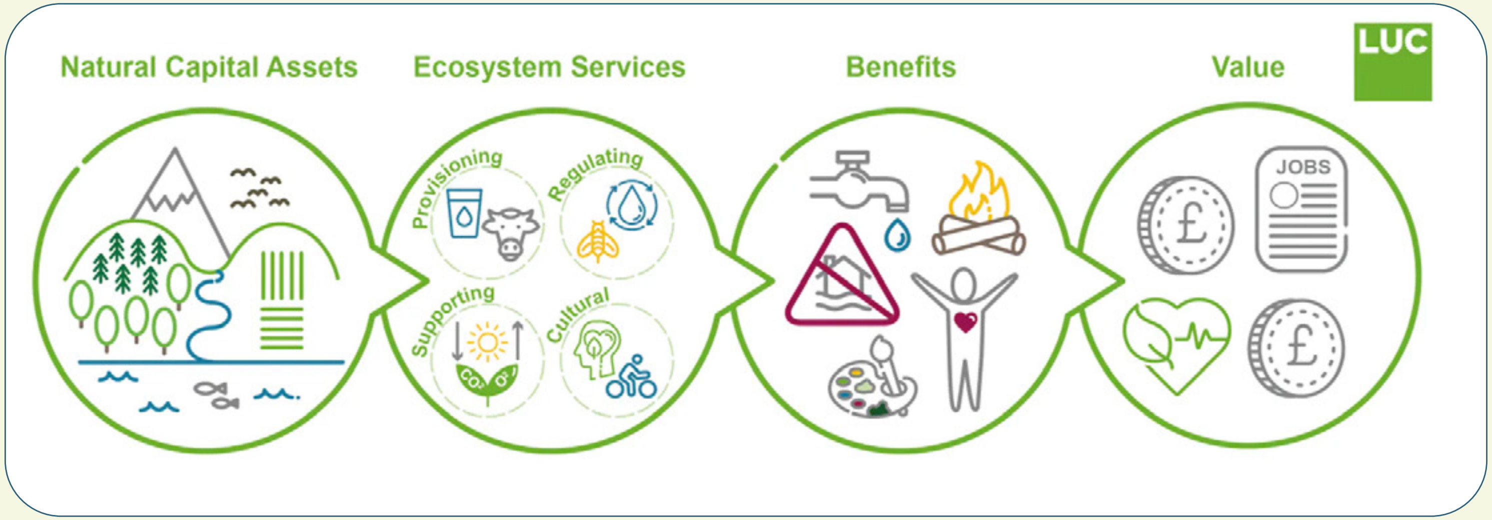
In order to maintain ecosystem services, it is essential that natural capital is preserved and restored. This imperative is reflected in the concept of nature-based solutions.

The International Union for Conservation of Nature (IUCN), which has played a central role in introducing this concept into international policy processes, defines nature-based solutions as **"actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature"** (IUCN s.a.).

The closely related concept of ecosystem-based adaptation refers to **"nature-based solutions that harnesses biodiversity and ecosystem services to reduce vulnerability and build resilience of human communities to climate change"** (Global EbA Fund s.a.).

These approaches underscore the importance of working with nature to address the world's most pressing challenges. This calls for informed and inclusive decision making around the use of natural capital, including land. Such decisions are complex as they involve a wide range of stakeholders with competing demands, political and socio-cultural power, and priorities.

Figure 1: Land Use, Natural Capital and Ecosystem Services



Source: Land Use Consultants. s.a. What are natural capital and ecosystems services? https://landuse.co.uk/what-are-natural-capital-and-ecosystems-services/

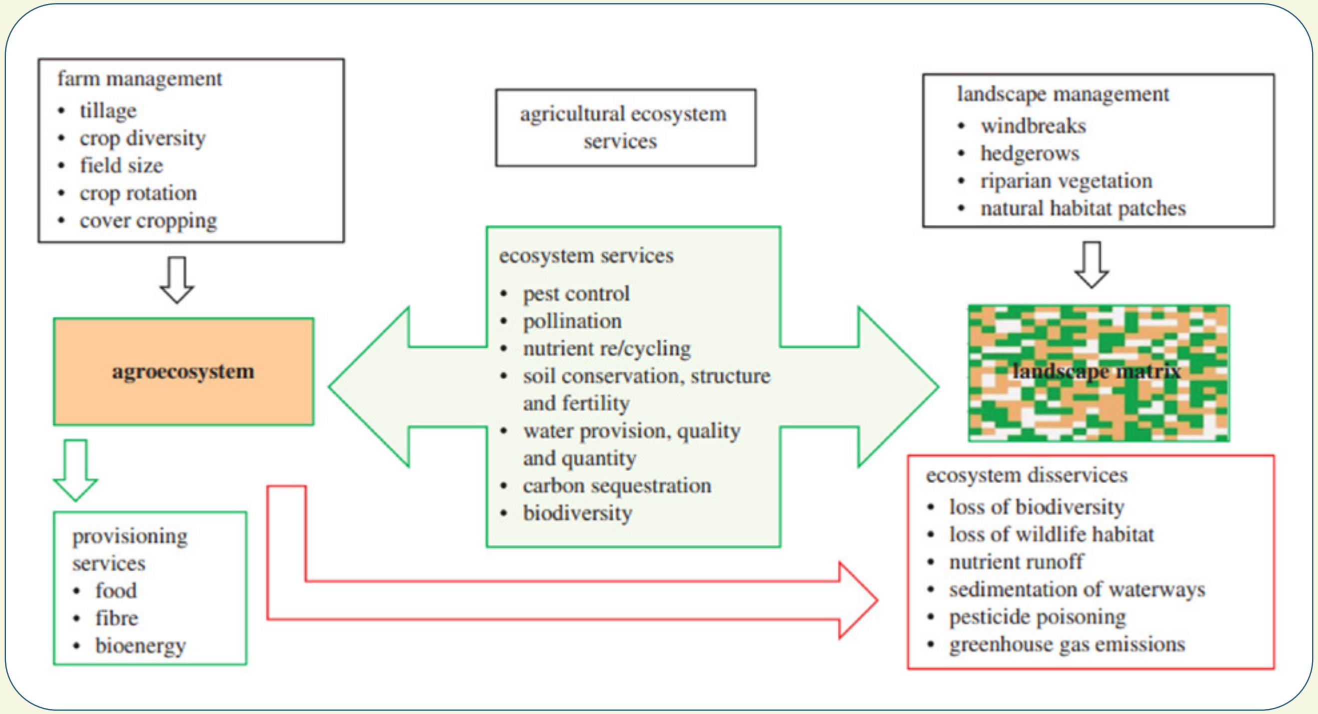
Among the most pervasive forms of land use is agriculture. About five billion hectares of the Earth's land surface is used for agriculture (one third of this is used for cropland, while the remaining two-thirds are used for grazing livestock) – this equates to almost 40 per cent of the Earth's land surface. These **"agroecosystems"** (i.e., any ecosystem that has been modified for the purposes of agricultural production) provide important ecosystem services to humanity, primarily provisioning services such as food, forage, bioenergy and pharmaceuticals. The scale of production is immense. Each year, more than 2 billion tonnes of the three most important grain crops (maize, rice and wheat) are produced. There are more than a billion cows and more than 34 billion chickens on Earth. The total weight of all domestic animals has recently been estimated at 630 million tonnes, more than thirty times the weight of all terrestrial wild animals.

These agroecosystems rely on ecosystem services, many of which emanate from natural, unmanaged ecosystems. These include genetic biodiversity, soil formation and structure, soil fertility, nutrient cycling, pollination and provision of water (Power 2010). Agriculture also results in negative ecosystem impacts or ecosystem **"dis-services"**, including loss of habitat for conserving biodiversity, nutrient runoff, sedimentation of waterways, and the release of pesticides.

The manner in which agroecosystems are managed plays a significant role in the flows of ecosystem services and dis-services from these systems, but this is also shaped by the diversity, composition, and functioning of wider natural ecosystems in the landscape (Zhang et al. 2007). Poor land management practices, overuse of fertilizers and pesticides, compaction of soil, overgrazing and other agricultural practices can significantly undermine soil health and undermine ecosystem services.

While agriculture is certainly the most pervasive way in which land use has impacted ecosystems across the world, the expansion of cities is also shaping ecosystem health in significant ways. Cities have been expanding rapidly. More than half the world's population currently lives in cities, and this will increase to 68 per cent by 2050. By mid-century, more than 6 billion people will live in cities, up from 750 million in 1950 and 4.2 billion in 2018 (UN DESA 2018). As urban populations have grown, so too have the land surface of cities. Urban

Figure 2: Land Use, Natural Capital and Ecosystem Services



Source: Power, A. G. 2010. 'Ecosystem Services and Agriculture: Trade-offs and synergies', Philosophical Transactions: Biological Sciences, 365 (1554), https://www.jstor.org/stable/20752990 .

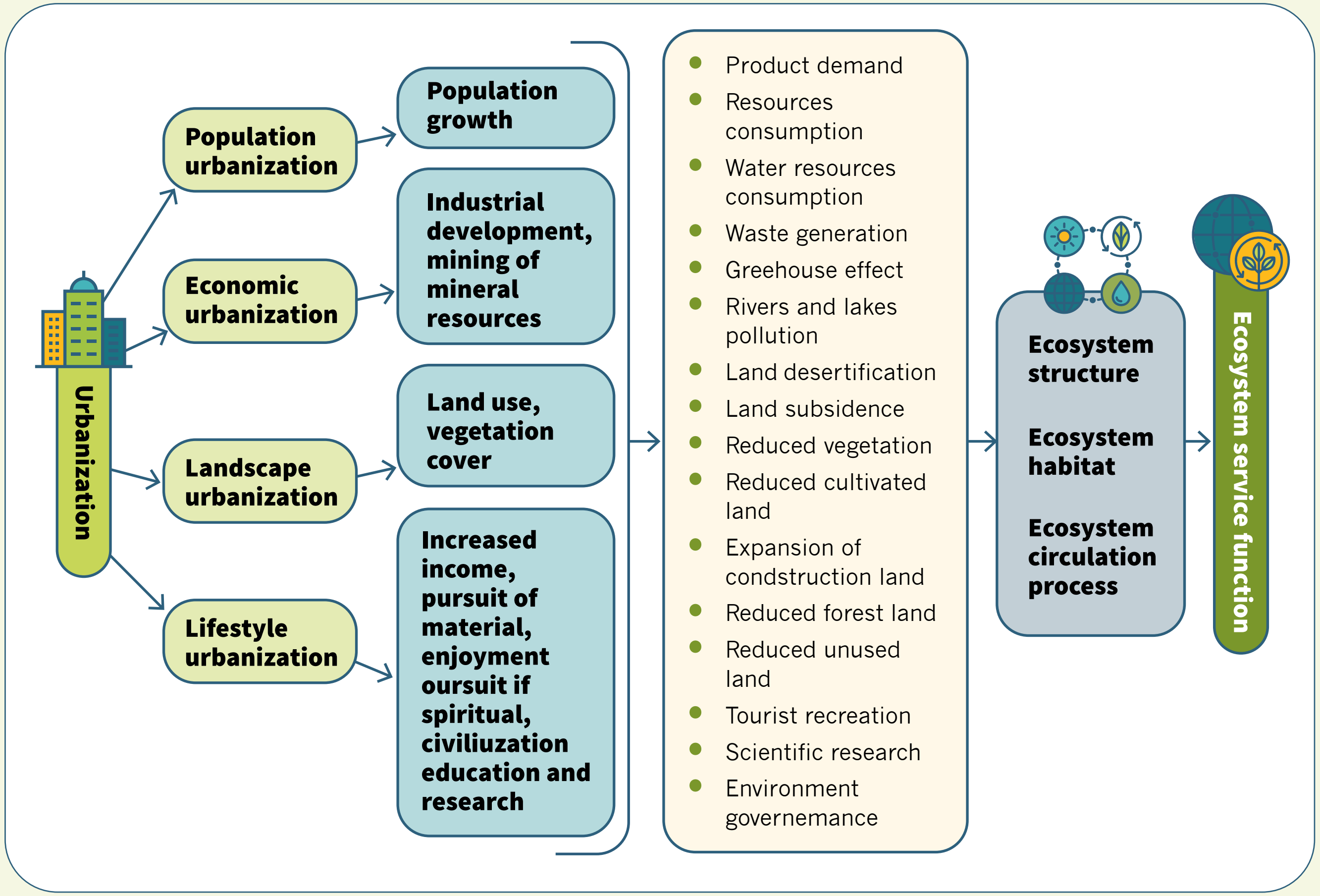
land quadrupled between 1970 and 2000. Urbanization has significant impacts on the atmosphere, hydrosphere and biosphere. Environmental impacts include climate warming, contamination of soil, air and water, and biodiversity loss (Lyu et al. 2018). Urban development contributes to the formation of heat islands, domes of warmer air over urban and suburban areas that result from the loss of vegetation cover and the absorption of heat by pavements, buildings and other surfaces (EPA 2022). As cities expand, ever greater areas are covered by impervious surfaces, which can lead to increased storm water runoff, erosion and the release of pollutants into water catchments (EPA 2022).

Ecosystem impacts associated with urban expansion extend well beyond the geographic limits of cities themselves. The UNCCD (2022b) has emphasised the importance of considering ecosystem services and restoration within the urban-rural continuum, arguing that:

"There is a mutual dependency between urban–rural linkages and ecosystems. Ecosystems are the basis for the flow of resources (through informal and formal channels) across the urban–rural continuum. It is important that the flows that constitute urban–rural linkages also support ecosystems, and this does not happen automatically. Urban–rural linkages, conceived narrowly as flows of resources, do not necessarily support ecosystems and in fact more often degrade ecosystems. Urban–rural linkages have to be managed to support ecosystems through functional and spatial management approaches to ecosystem restoration."

While the expansion of urban settlements can place pressures on land use and ecosystem services, there are also examples of more sustainable urban development that seeks to minimize, and sometimes actively restore, the functioning of natural ecosystems. Relationships between human settlements and ecosystem services are complex and therefore require area-specific research and interventions to support more sustainable urban development.

Figure 3: Urbanization and Ecosystem Service Function



Source: Wan, L. et al. 2015. 'Effects of Urbanization on Ecosystem Service Values in a Mineral Resource-based City', Habitat International, 46 (54-63), https://www.sciencedirect.com/science/article/abs/pii/S0197397514001581.

The world's limited land resources are facing increasing pressures, with food production and the expansion of urban settlements being among the key drivers of land use change. These dynamics are undermining the Earth's natural capital and associated ecosystem services, with significant implications not only for natural systems and biodiversity, but also for human society, which is highly reliant on these ecosystem services. As decision makers navigate this complex terrain, they must evaluate potential trade-offs and synergies in land use in efforts to support sustainable development.

Photo: © UNDP, Adamawa (RFS)

CHAPTER 3
Navigating Land Use Trade-offs

There are growing demands on available land resources to provide food, as well as to house people and support economic activities, often in the context of expanding urban settlements. As outlined above, utilizing a particular piece of land constrains or may entirely prevent its use for other purposes. Land use in a particular setting also has implications for adjoining land and broader ecosystem health. The relationship between various forms of land use and their impacts on ecosystem services can thus be understood within the framework of trade-offs and synergies. In a trade-off, a given form of land use, or emphasis on a specific ecosystem service, directly decreases the supply of another.

In a positive synergy, one form of land use or emphasis on a specific ecosystem service directly increases the supply of another. Note that negative synergies can also exist, where one type of negative impact is linked to another type of negative impact (Turkelboom et al. 2016).

Such trade-offs and synergies typically operate at broad scale – actions at farm level can have positive or negative impacts on adjoining farms and ecosystems. This requires integrating decision making around protection, management and restoration of land at broad scales, what is referred to as a landscape approach.

Landscape Approach

A landscape approach represents a commitment to multifunctional land use planning and management that promotes healthy economic growth, strong environmental stewardship, and social cohesion and stability. It encourages planners and decision makers to set priorities, manage trade-offs, and coordinate action across the various land-based sectors while engaging all relevant stakeholders. Managing trade-offs at a landscape scale will ultimately decide the future health and productivity of our land resources.

Elements and catalysts of the landscape approach:

1. Interested stakeholders come together for dialogue and action in a multi-stakeholder platform.
2. They undertake a systematic process to exchange information and discuss perspectives to achieve a shared understanding of the landscape conditions, challenges, and opportunities.
3. This enables collaborative leadership and planning to develop an agreed long-term and systemic action plan.
4. Stakeholders then implement the plan with care to maintaining collaborative commitments.
5. Stakeholders also undertake monitoring for adaptive management and accountability, which feeds into subsequent rounds of dialogue, knowledge exchange, and the design of new collaborative action.
6. Success is catalysed by good governance, long-term planning, and access to adequate and sustainable finance and markets

Source: UNCCD. 2017. Global Land Outlook.

Photo: © UNDP, Gombe (RFS)

There is a growing awareness of such synergies and trade-offs between issues such as climate mitigation, sustainable ecosystem management, biodiversity and food security within the land-use sector (OECD 2020a). At the same time, however, governance processes often fail to grapple with difficult decisions around trade-offs.

A study by Galafassi et al. (2017) highlight some of the reasons why this is so:

1. Trade-offs might be invisible to those making decisions, complex and hard to understand, and span multiple temporal and spatial scales;
2. Trade-offs can be differently perceived. What appears as a trade-off from one perspective appears as a win–win from another. These perspectives vary according to knowledge, values and beliefs, but also in relation to material assets, property rights and other livelihood capacities;
3. Trade-offs are not always explicit, and can be hidden, intentionally ignored or downplayed.

This means that institutions, incentive structures, political processes and social narratives can deliberately mask and hide trade-offs from decision-making processes. The fact is that **"Narratives that emphasise win–win solutions are often more socially, psychologically and politically attractive"** (Galafassi et al. 2017).

While such win-win solutions should certainly be pursued wherever possible, a major review of trade-offs between biodiversity conservation and socio-economic objectives noted that win-win solutions are difficult to realise, while **"Trade-offs and the hard choices they entail are the norm"** (McShane et al. 2011).

A review of key issues, interactions and trade-offs in the land-use nexus conducted by the OECD (2020a) highlighted the fact that trade-offs and synergies in this area are broader than just biophysical. They highlight several dimensions in which trade-offs and synergies can be considered. Increased use of agroforestry systems (when trees are planted in combination with crops) can improve resilience to climate impacts such as drought or extreme heat because of the shade provided by the trees. However, this shade can also reduce crop yields. A second dimension is considering impacts between different spatial scales. For example, increased consumption of water for agriculture upstream can increase upstream agricultural yields but reduce water availability and agricultural yields downstream. Impacts over time must also be considered, such as when leaving crop residues onsite reduces the potential for bioenergy production in the short term but can avoid a reduction in soil fertility in the longer-term. Critically, trade-offs and synergies must be considered between different groups of stakeholders. The example provided in the OECD analysis describes intensifying food production leading to increased nitrate pollution in surface water, which then negatively affects water quality for downstream populations and ecosystems.

However, by increasing food production levels and limiting pressure on food price rises, intensification of food production could positively affect the population as a whole. Finally, it is important to note that trade-offs between policy goals can occur. For example, a commitment to expand the production of dairy products for export, which can lead to an increase in absolute greenhouse gas (GHG) emissions, and a national commitment to reducing emission under the Paris agreement.

An analysis of enabling conditions for better trade-off management identified ten key factors (Hou-Jones et al. 2019):

1. Understanding and reconciling competing land use needs
2. Building trust among key stakeholders
3. Engaging multiple stakeholders
4. Clear land rights, responsibilities and accountability
5. Transparent and fair benefits and costs
6. Strengthened stakeholder capacities
7. Participatory and user-friendly monitoring
8. Multiple spatial scales
9. Financial and institutional sustainability, and
10. Continuous learning and adaptive management.

With land use decision making ever more complex and drivers of land use change accelerating, the need to effectively evaluate trade-offs and synergies is increasingly urgent. Governance processes have historically not adequately grappled with trade-offs for a variety of reasons, yet guidance exists on the enabling conditions required to address this. The following chapters explore land use patterns and land use change within the Africa region broadly, and at national level in the twelve Resilient Food Systems programme countries.

CHAPTER 4
Land Use Change in Africa

The global drivers of land use change outlined in the preceding chapters are also evident in Africa. Africa is uniquely vulnerable to land use change and ecosystem degradation, given the high level of dependence on ecosystem services, the critical role that agriculture plays in food security and regional economies, and generally low levels of adaptive capacity, exacerbated by a range of developmental challenges. This chapter reviews the key drivers of land use change in Africa and explores their impacts on ecosystems services, biodiversity loss and land degradation.

Drivers of land use change

POPULATION GROWTH

Africa's population is growing at a rate more than double that of Asia and Latin America. The region's population reached a billion in 2010; by 2050, it is projected to be 2.5 billion (UN s.a.). These broad trends conceal immense diversity across the continent, which includes states with large populations (**Nigeria**, Egypt and **Ethiopia** have populations in excess of 100 million) and small populations (Cabo Verde, Comoros and Seychelles all have populations under 1 million). Taken as a whole, however, Africa remains the region with the fastest growing population globally. Just eight countries will account for more than half the projected increase in global population up to 2050 – five of these countries are in Africa (Democratic Republic of the Congo, Egypt, **Ethiopia**, **Nigeria** and **Tanzania**) (UN DESA 2022).

Although Africa's population growth rate is very high, the continent's population density is quite low. Its population density is not nearly as great as other regions that are experiencing slower population growth. For example, the current population density of Angola and Somalia is 24 people per square kilometre; in **Tanzania** it is 65; and in the Democratic Republic of the Congo it is 37. **Nigeria** has the largest population in Africa at 223.8 million, and its population density is 215 people per square kilometre (World Population Review 2023). In contrast, India has a population density of 450 people per square kilometre and in Bangladesh it is 1,278 (Hoover Institution 2019). This suggests that there is sufficient space for Africa's growing population, and that the more important concern is whether the economy can grow to support and sustain the populations' livelihoods and the food system can ensure food security for these populations.

URBANIZATION

As Africa's population is expected to grow rapidly over the next few decades, so too will its urban centres. Africa is currently considered one of the least urbanized places in the world. The OECD (2020b) reports, however, that the continent is forecasted to have the highest rate of urbanization in the world by 2050, by which time two-thirds of Africa's substantially larger population is predicted to be living in urban areas (Brookings 2020). By 2050, cities in Africa will house an additional 950 million people. The fastest growing cities in Africa are Accra in **Ghana**, Ibadan and Lagos in **Nigeria**, and Dakar in **Senegal** (Business Insider 2022). At the same time, a great deal of the projected expansion of people living in urban areas in Africa will be accounted for by the growth of small and medium sized towns (Brookings 2020).


Photo: © Georgina Smith (Alliance of Bioversity International and CIAT)

The continent's rate of urbanization has been increasing significantly since the 1950s. Africa's urban population was measured at 27 million people in 1950, which has grown to approximately 567 million people today. Countries in Africa have urbanized significantly over the past 60 years, but this urbanization has been concentrated in particular subregions. North Africa is considered the most urbanized region in the continent, with Egypt and Libya having the highest levels of urbanization at 93 per cent and 81 per cent respectively (Brookings 2020). The rapid rate of urbanization in Africa presents concerns for the wellbeing of humans and the environment if it is not managed appropriately.

AGRICULTURAL EXPANSION

Agriculture is one of the most important sectors in Africa. About 60 per cent of the world's arable land is found in Africa (Oxford Business Group 2021). Agriculture contributes approximately 35 per cent to the continent's GDP, and between 30 per cent to 60 per cent for each country in Africa (Nachum 2023). Crops that are exported, such as coffee, cotton, tobacco, and fruit are valuable sources of income across the continent. Aside from its role in promoting economic growth, agriculture is key to alleviating food insecurity and poverty in the continent (Oxford Business Group 2021). Over 70 per cent of the rural population in Africa is reliant on agriculture for their sustenance and livelihoods (WEF 2016). In wealthier regions in the continent, such as South Africa, agriculture is relatively less economically important compared to other sectors such as mining, energy, manufacturing, and transport, yet it still plays an important role in supporting livelihoods and food security.

Crops account for over 75 per cent of the total agricultural output in Africa (Oxford Business Group 2021). There is, however, a great deal of variation across the continent with respect to the production and consumption of different kinds of crops. The staple crop in North Africa is wheat; in Central and West Africa it is roots and tubers; and in Southern Africa it is maize. The production of livestock and poultry is also significant in Africa, and the demand for meat in the continent is projected to increase steadily over the coming decades. The vast majority of agricultural production in the continent is accounted for by small-scale farmers (85 per cent), with the remaining 15 per cent being attributed to subsistence farmers and large-scale farming. Agricultural outputs in Africa are constrained by **"Underdeveloped physical infrastructure, insecure land rights, a lack of access to inputs and machinery, a lack of technical training and insufficient financial resources"** (Oxford Business Group 2021).

There is, therefore, significant untapped potential in Africa's agricultural sector, which could promise economic growth and food security if the land is used effectively and sustainably.

Impacts of Land Use Change

ECOSYSTEM SERVICES AND BIODIVERSITY LOSS

Africa contains a wealth of diverse productive ecosystems on which its people are highly reliant. It is noteworthy, however, that these ecosystem services are relatively unevenly distributed – 66 per cent of Africa's total surface area consists of deserts and arid lands, with only 27 per cent considered viable arable land (Wangai et al. 2016). The concentration of ecosystem services in particular areas highlights the importance of protecting these resources for the benefits they provide in support of human development and for the sake of the environment.

Africa contains a quarter of the world's species of mammals, and one-fifth of the world's species of birds (Africa Centre for Strategic Studies 2022). In addition, the continent is home to many recognized global biodiversity hotspots, including the Horn of Africa, the Cape Floral Region, and the coastal forests of Eastern Africa. The Regional Assessment Report on Biodiversity and Ecosystem Services for Africa produced by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) underscores that Africa is extremely rich in biodiversity and that **"Africa's natural richness, coupled with the wealth of indigenous and local knowledge on the continent, is central to, and constitutes a strategic asset for, the pursuit of sustainable development"** (IPBES 2018). Africa's biodiversity is threatened by the loss of species resulting from human encroachment onto habitats and the effects of climate change. An assessment by the IUCN in 2014 indicated that 6,419 animals and 3,148 plants in Africa are at risk of extinction (CBD 2016). Unsustainable farming practices, mining, and deforestation, together with climate change, are cited as some of the major causes for the loss of ecosystems and biodiversity in the continent. Of particular ecological importance is the Congo Basin, which is known as the **"lungs of Africa"**. Comprising rainforests that stretch over 240 million hectares and eight African countries, the Congo Basin is the world's greatest carbon sink. It absorbs 4 per cent of global carbon emissions every year, offsetting more than the entire African continent's annual emissions (Africa Centre for Strategic Studies 2022). Despite its significance, the Congo Basin faces threats including deforestation, encroachment from expanding populations, and environmental degradation. The preservation of forests such as those in the Congo Basin is essential for the future of the continent and the rest of the world; it will have to be a central component of international climate change mitigation efforts if they are to achieve any success.

LAND DEGRADATION

Land degradation can result in lower agricultural yields that are of diminished quality. It also exacerbates food insecurity, which is particularly threatening in certain regions in Africa. Up to 65 per cent of Africa's productive land is degraded, while desertification affects 45 per cent of the continent's land area (FAO 2021a). It is estimated that over 500 million people in sub-Saharan Africa live on land that is undergoing desertification. Deforestation is often cited as the primary cause of land degradation, as it contributes to soil erosion, desertification, flooding, and climate change. The cultivation of land for agriculture is responsible for over half of global deforestation (Malede et al. 2023). Agricultural expansion is necessary to meet the demands of increasing populations, but this places significant pressures on ecosystem health and the natural capital on which humans rely for their wellbeing.

Deforestation is central to discussions concerning land degradation, land use and land cover change and climate change. A recent study by Reiner et al.[2] suggests, however, that 29 per cent of tree cover in Africa is found outside of forests, in areas such as grassland and croplands. This figure is much greater than previously expected, and the findings hold implications for sustainable land management practices, climate change mitigation and adaptation approaches, and ecosystem restoration.

2. https://www.nature.com/articles/s41467-023-37880-4

CHAPTER 5
Country Analysis

The twelve countries of the Resilient Food Systems programme represent a diversity of different ecosystem types, as well as divergent socio-economic profiles. At the same time, there are important commonalities in the challenges they face in land use decision making in support of sustainable development, food security and resilient livelihoods. Population growth and urbanization rates are important drivers of land use and land cover change. The twelve countries have a cumulative population of 626.8 million. Each of these countries experiences varying rates of population growth, with the three highest being **Niger** (3.7 per cent), **Uganda** (3.2 per cent) and **Tanzania** (3 per cent). These high population growth rates are consistent with forecasts of Africa's population size increasing rapidly over the next few decades. At the same time, the rates of urbanization in these countries are expected to remain high. Of the twelve countries, **Ghana**, **Nigeria** and **Senegal** have the biggest urban populations as a percentage of total population, at 58 per cent, 53 per cent and 46 per cent respectively. These countries also have some of the fastest growing cities in the continent.

The twelve countries have a combined total land area of approximately 5.8 million km^2, with a large proportion of this consisting of arid land. All of the focus countries have fragile ecosystems that require sustainable management in order to preserve biodiversity and to keep their natural capital productive. The countries contain a total of about 1.1 million km^2 of forests, which translates to a forest cover of 19.28 per cent. The countries with the greatest amount of forest cover are **Tanzania** (51.6 per cent), **Senegal** (41.9 per cent), **Ghana** (35.1 per cent), and **Eswatini** (28.9 per cent). In contrast, those with the lowest forest cover are **Niger** (0.9 per cent), **Kenya** (6.3 per cent), **Burundi** (10.9 per cent), and **Uganda** (11.7 per cent). Several of the countries contain vast and arid pastoral areas, such as **Burkina Faso**, **Niger**, and **Senegal**. These countries are also water-stressed and experience droughts for extended periods of time. Some countries within the group contain significant areas of grassland and woodland, such as **Malawi** and **Tanzania**. There are two prominent biodiversity hotspots that are found in some of the focus countries, namely the Guinean Forests of West Africa (which extend into **Ghana** and **Nigeria**) and the Coastal Forests of East Africa (of which **Kenya** and **Tanzania** are a part).

Table 1: Resilient Food Systems Programme Focus Countries: Key statisticsstatistics

COUNTRY	Population (million) (2021)	Pop. Growth Rate (annual %) (2021)	Land area (km²) (2020)	Forest area (% of land area) (2020)	Forest area (km²)	Urban population (% of total population) (2021)	Agriculture, forestry and fishing value add (% of GDP) (2021)	% change in forest area (1990-2020)
Burkina Faso	22.1	2.7	273,600	22.7	62,107	31	17.5	-5.5
Burundi	12.55	2.7	25,680	10.9	2,799	14	28.7	0.1
Eswatini	1.19	1	17,200	28.9	4,970	24	8.1	2.1
Ethiopia	120.28	2.6	1,128,571	15.1	170,414	22	37.6	-3.4
Ghana	32.83	2	227,533	35.1	79,864	58	19.7	-8.5
Kenya	53.00	1.9	569,140	6.3	35,855	28	22.4	-0.5
Malawi	19.89	2.6	94,280	23.8	22 438	18	22.7	-13.3
Niger	25.25	3.7	1,266,700	0.9	11,400	17	36.5	-0.6
Nigeria	213.40	2.4	910,770	23.7	215,852	53	23.4	-5,4
Senegal	16.87	2.6	192,530	41.9	80,670	49	15.3	-6,4
Uganda	45.85	3.2	200,520	11.7	23,460	26	23.8	-6,2
United Republic of Tanzania	63.59	3.0	885,800	51.6	457,450	36	25.9	-13.2
Total	**626.8**	**30.4**	**5 792 324.3**		**1 116 906.4**			

Source: World Bank

The contribution of agriculture, forestry, and fisheries to the GDP of the twelve countries is significant, with the highest rates in **Ethiopia** (37.6 per cent), **Niger** (36.5 per cent), **Burundi** (28.7 per cent), and **Tanzania** (25.9 per cent). Maize, wheat, sorghum, millet, and barley are some of the main crops on which these countries rely (IFPRI 2012). Several of the countries, including **Niger**, are attempting to diversify their economies by investing in economic activities such as mining and industry to reduce their dependence on the agricultural sector. Such activities also place pressure on land and the ecosystem services it provides. In **Ghana**, for example, mining operations have been an important driver of deforestation.

Agriculture is also an important driver of deforestation. This is especially apparent in **Niger**, **Uganda**, **Tanzania**, **Burundi** and **Burkina Faso**, which have the highest population growth rates among the focus countries. During the period between 1990 and 2020, the countries that experienced the greatest change in forest cover out of the twelve countries were **Malawi**, with a decrease of 13.3 per cent, and **Tanzania**, with a decrease of 13.2 per cent (World Bank 2022).

More than 33 per cent of the world's soil is considered degraded, and that this figure could rise to 90 per cent by 2050 (Reinder et al. 2023). Addressing land degradation whilst at the same time producing food sustainably is therefore one of the greatest global challenges. This is particularly apparent in **Burundi**, as the country's population is forecasted to increase rapidly over the next few years. At the same time, it scores very low on the Global Food Security Index, at 108 out of 113 countries (Economist Impact s.a.). High levels of deforestation, unsustainable land use, and soil erosion have driven down agricultural productivity and the country is facing the threat of the permanent loss of ecosystem services (Kessler et al. 2020). Despite receiving significant international development assistance, **Burundi** has struggled to effectively alleviate food insecurity and protect the natural environment. Kessler et al. (2020) maintain that previous interventions were ineffective because they were conducted over a short period, they made use of top-down approaches, and they focused on the resolution of conflict or emergency aid. The authors argue that interventions should rather be bottom-up, focusing on the involvement of local populations and community-based development. **Burundi** has implemented policies and joined global and regional initiatives to address land degradation in the country. The Ewe **Burundi** Urambaye reforestation project was initiated by the government in 2007, with the objective to plant trees in forests throughout the country. It aims to diminish the effects of deforestation by regenerating the natural environment, thereby enhancing ecosystem service provision, agricultural productivity and food security.

The annual cost of land degradation in **Eswatini** is $100 million (2.9 per cent of its GDP), whereas this figure is estimated to be $1.4 billion in **Ghana** (6 per cent of the country's GDP) (Global Mechanism 2014). The Agriculture, Forestry, and Other Land Use sector is responsible for a significant proportion of the total greenhouse gas emissions of each country, measured at 44 per cent for **Eswatini** and 71 per cent for **Ghana**. **Ghana**'s forests are estimated to be able to remove 47 per cent of the country's total emissions, which presents an opportunity for climate change mitigation. Land is an integral component of climate change mitigation and adaptation strategies, given that it is one of the most cost-effective means of sequestering carbon emissions.

There are a number of long-term studies that have been conducted in **Ethiopia**, **Kenya**, **Tanzania**, and **Burundi**, amongst other countries, that examine the effects of land use and land cover change in particular areas. The results of these studies indicate that the primary causes of land use and land cover changes in are deforestation, agricultural expansion to meet the demands of growing populations, timber collection and firewood collection (Opiyo et al. 2022). Between 2000 and 2019, land use and land cover changes in Africa involved a decrease in forest cover, grassland, and wetland and an increase in human settlements and cropland (FAO 2021b).

Mount Kilimanjaro has been used as a case study for evaluating the effects of land use and land cover change, as one of the most well-known eco-tourism hotspots in the world. The land at the base of the mountain was initially covered in dense vegetation, which has been removed to allow for agricultural expansion and the development of built-up areas that can accommodate an increasing population. The mountain is surrounded by residential areas, sugar cane plantations, and crops that grow wheat, maize and beans, as well as rice paddies. Studies of the long-term effects of land cover conversion on biodiversity in this region highlight that Mount Kilimanjaro risks becoming an **"ecological island"** (Hemp & Hemp 2018). This refers to how the habitats of Mount Kilimanjaro are isolated from the surrounding natural environment, which inhibits the migration of animals, resulting in less genetic variation within species. The lack of diversity makes ecosystems particularly vulnerable to changes in environmental conditions.

Land use change can introduce, accelerate, or exacerbate the spread of alien species, which is one

of the biggest threats to biodiversity, along with the destruction of habitats. There are a number of practices, including overgrazing, fertilization, and the use of pesticides, that can promote the growth of invasive plants. These plants can damage habitats, contribute to the loss of biodiversity, and present health risks to humans. The introduction of alien species to agricultural land can cause water scarcity and diminish the quality of the water, which impacts indigenous species of plants and animals. This has occurred in **Kenya**, where a tree species from the Americas (Prosopis juliflora) was introduced into dry parts of the country to combat wind erosion and create islands of greenery on mainly desert landscapes (Maundu et al. 2009). The tree has become invasive and hinders pastoralists from keeping livestock in affected areas. As such, it has become a source of much contention as local communities that are unable to control its expansion have sought compensation from the government for the harm that these trees have caused.

Mount Elgon, in **Uganda**, has also experienced the adverse effects of land use and land cover change. Mugagga et al. (2012) report that there were minimal land use changes on the slopes of the mountain from 1960 to 1995, but that this changed between 1995 to 2006, during which time there was a marked loss of woodlands and forest areas. The authors argue that this caused a series of landslides on the slopes. Deforestation and land cultivation affect soil hydrology, making the soil saturated and increasing susceptibility to landslides. Mugagga et al. propose restoring the forest on the slopes and preventing further encroachment on the land for agricultural purposes (Mugagga et al. 2012).

Studies conducted at the local level can give insight into the importance of ecosystem services for the communities that are reliant on them. In the south-east of **Burkina Faso**, Ouedraogo et al. (2014) used an ethnobotanical approach to survey community members from Pama village, a partial fauna reserve, to record the services offered by different plants based on indigenous knowledge. The study identified 77 species of plants that provided 20 services, with two of the plant species contributing the bulk of the ecosystem services. The study highlights the dependence of local communities on indigenous plants and consequently their vulnerability to suffering the effects of biodiversity loss (Ouedraogo et al. 2014).

One of the most well-known initiatives to combat the effects of deforestation is Africa's Great Green Wall. It has been termed **"the largest living structure on the planet"**, as it is intended to extend 8,000 km across Africa. It comprises three dryland regions, namely North Africa, the Sahel and Southern Africa extending across 25 countries, including **Burkina Faso**, **Ethiopia**, **Niger**, **Nigeria**, and **Senegal** (Ouedraogo et al. 2014). The aim of the project is to restore 100 million hectares of currently degraded land; sequester 250 million tons of carbon and create 10 million green jobs by 2030. Over $8 billion has been pledged by international partners of the World Bank and the African Union to fund the initiative. The project uses an integrated landscape approach that enables each country to address environmental issues (such as climate change, land degradation, and deforestation) at the local level. The participating countries each have their own objectives, which range from combatting soil erosion, to stimulating economic diversification. The

Photo: © Kelvin Trautman (Agroforestry)

Great Green Wall initiative has also been cited as having a potential positive social impact, in that improvements in environmental conditions and economic benefits can help curb conflict in certain regions, where poverty and extreme weather events exacerbate violent extremism. While the Great Green Wall initiative has unlocked significant regional action, current implementation still falls significantly short of the initiative's ambitious targets and, despite significant new funding commitments in 2021, adequate and appropriate funding of the initiative remains a challenge (Nature 2022). Despite the implementation difficulties that have been faced, the initiative highlights the potential for regional land management and ecosystem restoration at scale and underscores the importance of strong and well-resourced institutions that are able to execute transboundary initiatives of this nature.

AFR100 is a project that incorporates the 12 focus countries. Its objective is to restore 100 million hectares of deforested and degraded land in the continent by 2030. AFR100 is led by the African Union Development Agency (AUDA-NEPAD) and is in support of the African Union Agenda 2063, the Bonn Challenge, and the SDGs. To date, 33 African nations have signed onto AFR100 and committed a combined 129 million hectares of land to be restored. Financial and technical partners support partner countries to assess restoration opportunities, develop strategies and accelerate implementation on the ground (WRI s.a.).

An important element of the Great Green Wall, AFR100 and other regional initiatives aimed at addressing land degradation and supporting ecosystem restoration is the ability to operate at scale, while retaining the necessary flexibility and institutional support for national and local action. Effective linkages between research, policy, institutions and financing are also essential to success. These elements are also evident in the recently concluded Regreening Africa project (Regreening Africa s.a.). The project focused on 500,000 households across eight countries in sub-Saharan Africa. These include five of the twelve focus countries, namely **Ethiopia**, **Ghana**, **Kenya**, **Niger**, and **Senegal**. Regreening Africa had two key objectives. The first was to 'scale-up evergreen agriculture' by using various types of agroforestry and sustainable land management practices that are context sensitive. The second objective emphasises the role of strategic decision making, engagement with multiple stakeholders, and policy processes to equip the target countries with the tools to restore degraded land through agroforestry. This entails the **"deliberate and systematic integration of trees, crops and livestock – all critical elements for the sustainable management of land and maintenance of healthy landscapes"** (Regreening Africa s.a.).

Ethiopia suffers from extreme weather conditions, and droughts in particular. Its economy is also dependent on sectors that are sensitive to the effects of climate change, given that agriculture, forestry, and fishing account for 36.7 per cent of the country's GDP. **Ethiopia** has addressed these concerns through various policy responses, including the National Adaptation Plan of Action in 2007 and its endorsement of the Climate Resilient Green Economy Strategy in 2011. The country has initiated a number of programmes within these frameworks, however, the Green Legacy Initiative has received the greatest deal of international attention. It was launched in 2019, and aims to address land degradation and biodiversity loss by planting trees across the country (UNEP 2019). The initiative's target to plant 20 billion seedlings by 2023 has been exceeded, and it is reported that over 700,000 jobs were created in the process (UN s.a.). The Green Legacy Initiative has been described as **"a demonstration of Ethiopia's long-term commitment to a multifaceted response to the impacts of climate change and environmental degradation that encompasses agroforestry, forest sector development, greening and renewal of urban areas, and integrated water and soil resources management"** (UN s.a.).

Desertification and land degradation are two major causes for low agricultural yields in **Senegal**. This is exacerbated by droughts that threaten food security and employment opportunities, prompting migration from rural to urban areas. Additional factors that contribute to land degradation are deforestation, overgrazing, and unsustainable farming practices. Ecosystem restoration, which involves planting trees, contributes to climate change adaptation and mitigation measures (FAO 2022a). Action Against Desertification has supported the Great Green Wall initiative in **Senegal** by implementing projects that focus on the restoration of degraded land and sustainable land management; that foster economic diversification by encouraging the sale of forest products that are not made from timber; and that assist with wildlife management (FAO 2022b).

About a third of Burkino Faso (more than 9 million hectares of land) is degraded (FAO 2022c). It is estimated that this area will increase by an average of 360,000 hectares every year. Action Against Desertification is a partner of the Great Green Wall initiative and has been involved in land restoration in several states, including Burkino Faso in the provinces of Soum, Seno and Yagha which are in the Sahel region.

There are multiple smaller-scale projects that aim to restore degraded and deforested land and develop agroforestry at the local level, with community involvement. **Kenya** provides an example of the need for these efforts, as it has one of the lowest percentages of forest cover (6.3 per cent) of the 12 focus countries. The forest on Mount **Kenya** provides resources and sustenance for local populations (such as the Kikuyu and Masaai) with fruit, plants, and water. Non-governmental organizations have initiated projects in the region, to advise local communities on the utility of planting species of trees that have agricultural value, through agroforestry systems. There have also been attempts to regenerate the forest, with the plantation of indigenous species (Reforest Action 2022a).

Another example of an attempt to regenerate land after deforestation can be found in several villages in Lilongwe, **Malawi**. Trees are being planted to form hedgerows around agricultural land that is degraded. The objective is to prevent soil erosion, increase biodiversity, and assist with the creation of jobs for members of local communities.[3] An ecosystem restoration initiative in the forests of the Kakumiro district in **Uganda** involves engagement with local communities to ensure biodiversity conservation and habitat preservation. The area is threatened by deforestation, unsustainable farming practices, and wildlife trafficking. The rehabilitation efforts include **"education and training, tree planting, seed collection, and identifying community leaders for the projects"**. The initiative has restored more than 10 hectares of land surrounding the forest reserve. Over 80,000 trees were planted in this region, including fruit trees (such as avocado, pawpaw, jackfruit, and mango); cash crop trees (such as coffee and nuts); and indigenous trees that are useful for agroforestry purposes (Reforest Action 2022b).

3. Reforest Action. 'Lilongwe (Malawi)', https://www.reforestaction.com/en/lilongwe-malawi

CHAPTER 6

Review of Decision Support Tools for Land Use Trade-offs

Decision makers face difficult choices in navigating the often fraught and complex process of managing trade-offs in the context of urgent social, economic and political pressures. Beyond these social, economic and political pressures, decisions must also integrate the broader environmental trends shaping opportunities and risks, including trends related to ecosystem degradation, land degradation, deforestation, biodiversity loss and climate change. It is important to ensure that such decision-making processes are inclusive, particularly of those stakeholder groups most directly affected by these decisions. It must also be acknowledged that there are disparities between stakeholder groups in terms of power and access to information, which influences their ability to engage in decision-making processes. Such inequalities exist not only between broad stakeholder groups such as government, communities, private sector operators, etc, but also within sectors (e.g. large scale commercial versus small scale farmers) and across social dimensions (e.g. the unique vulnerabilities and marginalization often experienced by women and youth). Such vulnerabilities and power disparities must be accounted for in decision-making processes and efforts made to ensure that all stakeholders have an opportunity to shape the outcomes of such processes.

A variety of tools exist to support sustainable land use and the management of trade-offs in this context. These have been comprehensively assessed in the Sustainable Land Management Toolbox, published by UNEP (2020) under the Resilient Food Systems programme and the International Institute for Environment and Development (IIED) working paper produced by Gusenbauer and Franks (2019) on managing trade-offs and synergies between agriculture and nature conservation in sub-Saharan Africa. Both these assessments are highly valuable resources that review a number of existing tools and approaches and evaluates their relative merits.

The Sustainable Land Management Toolbox identifies a number of tools, noting that they can roughly be classified as biophysical, socio-economic, integrated tools, databases and support tools:

Biophysical tools assist the user to analyse biophysical attributes (climate, soil, terrain, water, etc.) and their interactions in the land evaluation process. The output guides users to identify suitable options for land use alternatives based mainly on these attributes. Land suitability and similarity analyses are typical examples. Documents describing principles, approaches and guidelines for land evaluation are included. Such tools can classify soils based on suitability for a specific use, potential, fertility constraints, management and linkages to yield, productivity, physical and chemical properties. Sophisticated or simplified modelling of crop growth and yield also fall into this category.

Socio-economic tools characterise social and economic settings required for land use planning. They include approaches and methods of participatory decision making.

Integrated tools use as input information both biophysical characteristics and social and economic conditions and generally incorporate principles, approaches and methods of participatory land use planning, with the overall objective of reaching mutually beneficial outcomes for all stakeholders.

Databases facilitate land evaluation and land use planning by providing information that may serve as inputs for the process. These databases provide maps and data on soil and terrain characteristics, land degradation, land cover, land use, climatic data including future projections, crops and yields, food, agriculture, water resources, adaptability/suitability of identified plant species for a given environment, and socio-economic data and statistics on poverty, population, tenure and gender.

Support tools do not produce results that have direct use for land evaluation and land use planning but play a supporting role by providing various types of data that can be used in land evaluation studies and as input data sets for land use planning.

The Sustainable Land Management Toolbox reviews nine tools that have been developed to help decision makers assess the impact of land use on various aspects of ecosystem services. These are:

DIVERSITY ASSESSMENT TOOL FOR AGROBIODIVERSITY AND RESILIENCE (DATAR):

DATAR analyses agricultural biodiversity and resilience at the landscape level in order to assess the constraints faced by farming communities to benefit from the use of their own local crop and animal biodiversity. The purpose of DATAR is to identify and characterize local crop varieties and breeds, and from this information, to improve access, selection, and sharing of crop and animal genetic diversity at the community and national levels. DATAR is founded on the premise that intraspecific agrobiodiversity promotes resilience to threats such as climate change or pests and in turn enhances food security. The DATAR application has three main modules. The first, **"Agro-biodiversity data"**, gives a summary of the state of intra-specific genetic diversity at a given time based on data collection and analysis. The second, **"Agro-biodiversity interventions"**, points DATAR users towards adapted, intraspecific genetic diversity interventions depending on their constraints and priorities. The third module **"Agrobiodiversity impact"** measures the impacts on agrobiodiversity itself and the resilience of production systems.

THE EX-ANTE CARBON BALANCE TOOL (EX-ACT) was developed by the FAO. EX-ACT's overall objective is GHG reduction and climate change mitigation. EX-ACT is a field survey system to estimate the impact of agriculture and forestry development projects, programmes and policies on carbon-balance. It is a peer-reviewed, land-based accounting system which estimates emissions or sinks of CO2 as well as GHG emissions per unit of land. It is based on IPCC 2006 Guidelines for National GHG Inventories. One key objective is to directly support countries in accessing funds from international financial institutions and international mechanisms to support land-use projects, programmes and policies. Use of EX-ACT builds national capacity in estimating and monitoring emissions reductions, while setting the stage for policymakers to integrate climate change mitigation into national policies and international commitments (e.g. nationally determined contributions- NDCs). EX-ACT operates at various scales such as project (local), landscape, and regional.

LANDSCAPE DEGRADATION SURVEILLANCE FRAMEWORK (LDSF) is a tool for conducting an integrated field inventory of land degradation and building a biophysical baseline at the landscape scale to support project development and monitoring. LDSF provides a field protocol for measuring indicators of ecosystem health, including vegetation cover, structure and floristic composition, historic land use, land degradation, soil characteristics, including soil organic carbon stocks for assessing climate change mitigation potential, and infiltration capacity. The data layers provide a monitoring framework to detect changes over time. Input data requirements and outputs obtained through LDSF is linked to ICRAF's Landscape Portal, an interactive online spatial data storage and visualization platform. It can store and visualize spatial data and maps for management and spatial modelling. The portal consists of multiple data layers and maps, with supporting documentation.

THE MULTIDIMENSIONAL POVERTY ASSESSMENT TOOL (MPAT) is an open source, household survey-based, thematic indicator development tool that captures ten dimensions of rural poverty. It was designed to support planning, design, monitoring and evaluation, targeting and prioritizing efforts at the household and village scale by capturing baseline data on the socio-economic status of target populations. MPAT collects and organizes data on

1. food and nutrition security,
2. domestic water supply,
3. health and health care,
4. sanitation and hygiene,
5. housing, clothing and energy,
6. education,
7. farm assets,
8. non-farm assets,
9. exposure and resilience to shocks,
10. gender and social equality.

Such data is important in supporting food security interventions and land use planning in ways that are centred on the livelihoods of the target population.

RESILIENCE, ADAPTATION PATHWAYS AND TRANSFORMATION ASSESSMENT (RAPTA) assists project planners by assessing resilience of socio-ecological systems (including agro-ecosystems) to potential future stresses such as those emerging from climate change. RAPTA offers practical guidance in how to apply the concepts of resilience, adaptation and transformation in planning projects in the face of high uncertainty and rapid change. One objective of the tool is to increase the chances of a sustainable development project's success through a clearer understanding of the factors that control resilience. This understanding also helps users determine where achieving the desired state is impossible or unrealistic with existing project resources and reduces the probability of unplanned transitions to undesired systems. RAPTA operates at multiple scale levels, depending on project scope, and assists users by organizing information for reporting to international conventions.

THE RESILIENCE ATLAS is a free and open access online tool that integrates and analyses multiple datasets relevant to resilience assessment and adaptation planning. It is a spatial analysis tool which provides users with a data-driven model for decision making and funding. The Atlas has three components:

1. livelihoods, production systems, and ecosystems;
2. climate stressors and shocks; and
3. factors influencing vulnerability.

The Atlas is structured to guide users through a series of steps to help them understand where particular socioecological systems occur and which stressors and shocks affect them, and to then support assessment of how vulnerable particular system components (e.g. specific livelihood strategies, production systems, or ecosystems) might be to these stressors and shocks and which types of assets and capital (e.g., social, natural, financial, human, manufactured) reduce that vulnerability. Users gain insights into system resilience by:

1. selecting an area and theme of interest,
2. visualizing exposure of the system to stressors and shocks, and
3. modelling how different types of assets (natural capital, human capital, social capital, financial capital and manufactured capital) increase or decrease the resilience of the system to these stressors and shocks.

The user may then identify which assets need to be strengthened or managed differently to reduce food insecurity. The Resilience Atlas operates at the sub-regional and national levels and can provide contextual information for project level management.

The Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists (SHARP) tool seeks to assess and increase the resilience of farmers and pastoralists to climate change. SHARP is operated at the individual or farm level. It is a self-assessment survey for farmers and pastoralists to strengthen their own resilience by measuring their own progress, with technical support provided to evaluate, analyse and link indicators to tools. SHARP involves three major phases:

- A participatory self-assessment survey of smallholder farmers and pastoralists regarding their climate resilience;
- A gap analysis and assessment of the responses, both at the local level with farmers and with local policy makers to assess agricultural and pastoral policies regarding effectiveness and gaps; and,

- Use of this information in conjunction with climate and scientific data to inform and guide farmers' practices as well as curricula and local and national policies.

VITAL SIGNS is a tool for conducting integrated field inventories of vegetation, soils and household income. The outputs are maps of key resources and spatially explicit indicators of land health and potential threats to resilience and indirectly to food security. The objectives are two-fold:

- To provide a small set of relevant, scientifically valid indicators to assess and manage risk and to support policy; and,
- Through operating the tool, to increase local and national capacity for environmental monitoring among scientists, civil society, government leaders and the private sector.
- Vital Signs depicts the connection between agriculture, nature, and human well-being and is designed to be used at national, regional, sub-regional scales.

THE LAND DEGRADATION ASSESSMENT IN DRYLANDS MAPPING TOOL (WOCAT-LADA)

assesses and maps land degradation at scales from local to global. It was designed initially for dryland degradation (desertification), but its methods can be applied to other ecosystems. At the local level, LADA captures the effects of land management practices and investment plans. As dryland degradation affects resilience, LADA output is useful for planning and monitoring SLM activities. Output is multiscale, however most use cases are at the national level with selected local level applications in some 20 countries worldwide.

The above tools have been developed and recommended for use in different agro-ecological conditions and for specific purposes. For example, DATAR addresses agricultural diversity and resilience at the landscape level in order to assess the constraints faced by farming communities. EX-ACT is used to analyse the green-house gas emissions arising from agricultural production and how the impact of green-house gasses can be mitigated. LDSF is used to conduct an integrated field inventory of land degradation, mainly in project development and monitoring. MPAT is a tool used to support planning, design and monitoring of projects. RAPTA, like MPAT, is used for project planning and monitoring. Resilience Atlas is a tool used to integrate and analyse multiple datasets relevant to resilience assessment, adaptation and planning, whereas SHARP is used to assess and integrate resilience of farmers and pastoralists to climate change. Vital Signs is used to conduct integrated field inventories of vegetation, soils, and household incomes, while WOCAT-LADA is used to assess and map land degradation at scales from local to global levels.

In assessing the tools presented as part of the SLM Toolbox, the authors note that tools must be adapted to local needs, but also highlight challenges related to the overlap and complexity of existing tools. Adapting tools to local needs requires time and budget, and significant training may be required for officials, field personnel and other stakeholders in the use of these tools and interpretation of their results. Other challenges highlighted include the complexity of integrating multiple tools onto a single platform, the integration of both biophysical and socio-economic data into a decision support system, and the complexity of bringing such systems together in a protracted, iterative, multi-stakeholder planning process.

Table 2: Tabular Summary of Tools from Resilient Food Systems Sustainable Land Management Toolbox

TOOL NAME AND HYPERLINK	Purpose	Scale of Analysis	Indicators Measured	Focus
Diversity Assessment Tool for Agrobiodiversity and Resilience (DATAR) www.agrobiodiversityplatform.org/datar Produced by the Consortium of International Agricultural Research Centers (CGIAR) through Biodiversity International and its Platform for Agrobiodiversity Research (PAR).	A framework composed of a household survey and participatory mapping activity that measures on farm crop, tree, and livestock genetic diversity	Landscape	Resilience; Biodiversity	Conservation of on farm genetic diversity
EX-Ante Carbon Balance Tool (EX-ACT) www.fao.org/tc/exact/ex-act-home/en/	Estimates the impact of agriculture and forestry development projects on carbon-balances; land-based accounting system	Multi-scaler	GHG mitigation; wide range of development applications	GHG emission avoided or reduced
Landscape degradation Surveillance Framework (LDSF) www.landscapeportal.org	To provide a biophysical baseline at the landscape level, and a monitoring framework for assessing land degradation and the effectiveness of rehabilitation	Landscape	• Soil Organic Carbon • Soil Health (multiple parameters) • Soil Hydrology • Vegetation Cover • Land Cover Classification • Land Degradation • Land Use • Plant Biodiversity • Soil and Water Conservation	Land under integrated management; Land cover

TOOL NAME AND HYPERLINK	Purpose	Scale of Analysis	Indicators Measured	Focus
Multidimensional Poverty Assessment Tool (MPAT) www.Ifad.org	Household survey that captures the dimensions of rural poverty. A thematic indicator that assists M&E design, targeting, and prioritization.	Household; Village	• Food and Nutrition Security • Domestic Water Supply • Health and Health Care • Sanitation and Hygiene • Housing, Clothing and Energy • Education • Farm Assets • Non-farm Assets • Exposure and Resilience of a Household to Shocks • Gender and Social Equality	Food Security
Resilience, Adaptation, Pathway and Transformation Assessment (RAPTA) www.stapgef.org	A framework to embed concepts of resilience, adaptation and transformation into project design, implementation, and assessment	Multi scaler	Resilience	
Resilience Atlas www.resilienceatlas.org/	An interactive analytical tool for building (1) understanding of the extent and severity of some of the key stressors and shocks that are affecting rural livelihoods, production systems, and ecosystems	Regional; Sub regional/ country	Over 60 data sets	Ecosystems
Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists (SHARP) www.fao.org	Self-assessment used to access and increase the resilience of farmers and pastoralist to climate change	Individual; farm	Resilience	Food security

TOOL NAME AND HYPERLINK	Purpose	Scale of Analysis	Indicators Measured	Focus
Vital Signs www.conservation.org/ projects/ vital-signs	Gathers and spatially orients a number of sustainability indicators. Depicts the connection between agriculture, nature and human well-being.	Regional; Sub regional	• Sustainable Agricultural Production • Water Availability and Quality • Soil Health • Biodiversity • Carbon Stocks • Climate Resilience • Household Income • Nutrition and Market Access	Land under integrated management; Land cover
Land Degradation Assessment in Drylands Mapping Tool (WOCAT-LADA) www.fao.org/land-water/land/ land-assessment/assessment-and-monitoring-impacts/en/	Information from questionnaires is linked to GIS software to produce maps that has areal calculations on various types of land degradation and SLM/ conservation. Can be used to: spatially map land degradation; plan, support and monitor SLM activities; set programme priorities	Multi-scalar	Land degradation	Land cover

Source: IFAD/GEF Project. Food Security Integrated Project Progress Report (2020)

In their paper assessing tools for managing trade-offs and synergies between agriculture and nature conservation, Daniel Gusenbauer and Phil Franks highlight six tools or methods of analysis, each with its own strengths and weaknesses. They note that the use of a combination of methods is increasingly common as part of integrated and participatory approaches, arguing that such stakeholder-centred approaches are necessary to enable the necessary transformative changes required to address pressing sustainability challenges.

The six methods of analysis are:

1. simulation methods,
2. optimization methods,
3. multicriteria analysis,
4. spatially explicit methods,
5. integrated methods, and
6. stakeholder-centred methods.

Simulation methods adopt a forward-looking perspective use agroeconomic and/or agroecological simulation methods to assess future trade-offs in quantitative terms. Typically, these studies compare a baseline and estimated future indicator values under different scenarios and/or assumptions. Results are presented either as tables displaying indicator values or (if spatial data are included) as colour-coded maps with different shades representing figures. Such methods have the benefit of delivering concrete and comparable assessments of different management options and can illustrate the effects of different scenarios on important indicators, which policymakers and planners. There are also several disadvantages to such approaches, such as the fact that a lack of consistent and reliable data may constrain the applicability of the tool. Social and political aspects of trade-offs are also difficult to quantify and are therefore often not considered in simulation methods, which such methods also typically rely heavily on expert judgement and assumptions that may compromise the validity of outputs for real-world applications.

Optimization methods is another approach to trade-off management that relies heavily on quantitative analysis. These methods typically first develop a mathematical model using real or simulated data. In principle, all variables included are defined as either benefits or costs. A target variable is then chosen to be maximised (or minimised) under certain constraints using methods such as linear programming. Such optimization methods usually yield a combination of variables that are quantitatively optimal in terms of cost-efficiency. Such optimization methods can provide insights into the optimal allocation of limited resources and, when combined with spatial data, can illustrate what efficient, multi-purpose landscapes could look like. The fact that linear programming allows for objectives to be weighted differently means that stakeholder priorities can be incorporated into the analysis. Conversely, such methods can be difficult for stakeholders to interpret and integrate into decision-making processes. The reliance on purely quantitative approaches also means that important qualitative aspects are not integrated. The authors highlight that such approaches tend to ignore differences in wealth/poverty, vulnerability and adaptive capacity.

Multicriteria analysis allows decision makers to assess multiple objectives that may be valued differently by stakeholders. Such conflicting views around trade-offs are very common. Stakeholders may have different preferences related to use of a given landscape, with some focussing on food, timber, employment and business opportunities, while others are concerned about grazing areas, recreation, water regulation, species habitats or other ecosystem services. Some objectives may be mutually exclusive, while others may be complementary. Multicriteria analysis evaluates different policy or management options based on selected criteria that capture relevant dimensions of decision making. The authors note that multicriteria analysis was originally designed as a decision-support tool for single decision makers but it is increasingly being embedded into participatory processes where multiple stakeholders and researchers perform criteria selection, weighting and aggregations steps in a collaborative manner. The benefit of such approaches is that they can make trade-offs explicit and rank different priorities and criteria systematically. When used in participatory processes, multicriteria analysis also allows stakeholders to be explicit about their priorities and allows them to see how different options may affect criteria that matter to them. Multicriteria analysis is also better at dealing with complexity and incomplete information than the aforementioned quantitative approaches. Some of the challenges related to multicriteria analysis include that they are time consuming and resource intensive. These methods also work best for relatively small-scale settings with a limited number of relevant stakeholders and can be difficult to apply at larger scales.

Spatially explicit models combine GIS-based spatial mapping of services with methods such as correlation and cluster analysis. Quantitative methods are used to identify interactions between pairs of ecosystem service and highlight trade-offs and synergies between services. These methods can be helpful in identifying priority areas for conservation or potential land use conflicts. The maps generated by such methods are generally well understood by planners and policymakers and can stimulate discussion among stakeholders. It must be noted, however, that the usefulness of such methods is highly reliant on the availability and quality of data and, in many cases, methods are used to provide a picture of ecosystem services at a particular moment in time, rather than describing their change over time.

Photo: © Adrien K (Flickr)

In order to address some of the shortcomings of spatially explicit models, a number of **integrated modelling methods** have been developed. Such modelling allows for the quantification, spatial mapping and sometimes economic valuation of ecosystem services and other aspects of ecosystems. Examples include the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST), developed by the Natural Capital Project as a range of GIS-based spatial models that allow users to quantify and map changes in ecosystem services and biodiversity under different land use or management scenarios. InVEST can be applied to different scales, types of ecosystems and a broad range of regulating, provisioning and cultural ecosystem services. A further example is Artificial Intelligence for Ecosystem Services (ARIES), which is an open-source technology and online platform rather than a model itself. It enables users to select and run models from a library of ecosystem services models and spatial data sets at multiple scales. Using artificial intelligence, ARIES then utilizes artificial intelligence to choose ecological process models where appropriate and turns to heuristics where process models do not exist or prove inadequate. ARIES focuses on beneficiaries, probabilistic analysis and spatiotemporal dynamics of flows and scale. It can automatically assemble the most appropriate models, driven by context-specific data and machine-processed ecosystem services knowledge. With its modular structure, ARIES intends to avoid pitfalls of the common **"one model fits all"** paradigm. Other integrated modelling methods highlighted by Gusenbauer and Franks (2019) include the Land Utilization Capability Indicator (LUCI), a tool that estimates the impact of land use on various ecosystem services, and which can help decision-makers determine where interventions or changes in land use might improve ecosystem services. It also allows for the identification of areas where trade-offs and synergies in ecosystem services exist. GLOBIO assesses past, present and future impacts of human activities on biodiversity. It allows exploration of impacts of human-induced environmental drivers (such as land use, infrastructure or climate change) and effects of policy responses (such as climate change mitigation or protected areas) under different scenarios.

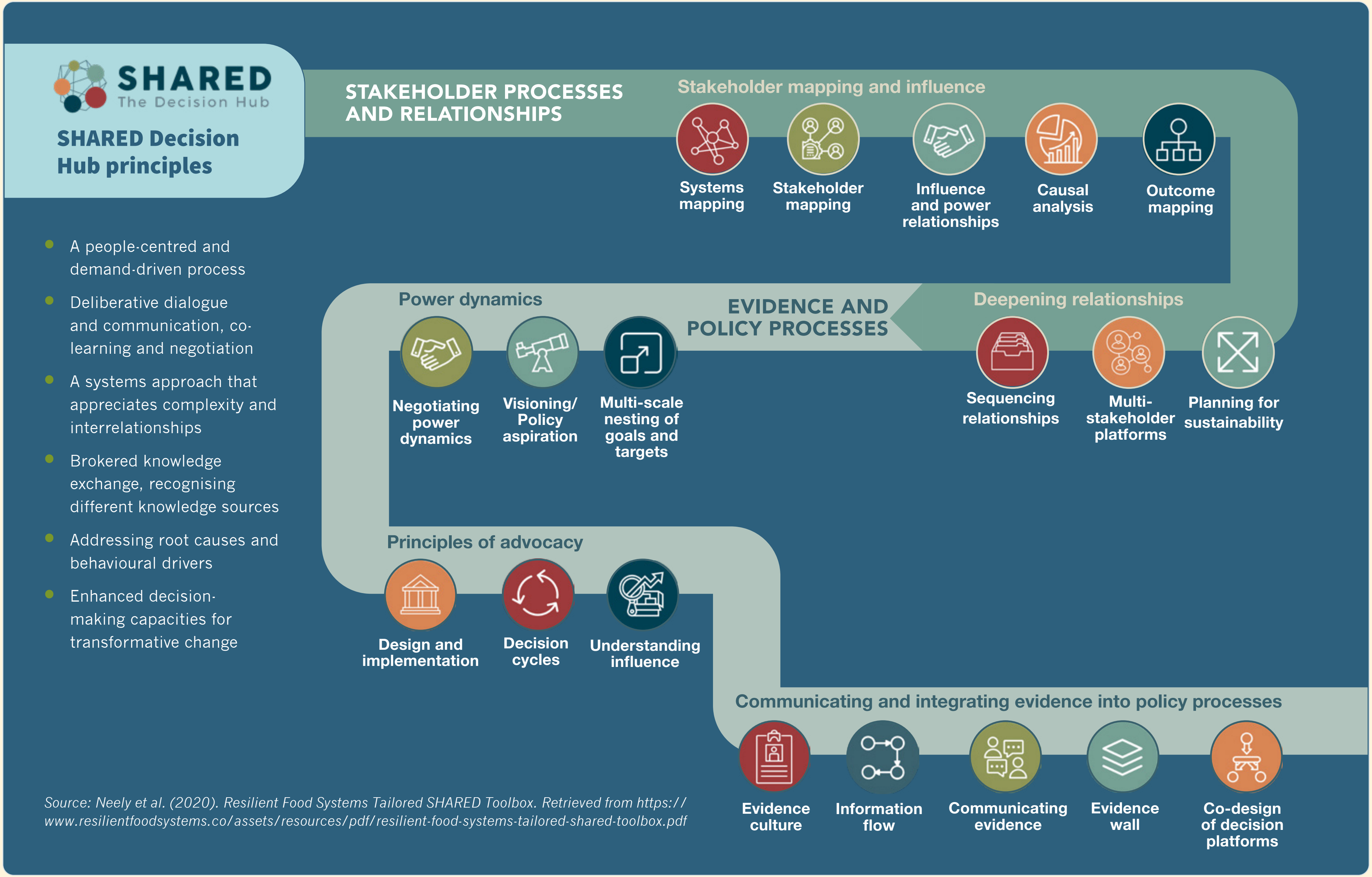
While such integrated modelling approaches have many advantages, including the combination of spatially explicit information (maps) with change over time (scenarios), and the ability to integrate a broad range of variables related to ecosystems, biodiversity and commodity production – there are some noteworthy disadvantages. These include considerable data requirements, the fact that important social and cultural dimensions related to equity, power or access that cannot be easily quantified are often overlooked, and, due to their complexity, such tools usually require advanced skills in GIS, as well as significant expertise and capacities with respect to statistical analysis.

The final group of tools highlighted by Gusenbauer and Franks (2019) are **stakeholder-centred approaches**. These approaches address a key shortcoming of the methods discussed earlier, namely their weakness in integrating the social dimensions of trade-offs. Stakeholders differ not only in terms of their access to, and reliance on, the benefits of ecosystem services, but also in terms of their perspectives and prioritisation of different outcomes. Stakeholder-centred approaches have important benefits, including the role that such inclusive approaches can play in social learning, trust-building, ownership and consensus building, which translates into enhanced legitimacy of decisions and greater success in implementation. Local stakeholders also often hold important informal and tacit information about the local context. Integrating local knowledge can lead to creative problem-solving and can allow for a fuller appreciation and integration of the complexity of decision making on trade-offs. It is important to recognize, however, that stakeholders have different motivations, needs, uses or values, even within groups. Stakeholders may prioritise short term gains over long term benefits or be unaware of the importance of some ecosystem functions and services. It must also be acknowledged that stakeholder-centred approaches tend to be time consuming, costly, and require a broad set of social skills. Despite these challenges, there is strong support for the value of stakeholder-centred approaches. On the basis of an analysis of 24 case studies of trade-off analysis and management, Turkelboom et al. (2016) conclude that

a social entry-point is most appropriate, given that drivers of ecosystem use and change are primarily dominated by socio-economic-institutional factors. Based on this, the authors argue that **"a better understanding of stakeholders and their ecosystem use should always be at the core of any trade-off analysis"**.

The Resilient Food Systems programme has itself drawn on an influential stakeholder-centred decision-making approach known as the Stakeholder Approach to Risk-informed and Evidence-based Decision-making (SHARED). SHARED is an approach that was developed collaboratively through the engagements of the SHARED Decision Hub, based at the international research organization World Agroforestry (ICRAF), which has played an integral part of the Resilient Food Systems programme through their scientific and project management role. The SHARED approach puts forward a four-stage process for stakeholder engagement, managing relationships, brokering multi-stakeholder and cross-sectoral partnerships, and fostering evidence- and experience- based dialogue, planning, and decision making. The SHARED Decision Hub has been applied in multiple countries and sustainable development thematic contexts to date (CIFOR-ICRAF s.a.).

Resilient Food Systems Tailored SHARED Toolbox (Neely et al. 2020) has been created for enhancing inclusive and evidence-based policy development through the programme. This has played an important role in supporting component one of the programme, which focuses on science, policy and institutions. These efforts have sought to link policy and scientific platforms to support dialogue and advocacy for the mainstreaming of ecosystem services, climate resilience and gender-sensitive approaches to food security and supporting policy and institutional innovations.



Source: Neely et al. (2020). Resilient Food Systems Tailored SHARED Toolbox. Retrieved from https://www.resilientfoodsystems.co/assets/resources/pdf/resilient-food-systems-tailored-shared-toolbox.pdf

The outline below provides guidance on how the SHARED framework may be employed to guide decision making related to managing land use trade-offs.

PHASE 1: CONTEXT

The initial phase focuses on establishing the foundational elements of land use decision-making process. It is at this stage that stakeholders are mapped and factors identified that shape decision making. In an inclusive and deliberative process, stakeholders collectively identify a desired future and the key indicators that will allow for progress towards this desired future be assessed. This process is informed by reflective situational and causal analysis. Stakeholders develop an engagement plan and agree on timelines, processes and indicators. For land use decision making and trade-off analysis, this phase may include an initial assessment of available tools, including those already in use by identified stakeholders, as well as an initial assessment of capacity building needs.

PHASE 2: INTEGRATE EVIDENCE

It is widely accepted that policy processes and programme interventions should be evidence-based, but often certain types or sources of evidence and knowledge are prioritised, while others, such as local and Indigenous knowledge, may be sidelined. The SHARED approach emphasises the need to scope, organize and analyse diverse evidence sources so that accessible and interpretable evidence may be co-designed by all relevant stakeholders. This often requires capacity development on systems thinking to link biophysical and socio-economic information. The focus should thus not only be on disseminating tailored actionable evidence, but also building capacity of stakeholders to access, interpret and apply data for decision making. Participatory consultation processes are required to ensure that local knowledge is effectively captured and integrated, and the collected evidence must be packaged for adaptive and planned advocacy and policy influencing. A deeper assessment of available land use decision-making and trade-off analysis tools should be undertaken in this phase. It is necessary to identify data gaps and key uncertainties, with subsequent development of strategies for how these gaps may be addressed. These steps should be implemented together with appropriate capacity building and technical assistance.

PHASE 3: PRIORITISE AND PLAN

It is in this phase that the planning and capacity building undertaken in the preceding phases translates into key decisions and trade-off analysis. At the same time, it must be emphasised that many of these steps are iterative, there should always be flexibility around drawing in additional stakeholders or incorporating new evidence. It is in this phase that inclusive knowledge exchange and negotiation events are convened. Capacity building is again an important element, with an emphasis on foresight capacity for developing participatory scenarios for plausible futures an important focus area. As noted, this phase may also entail identifying and incorporating into the decision-making process additional evidence and priorities. This phase may also entail formalising strategic partners and collaborative processes, as well as developing cross-sectoral and multi-sectoral strategic plans and pathways.

PHASE 4: LEARN AND RESPOND

The final phase allows for the integration of a monitoring and adaptive learning strategy into the decision-making process, drawing on the indicators and evidence-gathering that has emerged from the preceding phases. This is an opportunity to reflect on progress, integrate new evidence and ensure the sustainability of the interventions. An innovation of the SHARED approach has been the design and deployment of joint reflective learning events to draw on the collective insights of diverse stakeholder groups. These joint reflective learning events, combined with other forms of consultation and deliberation, subsequently inform the integration of feedback in ways that support learning and institutional strengthening. This phase also involves the consolidation of capacity building in order to support the iterative decision making and consultation required of land governance processes, as well as adapting and updating investment and implementation priorities. Strategic recommendations may be developed to guide the sustainability of the decision outcomes, particularly institutional and procedural innovations that have been adopted through the decision-making process. These processes feed into innovations that support adaptive governance appropriate to decision making in complex systems.

SHARED presents a framework that is intended to be flexible and adaptable to local contexts. Within the four-phase process, additional activities can be integrated as required, drawing on the insights from consultations and the iterative learning process. Governance processes, including those related to land governance, are rarely as contained and linear as presented in models and frameworks, and therefore a reflexive and adaptive approach to decision making is necessary within the broad parameters of the SHARED framework.

Recommendations

The following recommendations are aimed at strengthening the ability of stakeholders within the Resilient Food Systems focus countries to integrate trade-offs and synergies into land use decision making for more inclusive and effective land governance. Such governance is required to protect and restore valuable ecosystem services, combat land degradation, and support sustainable food systems and development. Key policy messages and recommendations from each of the preceding chapters is highlighted below:

CHAPTER 1: Introduction – Land Use and the Resilience Food Systems Programme

- Unsustainable land use practices and other pressures have been degrading land across Africa, with climate change an additional pressing threat to land health and the livelihoods that depend on it.
- There is a need to strengthen capacity among decision makers to identify and navigate land use trade-offs and synergies.
- The protection, management and restoration of land and related ecosystem services is addressed through a variety of global and continental policy frameworks. There is a need to align policy frameworks, as well as to strengthen integrated implementation and reporting of actions under these frameworks.

CHAPTER 2: Land Use, Natural Capital and Ecosystem Services

- Ecosystem services and the natural capital from which these services are derived are central to Africa's prosperity and must be effectively protected, managed and restored in support of long-term resilience and sustainable development.
- Land and ecosystem degradation are best addressed by working with nature through nature-based solutions. Such responses require effective policy and institutional support, as well as the scaling of effective and appropriate financing.
- There is a need to improve ecosystem service assessments and the integration of the outcomes of such assessments within decision-making processes.
- Inclusive decision making around land use is essential, as land use is complex and involves a wide range of stakeholders with competing demands, political and socio-cultural power, and priorities.

CHAPTER 3: Navigating Land Use Trade-offs

- With the drivers of land use change accelerating, the need to effectively evaluate trade-offs and synergies is increasingly urgent.
- Trade-offs and synergies typically operate at broad scale – actions at farm level can have positive or negative impacts on adjoining farms and ecosystems. While decision making at multiple scales should be supported, a landscape approach is most suited to decision making around protection, management and restoration of land at broad scales.
- Governance processes often fail to grapple with difficult decisions around trade-offs. Systems to identify and manage trade-offs must be strengthened within land governance processes, with specific focus on enabling conditions for better trade-off management.

CHAPTER 4 & 5: Land Use Change in Africa, Including the Twelve Resilient Food Systems Programme Focus Countries

- Africa is uniquely vulnerable to land use change and ecosystem degradation, given the high level of dependence on ecosystem services, the critical role that agriculture plays in food security and regional economies, and generally low levels of adaptive capacity, exacerbated by a range of developmental challenges.
- Agriculture and urbanization are key drivers of land use change, however, more sustainable models and approaches to agriculture production

and urban development are emerging and should be scaled, including efforts to minimize harmful impacts and actively restore natural capital.

- There is a need to strengthen science, policy and institutional linkages for integrated, evidence-based responses to land management and ecosystem restoration.
- Greater efforts are required to strengthen governance mechanisms that promote an integrated approach across multiple scales (local, state/provincial, national) and policy areas (agriculture, land management, climate change, biodiversity, etc).
- There is a need to support inclusive and adaptive governance, with a particular emphasis on the most vulnerable sectors of society.

CHAPTER 6: Review of Decision Support Tools for Land Use Trade-offs

- Decision makers face difficult choices in navigating the often fraught and complex process of managing trade-offs in the context of urgent social, economic and political pressures.
- Disparities exist between stakeholder groups in terms of power and access to information, which influence their ability to engage in decision making processes. Such disparities exist not only between broad stakeholder groups such as government, communities, private sector operators, etc, but also within sectors (e.g. large scale commercial versus small scale farmers) and across social dimensions (e.g. the unique vulnerabilities and marginalization often experienced by women and youth). Such vulnerabilities and power disparities must be accounted for in decision-making processes and efforts made to ensure that all stakeholders have an opportunity to shape the outcomes of such processes.
- A wide variety of tools and approaches exist to inform land use decision making and the management of trade-offs. Such tools must be adapted to local needs, with appropriate funding, technical resources and capacity building allocated to support the effective use of these tools.
- Decision-support tools each have their relative strengths and weaknesses. A combination of tools may be most suited as part of integrated and participatory approaches. Stakeholder-centred approaches are particularly important given their ability to integrate complexity, socio-economic disparities and divergent priorities. Stakeholder-centred approaches have important benefits, including the role that such inclusive approaches can play in social learning, trust-building, ownership and consensus building, which translates into enhanced legitimacy of decisions and greater success in implementation.

CHAPTER 7: A Guidance Tool for Integrated, Inclusive Land Use Decision-making

- SHARED is a process- and people-oriented approach that has been recommended to support decision-making and trade-off analysis. Core principles include:
    - A people-centred and demand-driven process
    - Deliberative dialogue and communication, co-learning and negotiation
    - A systems approach that appreciates complexity and interrelationships
    - Brokered knowledge exchange, recognising different knowledge sources
    - Addressing root causes and behavioural drivers
    - Enhanced decision-making capacities for transformative change
- SHARED presents a framework that is intended to be flexible and adaptable to local contexts. Within the four-phase process, additional activities can be integrated as required, drawing on the insights from consultations and the iterative learning process.
- Governance processes, including those related to land governance, are rarely as contained and linear as presented in models and frameworks, and therefore a reflexive and adaptive approach to decision making is necessary within the broad parameters of the decision-making framework.

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Conclusion

If Africa is to achieve its development ambitions, ensure food security for its people, and effectively leverage its natural capital, it is essential that land use decision making is improved. As this report has shown, there are a large number of tools and methodologies that allow for the identification of land use trade-offs, each with its own strengths and weaknesses. The framework provided in this report is intended to guide decision makers as they navigate complex and dynamic governance processes. Such processes can help stakeholders identify locally appropriate alternative policy trajectories to arrive at social and environmentally acceptable trade-offs and protection of ecosystem services. In this way, countries are able to pursue a sustainable development approach that aligns directly with the core objective of the Resilient Food Systems programme, that is, supporting efforts to tackle major drivers of environmental degradation by advancing a holistic approach to enhancing agricultural productivity in smallholder systems, where food security is tied to agriculture and the health of ecosystems. In the face of multiple sustainability crises, need for inclusive and adaptive governance processes has never been more pressing. SHARED has been recommended as a process- and people-centred approach that seeks to support decision making in a manner that enhances the agency of local stakeholders and results in transformative outcomes that recognize the interdependence between ecosystem health and human flourishing.

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