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CHAPTER 1

SETTING THE SCENE

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EXECUTIVE SUMMARY

Africa's extraordinary richness in biodiversity and ecosystem services, and wealth of indigenous and local knowledge, comprises a strategic asset for sustainable development in the region *(well-established)*. Africa is the last place on Earth with a broadly intact assemblage of mammalian megafauna. Africa has significant regional, subregional and national variations in biodiversity that reflect climatic and physical differences, as well as the continent's long and varied history of human interactions with the environment. This natural richness, accumulated over millions of years, 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 in the region {1.1, 1.3.2, 1.3.9}.

Africa's rich and diverse ecosystems generate flows of goods and services that are essential in providing for the continent's food-, water-, energy-, health- and secure livelihood- needs *(well-established)*. Tangible assets such as food, water and medicinal plants, and intangible assets such as sacred sites and religious spaces underpin nature's contribution to the economy and are central to a multitude of other livelihood strategies. Nature's contributions to people are generally of immense benefit to the inhabitants of the continent and others across the globe, but can occasionally be detrimental as a result of losses or of conflicts over their uses {1.1.4, 1.3.1, 1.3.8.4}.

Africa has opportunities to fully realise the benefits of having such rich biodiversity and to explore ways of using it in a sustainable way to contribute to its economic and technological development *(established)*. Existing indigenous and local knowledge on management of biodiversity and nature's contributions to people appears to be declining in parts of the continent. It is important that the people of Africa do not lose both the rich natural resources and the indigenous and local knowledge to manage these resources, especially at a time when knowledge is increasingly recognised as vital to the development of a low carbon, ecological, knowledge-based economy {1.3.7, 1.3.9}.

Certain ecosystems found in Africa are of great ecological, biological and cultural importance at regional and global levels *(established but incomplete)*. As a strategic measure to protect them, as well as the species, knowledge and genetic resources they harbour, countries have declared 14% of the continent's land and 2.5% of the seas as protected areas, while some sites have been designated as wetlands of international importance; Important Bird and Biodiversity Areas; Alliance for Zero Extinction sites, where endangered or critically endangered species occur; ecologically and biologically significant marine areas; community conserved areas; United Nations Educational, Scientific and Cultural Organization World Heritage Sites; and Biosphere reserves {1.1.3, 1.3.6}.

Africa still does not know the full potential of biodiversity and of nature's contributions to its economic and technological development, and it continues to lose a large part of these resources and knowledge *(well-established)*. Addressing these gaps and losses is critical at a time when the value of knowledge is recognised as vital to the development of a low carbon, ecological, knowledge-based economy. Value of biodiversity and ecosystem services in itself, but also in its supporting function Africa's wealth in natural resources is increasingly needed to be understood. Further, existing knowledge around biodiversity and ecosystem services and indigenous resources appears to be on the decline in parts of the continent {1.3.4, 1.3.7, 1.3.9}.

1.1 INTRODUCTION

The importance of interconnections between nature and people for human livelihoods, food security, and a good quality of life cannot be overstated. Yet, all too frequently, concerns around biodiversity and ecosystem services take a secondary role to other political, economic and social considerations. This state of affairs is unsustainable. It leads to the erosion of resources and critical knowledge that are the foundation for a good quality of life, both now and into the future. The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established in 2012 as a global response to the problem of declining biodiversity and ecosystem services, and the need for a credible evidence base to support policy making. Building on the previous work of the Millennium Ecosystem Assessment and the Intergovernmental Panel on Climate Change, IPBES specifically aims to strengthen knowledge foundations for better policy through science, for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. One component of the

IPBES work programme is the development of four policy-focussed regional assessments, including this one for Africa (Decision IPBES-3/1).

The Africa Assessment Report recognises the continent's global importance in terms of biodiversity and diversity in its peoples. As the cradle of humankind, Africa is where human-environment interactions have the longest history (Diop, 1981; Cann *et al.*, 1987; Malaspinas *et al.*, 2016; Mallick *et al.*, 2016; Pagani *et al.*, 2016) and where hundreds of millions of people still have a strong connection to nature and its multiple influences. Environmental factors – mainly those related to rainfall and net primary productivity – have been quantitatively associated with species variation and language richness (Moore *et al.*, 2002). In turn, population density in sub-Saharan Africa correlates with species richness for some taxa (Balmford *et al.*, 2001). This assessment illustrates, through a range of examples, the mutually beneficial interactions between nature and people, often supported by indigenous knowledge developed through generations (for example, Hammi *et al.*, 2010; Agidie *et al.*, 2014; Anderson *et al.*, 2014; Chibememe *et al.*, 2014; Blanco *et al.*, 2016). The value of interactions is already recognised through measures taken to respond to the well-established evidence of biodiversity loss and also to increase nature's contribution to people for a good quality of life for all. There are, nevertheless, also considerable threats and challenges from intricately woven and, often, mutually reinforcing drivers of land-use change, biodiversity loss and ecosystem degradation. The ultimate objective of the Africa regional assessment is to draw together what is currently known about the state and dynamics of African biodiversity and ecosystem services. This serves to help policymakers and practitioners to better recognise, value, protect and enhance nature and its benefits to Africans as we endeavour to eliminate poverty and emerge as a new economic and social force. Achieving better responses will require new perspectives and collaborations. This assessment marks an important step in the process of achieving these goals.

1.1.1 Purpose and scope of this assessment

The Africa regional assessment is one of the regional assessments being conducted under the umbrella of IPBES. The assessment is a critical evaluation of the state of knowledge of biodiversity and ecosystem services, as requested by governments and relevant stakeholders. Its purpose is to identify key priorities that will help policymakers develop policy solutions which meet the needs of the Africa region as a whole, as well as those of its five subregions and their national constituents. The assessment and the policy options that it outlines will help African Governments and institutions develop strategies to meet sustainability and conservation goals. Some of the most important of these are the Strategic Plan for Biodiversity 2011–2020 and its Aichi Biodiversity Targets, the national biodiversity strategies and action plans developed under the Convention on Biological Diversity (CBD), the African Aspirations for 2063, and the 2015–2030 Sustainable Development Goals (SDGs). The chapters in this assessment, therefore, make explicit reference to each of these strategies, targets and goals.

The overall scope of the regional and subregional assessments is to assess the status and trends of terrestrial, freshwater, coastal and marine biodiversity, ecosystem functions and ecosystem services together with their inter-linkages. The assessment also considers the impact of biodiversity, ecosystem functions and ecosystem services on quality of life and the effectiveness of responses to date. To this end, the contributors to the Africa Assessment Report have synthesized and critically judged existing knowledge. It is important to note that the Africa Assessment did not undertake original research. In accordance with the function of an assessment, it uses reliable sources of knowledge and information drawn from peer-reviewed literature and important grey literature, as well as indigenous and local knowledge (ILK) sources. The process of evaluating the state of knowledge helps to further identify key knowledge gaps and uncertainties, the associated implications for effective policy making, and the steps required to address them. The assessment consequently aims to achieve a broad readership and to provide the foundation for a meaningful dialogue across the full range of actors involved in African development.

Key policy-relevant questions underpinning the Africa Assessment are as follows:

- How do biodiversity and ecosystem functions and services contribute to the economy, livelihoods, food security, and good quality of life in the region, and what are the interdependencies among them?
- What are the status, trends and potential future dynamics of biodiversity components (i.e., plants, animals, microorganisms and ecosystems) that affect nature's contributions to people in the different regions of Africa, (such as ecosystem functions and services) that affect their contribution to the economy, livelihoods and well-being in the region?
- What are the pressures driving the change in the status and trends of biodiversity, ecosystem functions, ecosystem services and good quality of life in the region?
- What gaps in knowledge need to be addressed in order to better understand and assess drivers, impacts and responses of biodiversity, ecosystem functions and services at the regional level?

- What are the scenarios and related policy ideas and options for decision-makers at the regional and subregional levels; how effective are they and what policy environment would best ensure success of these options?

- What are the actual impacts of, and potential pathways for policies and interventions regarding the contribution of biodiversity and ecosystem services to the sustainability of the economy, livelihoods, food security and good quality of life in the region?

- What role do government, bureaucratic and political institutions play in advancing public policies to improve the quantity and quality of biological resources alongside other national priorities through mainstreaming biodiversity and ecosystem services?

In addition to these questions, the Africa Assessment considers a number of key thematic challenges including (but not limited to) the food-energy-water-livelihood nexus; health; climate change; land degradation; sustainable use and conservation; and invasive species. The assessment pays particular attention to questions of equity, rights, social relationships, spirituality and cultural identity/diversity in its investigation of biodiversity, ecosystem functions and nature's contributions to people. Given the critical backdrop of economic transition, the Africa Assessment further considers the impacts of trade and investment, as well as carbon smart prospects for green-blue transformations in the economy. By green-blue transformations, we refer to productivity gains and industrial innovations using renewable resources and energies, as well as local competencies and solutions – particularly those based on the untapped wealth of terrestrial and marine ecosystems. For green-blue transformations to succeed, they must protect the rights and livelihoods of those living in and dependant on terrestrial and marine ecosystems in Africa. Equally, a future vision for Africa cannot omit consideration of human and environmental health. Careful consideration is thus given to the connection between human health and nature, as determined through biodiversity and critical ecosystem functions. Finally, this assessment acknowledges that baseline evidence and knowledge of what needs to happen is seldom enough to affect real change. Therefore, we also assess institutional capacity to lead and bring about desired conservation outcomes. As part of this, we seek to understand the degree of independence that decision-makers have over internal impacts on biodiversity and ecosystem services within the region as one of the key factors that determines capacities to develop effective responses.

Due to IPBES being an interdisciplinary collaboration, it has been necessary to develop a standardised framework **(Figure 1.1)** to guide and structure its assessments. The framework identifies and links the people and nature components of the system being assessed. It also provides common terminology for use across IPBES assessments and proposes assumptions about key relationships in the system. **Figure 1.1** is a simplified version of the figure adopted by the second session of the Plenary of IPBES (UNEP, 2014), and modified by the fifth session of the Plenary (UNEP, 2017). A more complete description of all elements and linkages, together with examples, is presented in Díaz *et al.* (2015).

1.1.2 Background on Biodiversity and Ecosystem Services

The authors in the assessment use the terms "Nature's Contributions to People" (NCP) (Pascual *et al.*, 2017) and "Biodiversity and Ecosystem Services" (Díaz *et al.*, 2015) throughout the report. The latter is defined by Díaz *et al.* (2015) as follows (more on NCP later in this section):

- Biodiversity is shorthand for biological diversity. The Convention on Biological Diversity defines biodiversity as: "The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species ("genetic diversity"), between species and ecosystems."

- Biodiversity underpins the functioning of ecosystems. The Convention on Biological Diversity in its article 2 identifies an ecosystem as "a dynamic complex of plant, animal and micro-organism communities and the non-living environment interacting as a functional unit".

- Ecosystems provide a range of services as part of the wider contributions people receive from nature. The Millennium Ecosystem Assessment (MA, 2005) divided ecosystem services into four broad areas (see examples in **Table 1.1**):

    - Provisioning services (e.g., food, freshwater, timber),
    - Regulating services (e.g., climate regulation, pollination),
    - Cultural services (e.g., recreation, spiritual values), and
    - Supporting services that underpin these other three types.

Scientists have attempted to construct typologies of ecosystem services that assign different types of service to different categories. The Millennium Ecosystem Assessment (MA, 2005) recognised four categories of ecosystem services **(Figure 1.2)**. With debates over the years, these categories have been reduced to three broad areas with various explanations. For instance, Haines-Young *et al.*

(2010) contend that 'supporting services' are "structures, processes and functions characterising ecosystems", therefore should be excluded from the categories of ecosystem services.

IPBES now distinguishes three broad groups of NCP **(Figure 1.2)**: regulating, material and non-material. These represent different facets of the complex flow from nature to a good quality of life ranging from indispensable direct biological connections, such as oxygen, water, calories and vitamins without which the physical existence of humans is not possible, all the way to the anchoring of the symbolic components that give meaning to the identity of different social groups and their relationships with nature. Rather than an abrupt departure from previous classifications, the present broad categorisation of NCP is an evolution, still strongly rooted in the Millennium Ecosystem Assessment and its system of categorisation of ecosystem services (MA, 2003; MA, 2005). It reflects some key improvements to the original Millennium Ecosystem Assessment classification, based on more than a decade of progress in interdisciplinary thinking, with increasing involvement from the social sciences and humanities (including law, economics and policy).

Table 1 1 **A typology of nature's contributions to people and their ecological characteristics. Source: adapted from Kremen (2005).**

NATURE'S CONTRIBUTION	Ecosystem service providers/ trophic level	Functional units	Spatial scale	Potential application to ecological studies
Aesthetic, cultural	All biodiversity	Populations, species, communities, ecosystems	Local–global	Low
Ecosystem goods	Diverse species	Populations, species, communities, ecosystems	Local–global	Medium
UV protection	Biogeochemical cycles, micro-organisms, plants	Biogeochemical cycles, functional groups	Global	Low
Purification of air	Micro-organisms, plants	Biogeochemical cycles, populations, species, functional groups	Global-regional	Medium (plants)
Flood mitigation	Vegetation	Communities, habitats	Local–regional	Medium
Drought mitigation	Vegetation	Communities, habitats	Local–regional	Medium
Climate stability	Vegetation	Communities, habitats	Local–global	Medium
Pollination	Insects, birds, mammals	Populations, species, functional groups	Local	High
Pest control	Invertebrate parasitoids and predators and vertebrate predators	Populations, species, functional groups	Local	High
Purification of water	Vegetation, soil micro-organisms, aquatic micro-organisms, aquatic invertebrates	Populations, species, functional groups, communities, habitats	Local–regional	Medium to high
Detoxification and decomposition of wastes	Leaf litter and soil invertebrates, soil micro-organisms, aquatic micro-organisms	Populations, species, functional groups, communities, habitats	Local–regional	Medium
Soil generation and soil fertility	Leaf litter and soil invertebrates, soil micro-organisms, nitrogen-fixing plants, plant and animal production of waste products	Populations, species, functional groups	Local	Medium
Seed dispersal	Ants, birds, mammals	Populations, species, functional groups	Local	High

Figure 1 1 **The IPBES Conceptual Framework.**

The boxes and arrows denote the elements of nature and society. Headlines in black within each box are inclusive categories relevant to all IPBES stakeholders and embrace the categories of science (in green) and comparable or similar categories according to other knowledge systems (in purple). Solid arrows denote influence between elements included in IPBES (the dotted arrows denote links that are acknowledged as important, but are not the main focus of IPBES). Interactions between the elements change over time (horizontal broad orange arrow) and occur at various spatial scales (vertical broad orange arrow). Orange numbers refer to chapters where more information on the topic can be found. Source: Díaz *et al.* (2015).

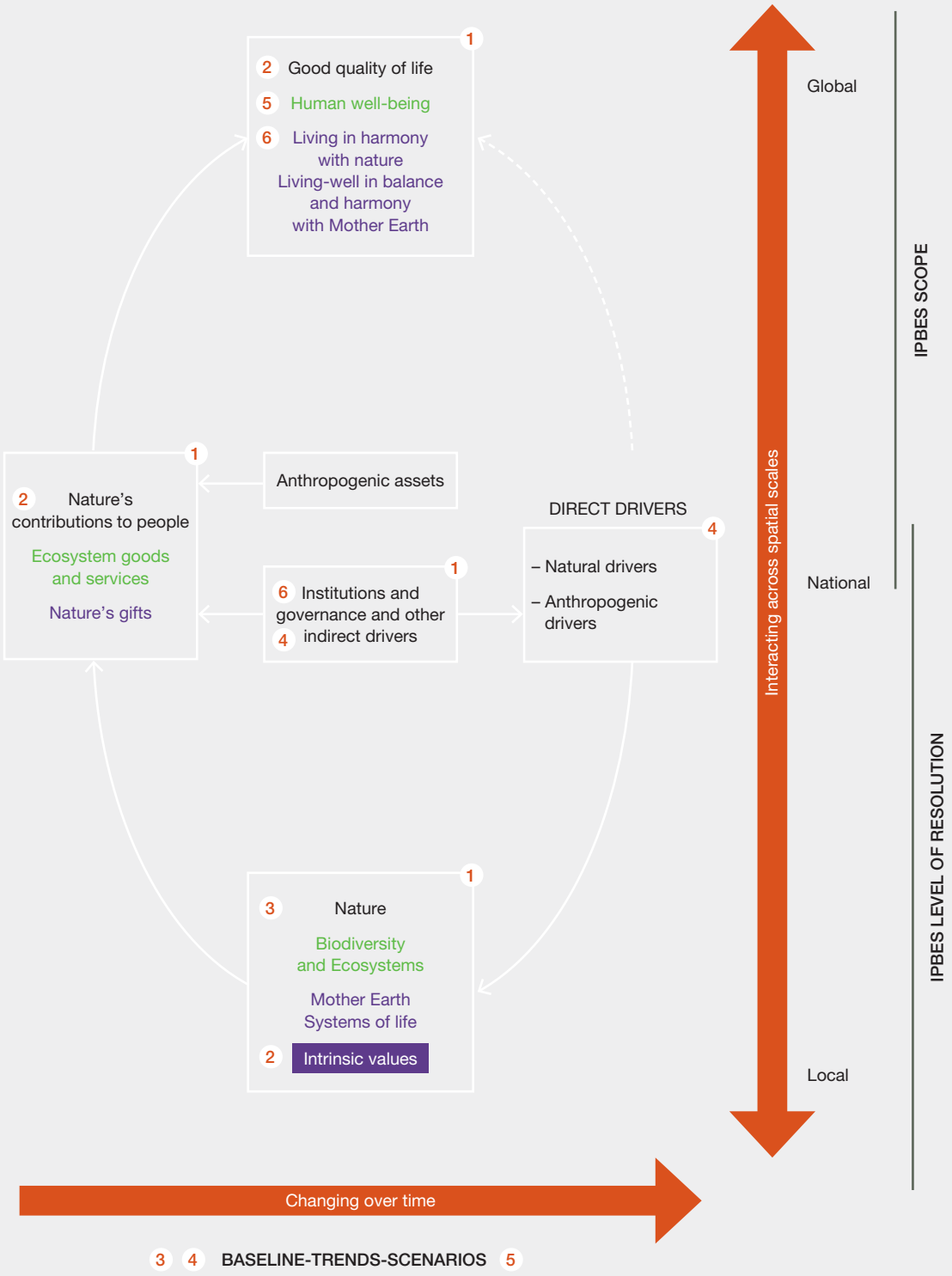
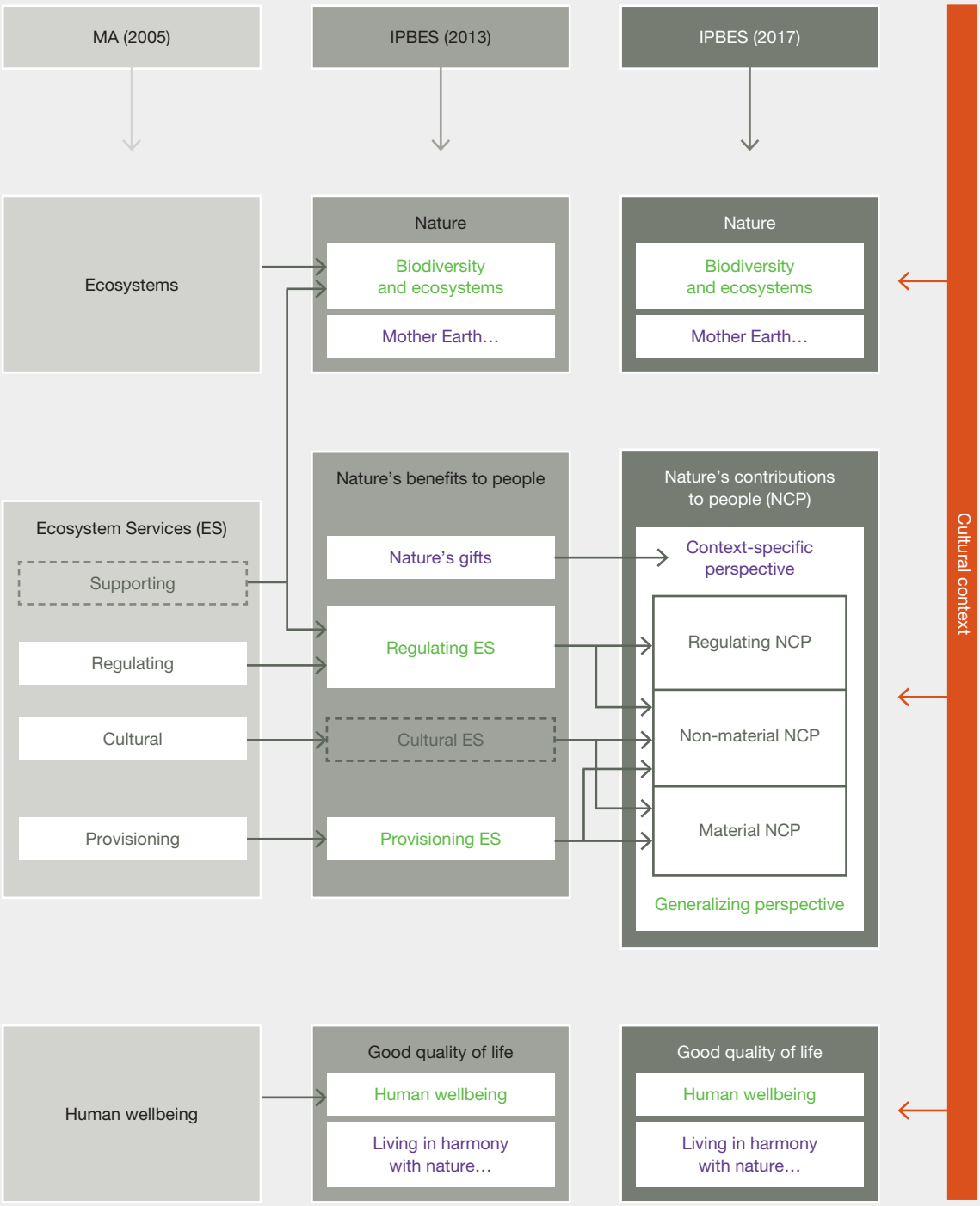


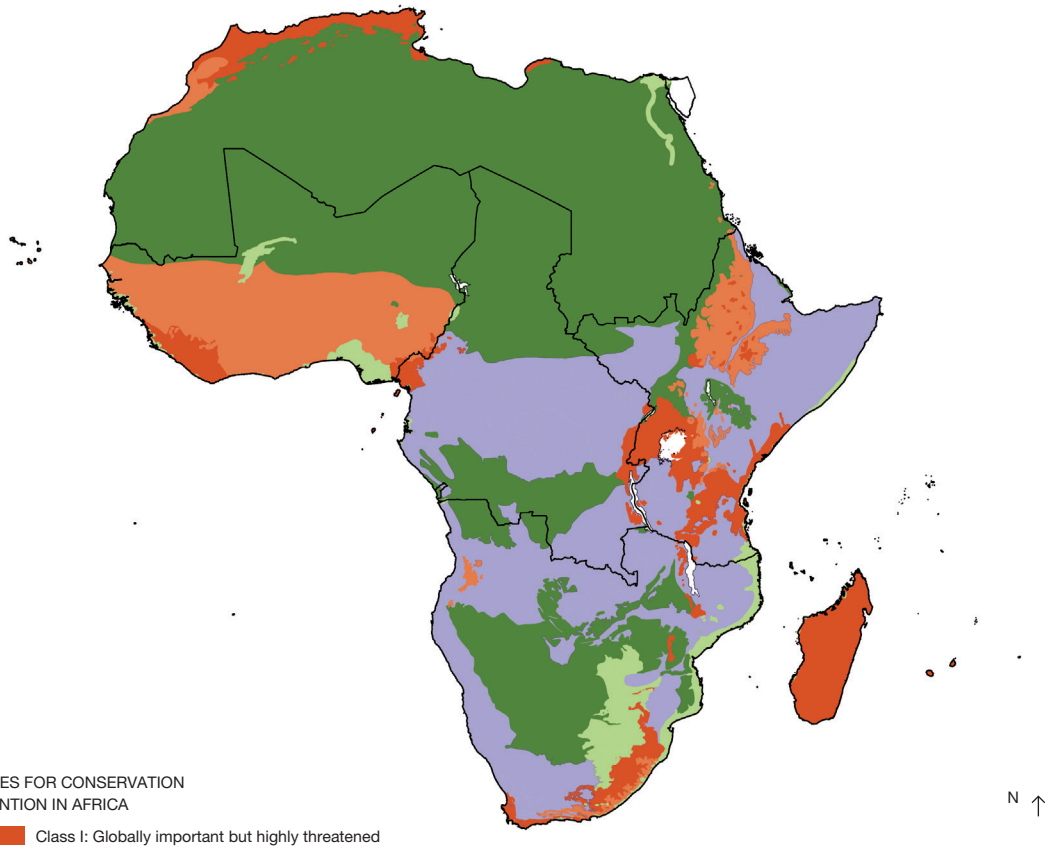
Figure 1 2 **Evolution of nature's contributions to people (NCP) and other major categories in the IPBES conceptual framework with respect to the concepts of ecosystem services and human well-being as defined in the Millennium Ecosystem Assessment.**

The element "nature's benefit to people" was adopted by IPBES Second Plenary, and further developed into NCP by IPBES Fifth Plenary in order to fully capture the fact that the concept includes all contributions to people, both positive (benefits) and negative (detriments). Concepts pointed by arrow heads replace or include concepts near arrow tails. Concepts in dotted-line boxes are no longer used: following the present view of the MA community, supporting ecosystem services are now components of nature or (to a lesser extent) regulating NCP. Cultural ecosystem services was defined as a separate ecosystem service category in the MA; IPBES instead recognises that culture mediates the relationship between people and all NCP. Source: Díaz *et al.* (2018).



Box 1 1 African biodiversity conservation priorities. Sources: map adapted from Olson *et al.* (2001); Burgess *et al.* (2006).

The location of and threats to biodiversity are unevenly distributed, thus it is important to prioritise conservation efforts to minimise biodiversity loss and maintain ecosystem services (Brooks *et al.*, 2006; Burgess *et al.*, 2006). Brooks *et al.* (2006) analysed all nine major global biodiversity conservation priority templates, i.e. 1) Crisis Ecoregions; 2) Biodiversity Hotspots; 3) Endemic Bird Areas; 4) Centers of Plant Diversity; 5) Megadiversity Countries; 6) Global 200 Ecoregions; 7) High-Biodiversity Wilderness Areas; 8) Frontier Forests; and 9) Last of the Wild, from which they developed two possible approaches to biodiversity conservation. Approaches comprised: 1) Prioritizing areas of high threat and high irreplaceability and 2) Prioritizing areas of low threat but high irreplaceability. Burgess *et al.* (2006) came up with a similar ecoregion prioritisation, i.e. 1) highly threatened ecoregions with many endemic species that require proactive actions to prevent further habitat loss and extinctions, and 2) less threatened ecoregions that require conservation of large areas that will support large-scale habitat processes and associated species. Burgess *et al.* (2006) further identified five classes of ecoregion priorities.



A method to focus this large scale conservation priority approach to a regional or national level is the identification and establishment of Key Biodiversity Areas (KBAs) to increase the coverage of protected areas in support of the Aichi biodiversity targets (CBD, 2013). Given the importance of freshwater, KBAs have been identified across continental Africa and conservation planning software used to prioritize a network of catchments that includes 99% of the total species (Holland, 2012). In addition to this concept, the Red List of Ecosystems (RLE) was recently developed to assess risks to biodiversity and ecosystem functioning (Rodriguez *et al.*, 2015). A large regional gap is the identification of conservation priorities for the coastal and offshore marine habitats and species.

1.1.3 Global importance and uniqueness of biodiversity in Africa

Africa has many biodiversity hotspots and globally important ecoregions **(Box 1.1)**, but it is important to note that biodiversity is unevenly distributed across the continent (Linder, 2014). Designated biodiversity hotspots are distributed all over Africa, from the Cape Floristic Region, the Maputaland-Pondoland-Albany area and the Succulent Karoo in South Africa to the Mediterranean Basin, the Coastal Forests and Afromontane regions of Eastern Africa, the Guinean Forests in West Africa, the Horn of Africa, as well as Madagascar and the Indian Ocean Islands (Mittermeier *et al.*, 2004; Taylor, 2015).

Burgess *et al.* (2006) further identified five classes of ecoregion priorities on land and across the 113 ecoregions in Africa. Based on freshwater biodiversity (mostly fish), Abell *et al.* (2008) highlighted 830 ecoregions worldwide, among which 87 are in Africa. Beaumont *et al.* (2011) showed that the Guinean moist forests and several other tropical and subtropical terrestrial ecoregions in Central, Southern and Eastern Africa ranked among areas of "exceptional biodiversity". This is true also for deserts, Succulent Karoo, Fynbos, lakes, great rivers, wetlands, coastal and mineral-rich areas, all exhibiting great biological diversity and playing important roles in food security. Important biodiversity areas in Africa encompass a wide range of biomes and landscape features. These areas are generally diverse in endemic animal species of global importance (for example, chimpanzee and gorilla species), but are also extremely rich in plants, reptiles, amphibians, birds and invertebrates. The biodiversity hotspots contain important ecosystems that are repositories of biodiversity and ecosystem services, notably the provision of water to lowland communities and the maintenance of lake systems.

There are 75 United Nations Educational, Scientific and Cultural Organization Man and Biosphere reserves in 28 countries in Africa (UNESCO, 2017). As for biodiversity hotspots, examples include the northern margin of Africa which is part of the Mediterranean Basin biodiversity hotspot, comprising the second largest hotspot in the world and the largest of the world's five Mediterranean-climate regions covering more than 2 million km^2 (CEPF, 2015). The Mediterranean Basin Forest that constitutes just 1.5% of the world's forests, yet is home to 25,000 plant species and 14 endemic genera (Quézel *et al.*, 1999). According to Harrison *et al.* (2016), the Congo Basin, the second largest humid forests ecosystem after the Amazon Basin covers 4 million km^2. It is home to over 1,200 fish species, 400 mammal species, 1,000 bird species, and over 10,000 vascular plant species, as well as providing about 30% of Africa's freshwater resources, with an estimated 77 million people in the Congo basin relying on these natural resources.

1.1.4 Links between biodiversity and ecosystem services, and human well-being in Africa

No matter who we are, or where we live, our well-being depends on functioning ecosystems. Most obviously, ecosystems can provide us with material objects that are essential for, and improve, our daily lives; such as food, beverages, housing, furniture, cosmetics, and medicines. Although the other types of ecosystem contributions are easily overlooked, they play an important role in shaping human cultures and regulating the environments in which we live. They help ensure the flow of clean water and protect people from flooding and other hazards like soil erosion, landslides and tsunamis. These ecosystems often have deep cultural or religious significance and are of paramount importance in the spiritual well-being of Africans. In addition, they provide the opportunities for recreation or the enjoyment of nature (Haines-Young *et al.*, 2010). Well-conserved ecosystems also have the potential to significantly improve human health and well-being (Myers *et al.*, 2013; Finlayson *et al.*, 2015).

1.2 METHODOLOGY

1.2.1 Basic methods and approaches used in the assessment

In accordance with IPBES prescriptions as stated in IPBES deliverables **(Box 1.2)**, all IPBES assessments must be based on data and knowledge resources that are:

- Fully referenced and for which all contributions are appropriately attributed and recognised;
- Comprehensively documented in underlying sources and methodologies and that adhere to domain-specific meta-data standards; and
- Archived and accessible to IPBES experts and, wherever possible, the public.

The methodologies and approaches used in the regional assessment for Africa have followed these rules to ensure that the assessment incorporates accessible, reliable and diverse information sources, from life sciences to indigenous and local knowledge. Though indigenous and

Box 1 2 **The knowledge, information, and data checklist for IPBES assessments. Source: IPBES (2016a).**

1. Consider all sources of knowledge, information, and data (global, regional, and local) – noting that:
- key global datasets and knowledge products serve a significant role for allowing (sub) regional assessments to replicate and standardize efforts, simplify documentation requirements, and facilitate global synthesis; and
- regional and subregional assessments may be able to tap into geographically restricted data, information and knowledge products of greater relevance, quality, spatial resolution, accessibility, taxonomic or temporal scope than are available globally.

2. Fully document methodology for selecting knowledge, information, and data to be used in the assessment.

3. All assessments and associated products should be based on knowledge, information, and data that is:
- fully referenced;
- sufficiently documented and that adhere to domain-specific meta-data standards; and
- archived and accessible.

4. Adopt existing knowledge, information, and data and meta-data standards.

5. Knowledge, information, and data quality and confidence should be assessed and reported.

6. Ensure long-term storage and archiving of knowledge, information, and data versions used in the assessment to ensure transparency.

local knowledge refers to forms of knowledge that make the best sense in relation to the social and cultural systems in which they are embedded (Agrawal, 1995), it is also sought out as a source of knowledge that has validity and wide applicability in the world. There are controversies on whether validation by science (Nakashima *et al.*, 2002; Roué *et al.*, 2002; Tsui, 2004; Gratani *et al.*, 2011) is relevant since indigenous and local knowledge and scientific knowledge are based on different philosophies and both make sense in their own systems of reference. However, both systems are to be valued and can be complementary and inform each other. Indigenous and local knowledge is now widely cited in the mainstream scientific literature today and examples abound, in particular regarding vegetation state and dynamics (Lykke, 2000; Wezel *et al.*, 2000; Lykke *et al.*, 2004; Thomas *et al.*, 2004) and deforestation and carbon reduction emissions (Mistry *et al.*, 2016). By highlighting data gaps in both mainstream science and ILK, IPBES will provide opportunities for countries to define appropriate actions and corresponding data and research needs, with links from local to global scales (Faith *et al.*, 2013).

The Africa Regional Assessment makes use of prescribed IPBES methodologies together with a range of bespoke analyses. Results are reported with maps and infographics to aid in the appreciation of complex messages and inter-related data. Each chapter has been developed as a collaborative effort coordinated by the coordinating lead authors and assessment co-chairs, involving lead authors, fellows and invited external contributors. Chapters follow structures agreed at IPBES Plenary sessions and were developed in several iterations to take account of contributions from government and expert independent reviewers, guided by review editors.

1.2.2 Indicators

IPBES has consulted widely in arriving at a list of 81 indicators for its assessments, including a core list of 30 indicators, of which nine are intended to assess socio-ecological status and trends. Indicators have been selected to cover the conceptual framework comprehensively. Indicators are here defined as data aggregated in a particular manner (quantitative or qualitative) that reflect the status, cause or outcome of an object or process, especially towards targets such as the Aichi Biodiversity Targets or those set by the Sustainable Development Goals (CBD Secretariat, 2014). Indicators can help simplify the enormous complexity of datasets, variables, frameworks and approaches available to IPBES assessments (Müller *et al.*, 2012). They also serve as useful tools for communicating the results of assessments. It is, however, important to recognise the limitations of a given set of indicators in capturing the complexities of the 'real world', since indicators are restricted to what can be measured and for which there are available data. Notably, these limitations are especially significant when it comes to assessing nature's non-material contributions to people and to their quality of life. Indicators are not independent of one another, and relationships between them are non-linear. Moreover, the choices of indicators are related to diverse cultural perspectives. Hence, in IPBES assessments, indicators are subjected to critical analysis and review from a diversity of stakeholders and experts.

1.2.3 Scenarios

Scenarios and models play complementary roles, with scenarios describing possible futures for drivers of change or policy interventions, and models translating those

scenarios into projected consequences for nature and nature's contributions to people. In brief, the goals of using scenarios and models are:

- to better understand and synthesize a broad range of observations,
- to alert decision-makers to future impacts,
- to provide decision support for developing adaptive management strategies, and
- to explore the implications of alternative social-ecological development pathways, governance and policy options (Source: IPBES, 2016b).

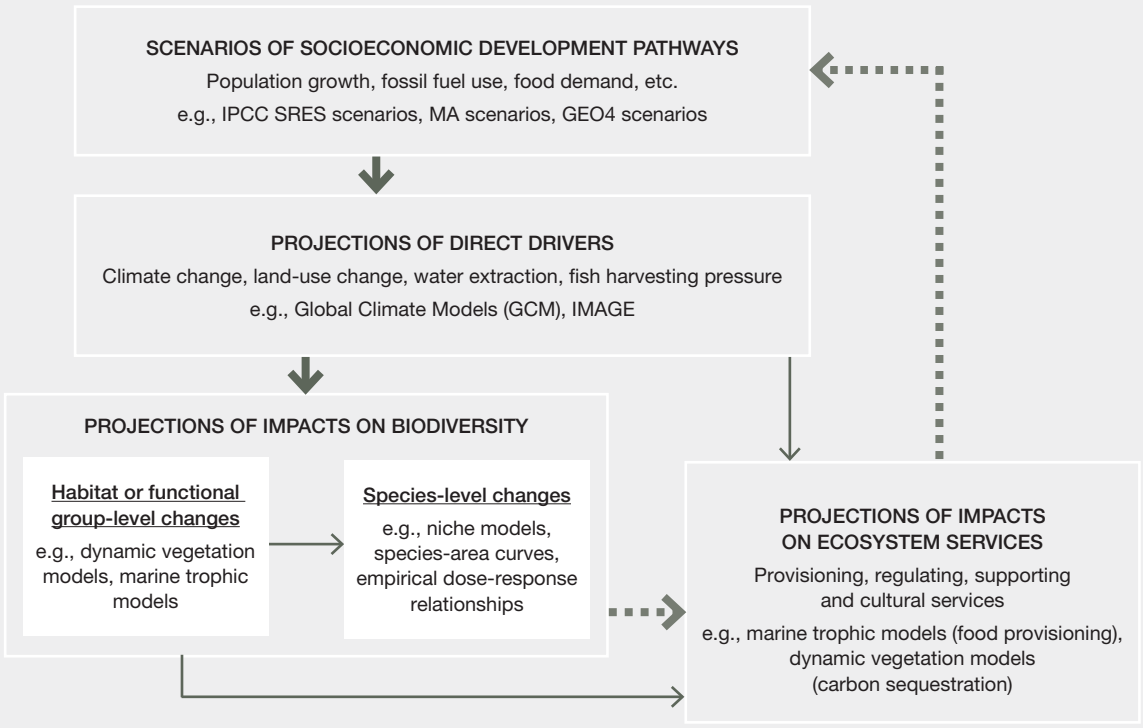
There are a number of methods and models commonly used for constructing biodiversity scenarios (Pereira *et al.*, 2010; **Figure 1.3**) and 'forward-looking' approaches (Leadley *et al.*, 2013). These include:

- Expectation (revealing plausible futures) versus desire (defining targets);
- Outlining the future (policymakers) versus fostering anticipatory learning to enable adaptive co-management (local community).

Assessments of status and trends are typically well understood by policymakers and stakeholders because they rely heavily on the analysis of observations. Looking into the future, however, is more complex because it relies on coupling scenarios of future socioeconomic development pathways with models of the impacts of future states of various direct and indirect drivers on biodiversity and ecosystem function and, in turn, nature's contributions to people underpinning human well-being. Assessments of the future of nature and nature's contributions to people are typically explicitly or implicitly built on three main components:

- Scenarios of socio-economic development (e.g., population growth, economic growth, per capita food consumption, greenhouse gas emissions) and policy options (e.g., reducing carbon emissions from deforestation and forest degradation, subsidies for bioenergy, etc.);
- Models projecting changes in direct drivers of biodiversity and ecosystem function (e.g., land-use change, fishing pressure, climate change, invasive alien species, nitrogen deposition, etc.);
- Models assessing the impacts of drivers and changes in biodiversity and ecosystem function on nature's

Figure 1 3 **Overview of methods and models commonly used for constructing biodiversity scenarios. Source: Pereira *et al.* (2010).**



contributions to people (e.g., ecosystem productivity, control of water quantity and quality, carbon storage, cultural values, etc.).

IPBES aims to match its scenarios carefully to the needs of particular policy or decision contexts, paying particular attention to (i) the choice of drivers or policy options that determine the appropriate types of scenarios (e.g., exploratory, target-seeking or policy screening); (ii) the impacts on nature and its contributions to people nature's that are of interest and that determine the types of models of impacts that should be mobilised; (iii) the diverse values that need to be addressed and that determine the appropriate methods for assessing those values; and (iv) the type of policy or decision-making processes that are being supported and that determine the suitability of different assessment or decision-support tools (e.g., multi-criteria analysis and management strategy evaluation).

The regional assessments make use of scenario archetypes – i.e., groups of futures which are deemed 'similar' for the purpose of a specific analysis (Boschetti *et al.*, 2016).

According to current large-scale models and scenarios, in both marine (Cheung *et al.*, 2009; Kaimuddin *et al.*, 2016) and terrestrial (Sekercioglu *et al.*, 2008) realms, climate change has already caused species and biomes poleward/upward/deepward range shifts. This trend is projected to continue and increase throughout the 21st century (Loarie *et al.*, 2009). Extinction rates are also expected to increase (Pimm *et al.*, 1995; Pimm *et al.*, 2014). Modelled projected shifts in the distributions of sub-Saharan Africa's entire breeding avifauna by Hole *et al.* (2009), showed, however, that species turnover across the continent's Important bird area network is likely to vary regionally and will be substantial at many sites. Identifying and protecting these important natural resources under threat from the effects of global climate change will play a key role in mitigating the worst impacts of climate change on biodiversity, as well as helping support human adaptation. The authors of this report emphasise, however, that the protection of these resources will only be achieved if those who live in and depend on these resources are given the power to decide how these resources are managed. Chapter 5 explores this issue further as well as issues related to other drivers and to ecosystem services scenarios (see MA, 2005) for an overview of ecosystem services). Chapter 5 focusses on studies in Africa, and on their implications for human well-being and society, or for future interactions between nature and society using a range of scenario types.

1.2.4 IPBES terrestrial and aquatic units of analysis

The subdivision of the Earth's surface into units for the purpose of analysis is notoriously controversial and there is no single agreed perfect system that IPBES can adopt as its standard. IPBES has consulted widely among the MEP and the experts contributing to the IPBES assessments to arrive at the classification below. This system serves as a framework for comparisons within and between assessments and represents a pragmatic solution, which may evolve as the work of IPBES develops. Note that we describe these as the 'IPBES terrestrial and aquatic units of analysis.' They serve the purposes of IPBES, and are not intended to be prescriptive for other purposes. Note also that the word 'aquatic' is used here to include both marine and freshwater units **(Table 1.2)**.

Table 1 2 **The IPBES terrestrial and aquatic units of analysis including some examples for Africa.**

UNITS AT GLOBAL LEVEL		UNITS AND EXAMPLES IN THE AFRICA REGION				
TERRESTRIAL	Type	Subregion				
		East Africa & adjacent islands	Southern Africa	Central Africa	North Africa	West Africa
1. Tropical & subtropical dry and humid forests		Afromontane forests (Ethiopia, Kenya, Tanzania & Uganda), Madagascar	Zambia, South Africa	DRC, Congo, Gabon, Cameroon, Equatorial Guinea, Central African Republic		Guinea, Cape Verde Islands
2. Temperate & boreal forests and woodlands						
3. Mediterranean forests, woodlands and scrub					Morocco, Algeria and Tunisia, Atlas Mountain	

Table 1 2

UNITS AT GLOBAL LEVEL		UNITS AND EXAMPLES IN THE AFRICA REGION				
TERRESTRIAL	Type	Subregion				
		East Africa & adjacent islands	Southern Africa	Central Africa	North Africa	West Africa
4. Tundra and High mountain habitats	High mountain forest	No data	Southern African Great Escarpment and the Cape Fold Mountains	Congo (Ngaliema/ Mount Stanley and Mount Emin), Angola, DRC	North African mountains (Atlas and Rift Mountain)	Niger, Sao Tome & Principe, Senegal, Niger, Gambia
5. Tropical and subtropical savannas and grasslands	Savannas and grasslands	Somalia and Tanzania	South Africa, Zimbabwe	Congo wetlands to Cameroon highlands, Central African Republic, DRC	Morocco, Libya, Algeria, Tunisia, Egypt, Sudan	Burkina Faso, Mali, Niger, Senegal
6. Temperate Grasslands						
7. Drylands and Deserts		Somalia, Madagascar, Eritrean coastal desert	South Africa (Succulent Karoo, Namib desert, Nama Karoo and the Kalahari)	Central African Republic (Chad)	Morocco, Libya, Algeria, Tunisia, Egypt, Sudan	Chad, Mali, Mauritania, Niger, Benin, Gambia, Ghana, Nigeria, Senegal, Sahelian zones
8. Cultivated areas (e.g. cropping, intensive livestock farming)		No data	No data	No data	No specific data	No data
9. Urban/Semi-urban		Dar es Salaam (Tanzania), Addis Ababa (Ethiopia), Nairobi (Kenya), Kampala (Uganda)	Johannesburg (South Africa), Luanda (Angola)	Central African Republic, Kinshasa (Tanzania)	Cairo (Egypt)	Guinea, Nigeria
10. Wetlands – peatlands, mires and bogs	6. Wetlands	Tanzania, Kenya, Somalia	Mozambique Angola South Africa	Central Congo Basin, Central Africa, Gabon	Morocco, Sudan, Tunisia, Egypt	Senegal River, Niger delta
11. Cryosphere						
12. Aquaculture areas						
13. Inland surface waters and water bodies /freshwater	7. Inland surface waters and water bodies/ freshwater	Lake Victoria, Lake Tanganyika, Malawi, Zambesi River, Jordan River	Zambia and Zimbabwe, South Africa, Botswana	Central African Republic, Equatorial Guinea, DRC	Sudan	Lake Gambia, Lake Volta, Senegal River, Lake Chad, Niger, Mali
14. Shelf ecosystems (neritic and intertidal/ littoral zone)	8. Shelf ecosystems	Madagascar, Tanzania, Zanzibar, Seychelles, Mayotte, Kenya, Somalia	Angola, Tanzania, Mozambique, South Africa	Nigeria, Cameroon, Gabon, Ghana, Congo, Angola	Sudan, Mauritania, Senegal delta and river	Guinea-Bissau and Nigeria, Senegal to the Niger Delta (mangroves), Ghana, Liberia
15. Open ocean pelagic systems	9. Ocean pelagic systems	Kenya, Tanzania, Seychelles	Tanzania, Mozambique, South Africa	Central African Republic	No data	Guinea
16. Deep-Sea	10. Deep-Sea	West Indian Ocean, Eritrea	No data	Congo, Angola	No data	Exists, but no data
17. Coastal areas intensively used by humans						

1.2.5 Addressing data gaps and uncertainties

A range of factors explains why gaps exist in knowledge, information and data (Geijzendorffer *et al.*, 2016; Meyer *et al.*, 2015). In the Africa assessment, data and knowledge gaps are particularly critical due to the considerable size of the informal economy and the weak statistical basis in a number of countries. A few years ago, the World Bank's chief economist for Africa referred to this as "Africa's statistical tragedy" (Devarajan, 2013).

A number of factors have been identified that may provide proxy indicators about the completeness of biodiversity datasets. However, proxies only provide rough approximations, and the completeness of information about biodiversity at different spatial scales must be considered (Soberón *et al.*, 2007). Although there is a strong emphasis on and promotion of peer-reviewed biodiversity data (Costello *et al.*, 2013) to overcome concerns on data quality, there is also a serious limit on the quantity of such published resources for this particular region. In addition, biodiversity and ecosystem services relevant data go well beyond biodiversity data to address a whole range of thematic domains with their own data issues. This serves as a source of uncertainty regarding the data on which to act upon, adding to the inherent uncertainty of complex social-ecological systems in Africa.

The use of rigorous quantitative methods to estimate uncertainty is rarely possible; but, whenever possible, authors have sought to assign confidence terms reflecting the degree of estimated scientific consensus on a particular question. The predictions made in this assessment are based upon a range of different scenarios and wherever possible, outcomes are expressed in terms of ranges, rather than giving precise figures, so that uncertainty may be reflected in an appropriate manner. This should not, however, prevent early action, particularly when different thresholds for critical tipping points have been identified.

Facing the uneven distribution of data and information, this report provides an assessment of gaps and systematically prioritises research to address the gaps associated with each element of the IPBES assessment framework. These are elaborated in the individual chapters and summarised in the executive summary. The knowledge gaps will then help to inform strategic planning of future research activities, including identifying appropriate funding mechanisms and support programmes. From a long-term perspective, an important product of the assessment would be the establishment of an Africa region research agenda that clearly articulates gaps and set priorities for addressing them. This would allow governments, in linkage with the IPBES platform and the wider scientific community to strategically decide where to put more efforts to generate the knowledge base needed for evidence-based development policies fully integrating nature's beneficial contributions to society.

1.2.6 Stakeholder linkages: who will benefit?

Societies, as IPBES guidelines indicate, are faced with threats to long-term human well-being from the loss of biodiversity and degradation of ecosystem services. The global community, in its effort to reverse this trend, has developed a number of conservation and sustainable use strategies of biodiversity commonly referred to as blueprints. Outcomes from the implementation of these blueprints have, in some cases, fallen short of expectations (see **Box 1.3** for examples of blueprints).

One of the hidden pitfalls of blueprints is their inability to address the uncertainty and surprise that characterises complex social-ecological systems (Gunderson *et al.*, 2002). They cannot, in themselves, fully integrate the interests and dynamic interplay of diverse actors and stakeholders at various scales of significance. A range of participatory approaches and platforms developed over the years need to be mobilised so as to fully involve biodiversity and ecosystem services stakeholders in the design and adaptive implementation of these blueprints. Secondly, to effectively play their roles, some of these stakeholders must be empowered and their capacities strengthened. This will help knowledge flow and co-creation of solutions on the basis of

Box 1 3 **Examples of blueprints.**

Examples at the international level include:
The Strategic Plan for Biodiversity 2011–2020 and its Aichi Targets prepared under the auspices of the Convention on Biological Diversity, the 10-year strategic plan and framework (2008–2018) of the United Nations Convention to Combat Desertification (UNCCD), and the development by the UN General Assembly of the post-2015 Development Agenda and a set of sustainable development goals (SDGs).

Examples at regional and subregional levels include:
The Lake Chad Basin Commission, the Nile Basin Commission, the Central Africa Forest Commission (COMIFAC), etc.

Examples at the national level include:
Forest and environmental management policies and their decrees of application in many countries around Africa.

Examples at the local and community levels:
Not evident

shared understandings. Thirdly, there is a need to recognise where stakeholders might be marginalised and left out of planning and decision-making due to their political leanings, cultural characteristics and levels of education. This is important because stakeholders could be left out of planning and decision-making but not of the actual use or abuse of resources. Fourthly, some of the stakeholder's indigenous and local knowledge systems, particularly in Africa, have large, untapped potential for new ideas and solutions, not only in planning and decision-making but also in the actual process of creating a sustainable, ecologically grounded future.

Given IPBES's commitment to stakeholder engagement, each chapter in this assessment has given due consideration to stakeholder identification, analysis, linkages, mapping and engagement. Such thinking has afforded answers to the questions identified in **Box 1.4**.

The IPBES Africa regional assessment is the first of its kind in Africa. Previously, a subregional assessment was undertaken for southern Africa in the context of the Millennium Ecosystem Assessment. There have, however, been several publications focusing on Africa's biodiversity from the United Nations Environment Programme (UNEP) and a range of other organisations, as well as a report on the State of Biodiversity in Africa, which documents progress on implementation of the Aichi Biodiversity Targets. This assessment will identify key priorities that will help African governments and institutions to develop responses and policy solutions that meet the specific needs of the Africa region as a whole, as well as the five subregions and their national constituents. The knowledge produced has policy implications to assist African efforts to meet the conservation goals set out in the Aichi Biodiversity Targets as well as the Sustainable Development Goals and the African Aspirations for 2063. The knowledge and recommendations produced in this assessment will also be important sources of information for other stakeholders, including the private sector, concerned with the state of biodiversity in Africa and its sustainable future. Interested civil society organisations, such as non-governmental organisations, the media and individuals, may also find the document a useful source of information linking Africa's biodiversity and ecosystem services to human well-being.

Box 1 4 Consideration of stakeholders in the IPBES Africa regional assessment.

Who is a stakeholder?
They are actors, key players (persons or organisations) who have a vested interest in the formulation of policies and the use of biodiversity and ecosystem services for their well-being. These stakeholders or "interested parties" can be grouped into the following categories: international, public, national political, commercial/private, nongovernmental organization /civil society, labour, and users/ consumers just to name a few. On one level, the remit of IPBES means that everyone is a stakeholder, including future generations.

What forms of stakeholder analysis are used?
Stakeholder analysis refers to the systematically gathering and analysing of qualitative information to determine whose interests should be taken into account when developing and/ or implementing a policy or program on biodiversity and sustainable use of biodiversity and ecosystem services.

Which stakeholder characteristics need to be analysed?
Characteristics such as knowledge of policies on biodiversity and ecosystem services, interests related to the policy on biodiversity use and well-being, position for or against the policy on sustainable use and biodiversity conservation, potential alliances with other stakeholders, and ability to affect the policy implementation process (through their power and leadership) are analysed.

What are the steps in stakeholder analysis?
The following are the major steps in the process: Planning the process, Selecting and defining a policy, Identifying key stakeholders, adapting the tools, collecting and recording the information, filling in the stakeholder table, analysing the stakeholder table, using the information.

Why is this analysis useful to IPBES?
Knowing who the key actors are, their knowledge, interests, positions, alliances, and importance related to the policy on biodiversity, ecosystem services and sustainable use, allows IPBES to interact more effectively with policy makers, key stakeholders and increase their support for the implementation of given policy options on biodiversity and ecosystem services.

What is stakeholder mapping?
Stakeholder mapping is a collaborative process of research, debate, and discussion that draws from multiple perspectives to determine a key list of stakeholders across the entire stakeholder spectrum. Mapping can be broken down into four phases.

1. **Identifying:** listing to relevant groups, organizations, and people;
2. **Analysing:** understanding stakeholder perspectives and interests;
3. **Mapping:** visualizing relationships and links to objectives and other stakeholders; and
4. **Prioritising:** ranking stakeholder relevance and identifying issues.

Stakeholder mapping and analysis involves an understanding of key actors and agencies, their networks and capacities, information flows and barriers to action.

1.3 PRIORITY ISSUES IN BIODIVERSITY AND ECOSYSTEM SERVICES POLICY AND MANAGEMENT INTERVENTIONS IN AFRICA

This first assessment of biodiversity and ecosystem services in Africa is taking place at a critical juncture in Africa's history. From a remarkably desolate state at the beginning of the 1990s, Africa began an economic recovery at the end of that decade. By 2010, albeit with important differences between countries, it had become the second fastest growing economy and a prime destination for Foreign Direct Investments and other financial flows. The latter include remittances that now surpass foreign aid to the region (Bodomo, 2013). Such growth has been widespread across sectors, including in services, natural resources, and agriculture (Roxburgh *et al.*, 2010). At the same time, Africa was considered the only region that emerged from the Millennium Development Goals with increasing extreme poverty (Asongu, 2015; World Bank, 2016). In 2010, half of its population was living under the extreme poverty line of $1.25 per day (UN, 2013). The related conclusions are, however, contested by certain recent studies. These studies estimate that during the Millennium Development Goals period, Africa actually reduced its income inequality and its poverty (Pinkovskiy *et al.*, 2014) and outperformed the world average of 39% with respect to reducing the proportion of the population with incomes below $1 a day (Fukuda-Parr *et al.*, 2013). This controversy and related observations underscore Africa's current scientific and development challenges, including the critical role that dynamic knowledge of biodiversity and ecosystem services must play in overcoming them.

As mentioned earlier, Africa has abundant biodiversity, arable land, and richly diversified ecosystems. These serve as essential building blocks of sustainable development. African countries are, in general, matching the global trends in achieving Aichi Biodiversity Targets (UNEP-WCMC, 2016). This is despite the fact that there is an ongoing loss of biodiversity in Africa due to anthropogenic factors in addition to the negative impact of climate change that intensifies the impact of pressures. It is reported to the Convention on Biological Diversity that over 80% of African countries have made progress towards Aichi Biodiversity Target 17, i.e., updating their National Biodiversity and Strategic Action Plans. There is, however, a need to transfer the National Biodiversity Strategies and Action Plans into actions and use them as policy instruments (see Chapter 6). There is also a lack of consistent biodiversity indicators to evaluate conservation requirements and progress in National Biodiversity Strategies and Action Plans, a situation which is, in part, related to financial constraints.

Looking forward, this assessment thus takes into account the essential need for African policymakers to gain first-rate understanding of biodiversity and ecosystem services and, thus, to fully integrate them as assets into Africa's growth and transformation plans. Biodiversity and ecosystem services and policies should thus mutually affect each other in a way that ensures the creation of more benefits and fewer losses now and for future generations. To sustain its growth under conditions of climate change and increased pressure on natural resources, the continent needs to better understand and harness its biodiversity and ecosystem services potential in order to innovatively meet the demand of its population and nascent industries. In turn, the growth and transformation paths that it chooses will affect biodiversity and ecosystem services trends under different future scenarios, which will be discussed in Chapters 4 and 5 (see also SPM sections B and D). Africa has not yet achieved its structural transformation; thus, the direction and forms of this impact remain uncertain due to sharply contrasting predictions of future economic development. Important differences are also emerging within countries, between countries, groups of countries and regional blocs (Diaw, 2014), which may lead to diverse configurations of biodiversity and ecosystem services and economic development across the continent.

This section presents an overarching description and an initial assessment of the priority issues concerning biodiversity and ecosystem services in Africa. They are organised into nine clusters of thematic foci previously outlined by the scoping document for the Africa Regional Assessment (IPBES_3_6_Add.2):

- The first three – gender, indigenous and local knowledge, and climate change (1.3.1 to 1.3.3) – are cross-cutting themes that are relevant to most, if not all, the other themes discussed in the section.

- This is followed (in 1.3.4) by a presentation on food, water and energy as a nexus of interrelated biodiversity and ecosystem services issues. All are tightly linked to agriculture, as well as agro-pastoral and renewable natural resource domains, such as forestry, agroforestry and fisheries. All are critically important to biodiversity and ecosystem services. Key thematic foci concerning invasive species (1.3.5) and marine and terrestrial habitats degradation and restoration (1.3.6) complete the presentation of this central node of questions for livelihoods and environmental health in Africa.

- Population, poverty and health (in 1.3.7) is the fourth major cluster of issues that the section addresses in a

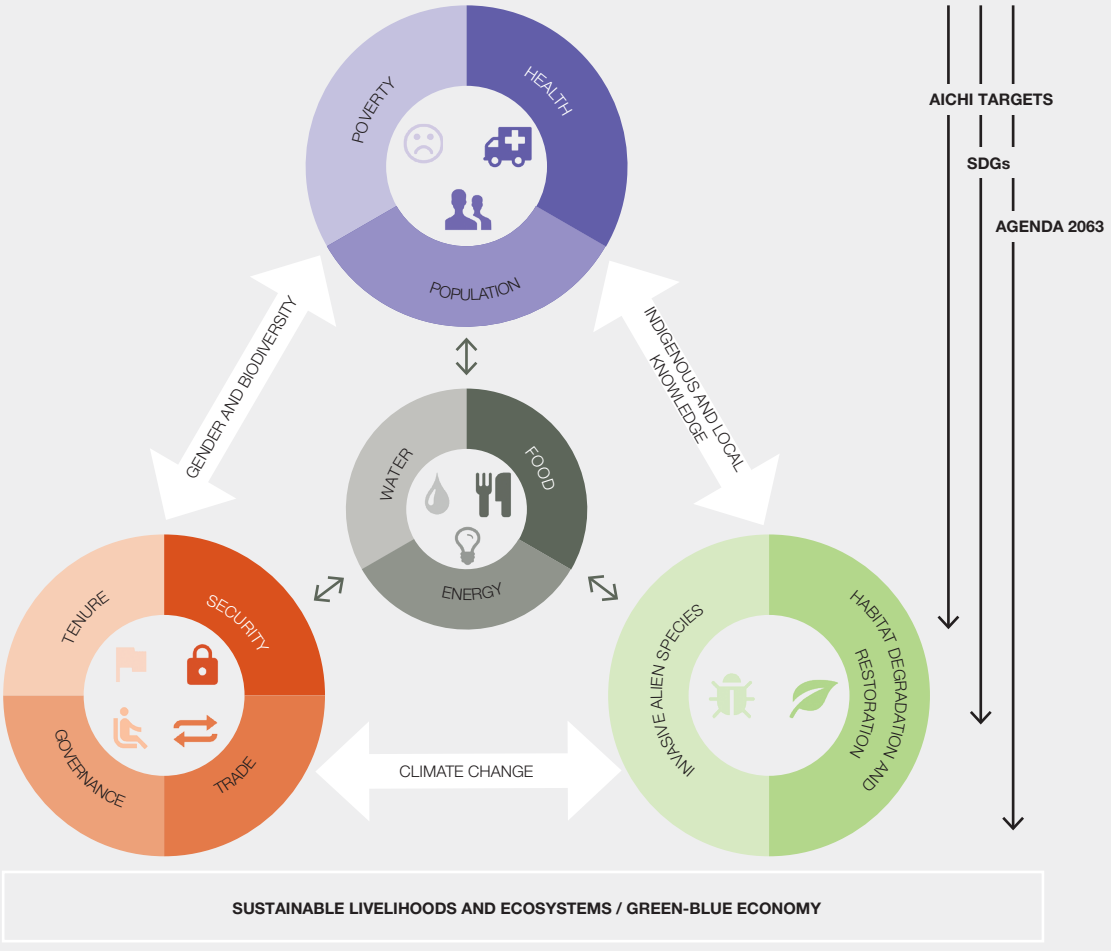
way that emphasises their interrelations both as causal factors and partial outcomes of environmental health and environmental processes.

- Essential to the present state and to the future of biodiversity and ecosystem services, tenure and governance are then presented, in order to provide preliminary insights into the policy and management interventions that will be required in the context of this assessment and in relation to issues of peace, security and trade (1.3.8)
- This review of issues ends (1.3.9) with an overview of sustainable use challenges in a context of transition toward green-blue models of economic development more reliant on nature and on the many goods, services and wider beneficial contributions that can be drawn from it.

Figure 1.4, below, graphically illustrates this broad articulation of thematic issues. It is an indicative rather than exhaustive figure, solely meant to set the scene and guide the reader through the complex set of themes and

Figure 1 4 **Nature's contributions to people in Africa is related to complex social-ecological, economic and political challenges that are interrelated and, at times, nested into each other.**

Things happening in one area of policy have repercussions on, or implications for, other areas. This is why each of the illustrated issues can potentially be considered both as entry points for, and outcomes of public policies. For instance, interrelated water, food and energy issues are influenced by, and impact on, population, poverty, and health, which in turn show mutual influences with governance, trade and tenure. In parts of Africa, problems related for instance, to land tenure and access to natural resources are known to have spilled into grave problems of peace and security, severely affecting biodiversity and ecosystem services to people. This is amplified by climate change that impacts all of these factors and future economic options. Indigenous and local knowledge and the role of women and gender relations have proved to be essential to understanding these interrelated challenges and to addressing them positively. These roles and mutual influences will be essential to the development of sustainable trajectories for livelihoods and ecosystems and to ecological gains in the social transformation of the African economy, an underlying goal of Africa's major international commitments, including Agenda 2063, the SDGs and the Aichi biodiversity targets.



interactions addressed in the section. These elements should be viewed separately with their interrelations and cross-sector connections. They are addressed in more detail from Chapter 2 through to Chapter 6, in this assessment.

1.3.1 Gender and biodiversity

Biodiversity, as indicated earlier, represents a cornerstone for many indigenous and local communities, in particular women and vulnerable groups. It can provide them with multiple benefits, can support their needs, work, value systems, and is a potential asset in their economic future. Direct connection with land is an essential concern for indigenous and local communities who, for centuries, have collected firewood and other bush products for food, medicine, cosmetic use and building material. Natural resources play a key role in enhancing many communities' livelihood and subsistence (UNEP, 1999).

In order to fully understand the interactions of people with biodiversity and ecosystems services in Africa, these must be seen through the lens of gender, culture and social relations, while at the same time considering the social roles and power relations between both men and women. Gender analysts have reiterated the fact that men and women often manage, utilise and organise natural and agricultural resources differently, with consequent impacts on biodiversity and ecosystem services and the management thereof in Africa.

Women have developed a distinctive relationship with biodiversity and they often play the predominant role as users and guardians of biodiversity – as plant collectors, family gardeners, plant domesticators, herbalists and seed guardians. For example, in Sierra Leone, women were found to be able to name nearly four times as many uses of trees compared to men (Sasvari *et al.*, 2010).

1.3.2 Indigenous and Local Knowledge (ILK)

Indigenous and local knowledge and practices (ILKP) systems are considered by IPBES to be dynamic bodies of social-ecological knowledge, practices and beliefs about the relationship of living beings, including humans, with one another and with their environment. ILKP is highly diverse, produced in a collective manner and reproduced at the interface between the diversity of ecosystems and human cultural systems. It is continuously evolving through the interaction of experiences and different types of knowledge (written, oral, tacit, practical, and scientific) among indigenous peoples and local communities. IPBES is developing guidance for the integration of ILKP into its assessments that respects not only the diversity and value of ILKP, but also the rights of indigenous and local communities to share in the benefits of knowledge gained from the assessments. IPBES integrates ILKP into its assessments through the appointment of experts to conduct and review assessments (Annex to IPBES/4/7).

The value of ILK is becoming recognised by scientists and policymakers, and is an evolving subject in national and international law (Mauro *et al.*, 2000 in Abdel Rahman, 2009). The UN and similar agencies have acknowledged the rights of indigenous people to be recognised and the right of their knowledge to be respected as any other form of knowledge, including scientific knowledge (Abdel Rahman, 2009). The potential contribution of ILK in traditional ecological knowledge and social-ecological studies has gained growing attention in the context of accelerated global change and generalized ecosystem service decline. Scholars assert that indigenous and local cultures are not adequately analysed, and yet they are more environmentally embedded than knowledge in modern society (Gómez-Baggethun *et al.*, 2013). ILK's role has been highlighted by the CBD in article 8(j), section 1.3.5. *"where it states that all parties subject to national legislation, shall respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity, all relevant parties shall promote ILK's wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices"* (UN, 1992). Indigenous knowledge systems are based on cognitive understandings and interpretations of the social and physical/spiritual world (Dei, 2000).

"Indigenous people and their communities represent a significant percentage of the global population. They have developed over many generations a holistic traditional scientific knowledge of their land, natural resources and environments"
(UNCED, 1992)

Despite the fact that ILK is relatively new to climate science, it has long been known as a major basis of perception and information in various fields such as agroforestry, traditional medicine, biodiversity conservation, customary resource management, impact assessment and natural disaster preparedness and response (Raygorodetsky, 2011). Indigenous/local people, who have developed rich knowledge over the centuries, could be negatively influenced by other modern cultures if this traditional knowledge disappears (World Bank, 1998). This will also negatively affect sustainable development prospects in Africa.

1.3.3 Climate change

In his foreword to the "Guidebook – Addressing Climate Change Challenges in Africa: A Practical Guide towards Sustainable Development" (AMCEN, 2011), Sangare, highlighted that *"There is a consensus among scientists, policy makers and development practitioners that climate change poses complex challenges to the development of countries in Africa"*. Recent scientific information published since the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report confirms that the world is on course for levels of warming that will be catastrophic, especially for Africa, where these impacts are combined with "poverty, poor policy and institutional framework". West Africa, and particularly Sahel and the Horn of Africa would be particularly affected by desertification and droughts linked to climate change (Beg *et al.*, 2002; Gan *et al.*, 2016), despite the overall re-greening of the Sahel that was observed by remote sensing since the drought of the 1980s (Hiernaux *et al.*, 2016). Along the northern coast of Africa, changing climate conditions and accelerating sea level rise will intensify the stress on many coastal zones, coastal cities, lagoons, wetlands and deltas (El-Nahry *et al.*, 2009; Kilroy, 2015) (see Chapter 4, section 4.2.2.2).

The IPCC 5th Assessment report confirmed that climate change serves as the ultimate threat multiplier to the pressures already experienced by various sectors, and is likely to have widespread impacts on human and natural systems (IPCC, 2014). Major challenges affecting ecosystems on the African continent, based upon the IPCC report, were summarised by the Climate and Development Knowledge Network (CDKN, 2014), and are illustrated in **Figures 1.5 and 1.6.**

Climate change affects virtually all the priority issues addressed in this section (see also Chapter 4, section 4.2.2.2). This, of course, includes the critical sector of water. For example, as mentioned with regard to the Nile river basin in the following subsection, the struggle to control dwindling water resources can lead to conflict. The challenge will be to provide water resources for future populations and manage climate and water-related diseases, land degradation, crop failures and diminished yields and their impact on food security, energy and livelihoods. Poverty and human well-being may be substantially affected. Poverty is, of course, a central issue in terms of how climate change affects both people and ecosystems by restricting adaptive capacity and enhancing vulnerability over the longer term. Humans, animals and plants may be pushed out of water-stressed areas and thus become displaced (see Chapter 4). Where people cannot move, they are forced to cope however they can. The adverse effects of climate change in Africa may include (but are not limited to) reduced crop production and diversity, regime shifts in the African ecosystem, worsening of food security, the increased incidence of flooding and droughts, spreading disease and an increased risk of conflict over scarce land and water resources (World Bank, 2012a). Climate change impacts are transmitted through a complex array of mechanisms. The effects on individual countries and cross-countries ecological zones are mediated by specific social, economic and environmental circumstances.

It is important to note, however, that there are also indigenous strategies for resource management, which should, with the right support, play an important role in adaptation. A critical role for this Assessment, as well as the IPBES process, is to help identify such strategies and to enable knowledge exchanges between different communities; and well as considering circumstances under which such strategies may be best enabled and supported. People's adaptive practices may also be informative as to what changes are taking place and how biodiversity and ecosystem services are affected (see, for example, the IPBES Assessment Report on Pollinators, Pollination and Food Production; IPBES, 2016c). Climate change may also, under certain circumstances, be beneficial and present opportunities – and such opportunities require identification. Indigenous and local communities, whose livelihoods highly depend on environmental conditions, have developed detailed knowledge of climate phenomena and influences through repeated observations transmitted over generations. This allowed them to develop adaptive strategies to deal with climate variation and risk (Gemedo-Dalle *et al.*, 2006). Many communities have already recognised the effects of climate change and their current livelihood strategies are increasingly climate independent (Nielsen *et al.*, 2010a, 2010b). For thousands of African farmers, who are abandoning farming and leaving rural areas because of low yields due to increasing droughts, the tipping point for climate change adaptation may already have passed.

1.3.4 The Food, Water and Energy Nexus

Africa's increasing population (see 1.3.7) is leading to a growing demand for, and consumption of natural resources, collectively resulting in land-use change as agricultural expansion into natural habitats takes place. What makes the situation all the more paradoxical is that Africa is also a major supplier of food to the rest of the world. While the demand for food, water and energy is steadily growing, the resources required to meet it are, in a number of cases, dwindling (Rockström *et al.*, 2009; State of the Planet Declaration, 2012). The interdependencies amongst water, food and energy – represented by the food-water-energy nexus concept (Hoff, 2011; Hussey *et al.*, 2012; Marsh *et al.*, 2007) – are numerous and complex. The following sections provide an overview of

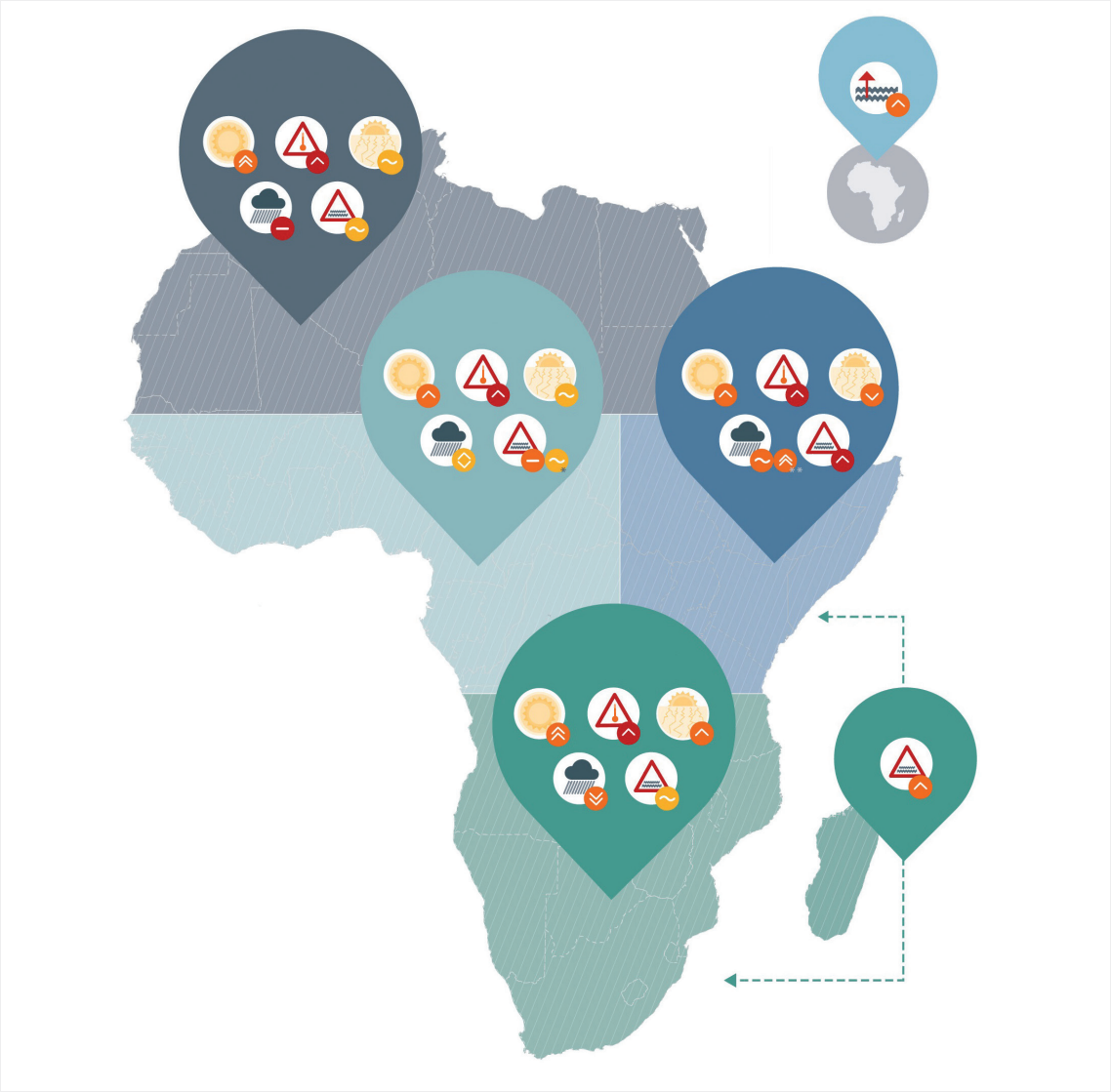
Figure 1 5 The IPCC 5th Assessment Report summary of impacts of climate change in Africa. Sources: CDKN (2014); IPCC (2014).

some of these in terms of how they affect biodiversity and ecosystem contributions in the context of Africa.

1.3.4.1 Meeting Africa's demand for food: Agriculture and African food systems

Africa arable land is estimated at 8.07 million km^2 (27% of Africa's landmass), of which only about 1.97 million km^2 is under cultivation (UNEP, 2016). This amounts to around 60% of the world's uncultivated arable land (Roxburgh *et al.*, 2010; APP, 2014). Yet, its agriculture does not presently feed all the population and it has to resort to increasing food imports. According to the Africa Progress Report (APP, 2014), the region, which used to be a net exporter of food in the 1990s, now foots an import bill worth $35 billion per year for rice alone. As a whole, sub-Saharan Africa today exports less than Thailand, and the continent exploits less than 1.5% of the 240 million hectares suitable for rice cultivation. In addition, Africa makes less use of improved seeds and fertilisers than any other region, and its soils are literally mined as a result: "An estimated 8 million tons

Figure 16 **The IPCC 5th Assessment Report summary of future climate trends for Africa. Sources: CDKN (2014); IPCC (2014).**



Climatic factors

Average temperature | Extreme temperature | Drought | Average rainfall | Extreme rainfall | Sea-level rise

SYMBOL	RAINFALL	TEMPERATURE	EXTREME RAINFALL, EXTREME TEMPERATURE, SEA-LEVEL RISE
	up to 30% increasing trend	1-6°C increasing trend	–
	up to 10% increasing trend	1-4.5°C increasing trend	increasing trend
	both increasing and decreasing trends	–	both increasing and decreasing trends
	up to 10% decreasing trend	–	decreasing trend
	up to 30% decreasing trend	–	–
	inconsistent trend	inconsistent trend	inconsistent trend
	no or only slight change	inconsistent trend	inconsistent trend

Levels of confidence in findings

High confidence | Medium confidence | Low confidence

of nutrients are depleted every year in Africa" (APP, 2014). As indicated earlier, African agriculture has faced multiple challenges, ranging from low productivity to poor or non-existent markets and infrastructure. There has been a decline in the production of major cereal crops over the past four years, which has been attributed to low input usage, declining soil fertility, erratic climatic conditions and low government funding of development efforts in the sector. A key question, therefore (amongst others), is how Africa is going to address these issues of soil fertility and productivity of its agriculture in the coming years (the timeframe of the Sustainable Development Goals).

Biotechnology, in the form of genetically modified crops, was advanced for years as a possible response to low agricultural productivity in Africa. It is claimed, for instance, that since Bt-maize was introduced into South Africa in 2003, it has reduced losses of maize incurred through damage by stem borers. Bt-maize is corn that is genetically modified to express one or more proteins from *Bacillus thuringiensis*, a soil bacterium; protein poisonous to certain insect pests. Genetically modified organisms, however, face much opposition. Key among the perceived threats are the incomplete local knowledge and control of the technology, the loss of food sovereignty through proprietary technology of multinational corporations, and the potential for irreparable damage to African indigenous seeds (African Centre for Biodiversity, 2017). For example, Burkina Faso's recent decision in early 2016 to completely phase out production of Monsanto's genetically modified Bt cotton was caused by the deterioration of the quality of its cotton and is likely to become a case study in the genetic modification policy debate in Africa. Burkina Faso was a top world producer of high-quality cotton in 2003, when it started experimenting with Bt cotton. Monsanto's genetically modified cotton seed was producing higher yields and had passed all field trials. The transgenic seed was launched on a large scale in 2007 and, within two years, had taken over 80% of the country's cotton crop, with tens of thousands of people economically dependent on its production. The economic boom was, however, short-lived. With a deteriorating quality, the country's cotton ceased to be economically viable in the marketplace, which led to the reversal of Burkina Faso's genetically modified organisms' policy.

Other approaches do exist and can help tackle the dual challenge of productivity and ecology in Africa. Agriculture captures more than 70% of all water used globally (WWAP, 2016) and further affects the water sector through land degradation, changes in runoff, and disruption of groundwater discharge (Alauddin *et al.*, 2008). Sustainable agricultural management based on indigenous local knowledge (ILK) and local practices, and interventions designed to prevent land degradation and to save water and energy are thus particularly important. These can help increase groundwater recharge and water storage in the soil, as well as reduce the use of energy-intensive fertilisers. Ecological intensification of agriculture, which relies solely on natural processes, including biomass, indigenous microorganisms and symbiotic microorganisms, is another alternative to chemical fertilisers and pesticides, which are known for their long-term negative impacts on soil biodiversity, environment, and human health (Matson *et al.*, 1997; FAO, 2007a; Barreiro-Hurlé, 2012).

Bio-fertilisers based on such natural processes have been successfully tested in West and Central Africa (Sene *et al.*, 2012; Ngonkeu *et al.*, 2013), although their considerable market potential is still largely unknown and underdeveloped on the continent. This ecological smart agriculture has been associated with eco-agriculture and large-scale approaches such as Integrated Landscape Management (ILM). ILM is an increasingly popular set of approaches that seek to address complex people-food-climate-biodiversity and ecosystem issues in an integrated manner and through long-term cooperation of land managers and stakeholders (LPFN, 2015).

Closely linked to, and sometimes in competition with agriculture, extensive pastoral production is practised on 25% of the global land area, from the drylands of Africa (66% of the total continental land area) and the Arabian Peninsula to the highlands of Asia and Latin America. It provides 10% of the world's meat production and supports some 200 million pastoral households who raise nearly 1 billion head of camel, cattle and smaller livestock, about a third of which are found in sub-Saharan Africa.

Statistics from the African Union's policy framework for pastoralism show that there are 268 million pastoralists. They live and move on 43% of Africa's landmass, and contribute between 10 and 44% of the GDP in the countries where they reside (AU, 2010). Pastoralism is faced with important challenges related to population growth and the resulting shrinking and fragmentation of land; related conflicts over resources; security of pastoral livestock assets; climate change; as well as food price increases and financial crises. However, its potential for reducing poverty; generating economic growth; managing the environment; promoting sustainable development; and building climate resilience, is considerable. A study by the International Institute for Environment and Development (Hesse, 2014) shows that pastoralists who feed their animals solely on natural dryland pastures can achieve rates of productivity as high as on modern farms. Pastoralism has such potential because it relies on ILK built through generations of practice and living in specific environments. Pastoralism has been a livelihood in many areas for millennia and, through these practices, has contributed to shaping present ecosystems (see for example Gemedo-Dalle *et al.*, 2005, on Borana pastoralists).

1.3.4.1.1 Forest and agroforestry systems

Forests in Africa are major providers of food and energy on the continent, and they play a crucial role in conserving biodiversity, mitigating climate and maintaining functional ecosystems. Africa is home to 17% of the world's natural forests (675 million hectares), yet, it makes only contributes 2.8% of the value-add of forests globally (FAO, 2014a). The Congo Basin, the second largest contiguous block of tropical rainforest, also contains tropical dry forests, representing nearly a third of Africa's natural forest areas. In addition, the continent contains 31% of the world's 'other wooded lands'. This represents a combined area of 350 million ha of savanna where "scattered tree growth is too sparse to be defined as forest but where the ecological and socioeconomic functions of trees are nonetheless important" (FAO, 2011).

Within these forested landscapes are also found agroforestry systems – that is, land-use management systems in which trees or shrubs are grown around or among crops or pastureland. Agroforestry lands are the most widespread agricultural system in sub-Saharan Africa (Boffa, 2000; Garrity 2010). They include semi-domestic woody species of trees and shrubs that are neither planted nor cultivated but are vitally important. A remarkable example is the commonly known shea tree (karité in French), *Vitellaria paradoxa*, probably the most economically and culturally important tree species in all the Sudanian belt (Boffa, 2015). That region is the sole supplier of shea to the growing international market fuelled by the chocolate and cosmetic industries; although shea is still produced and processed by smallholder farmers and entrepreneurs, many of them women.

The International Standard Industrial Classification of All Economic activities, revised and published by the UN Statistics Division, subsume forestry and fishing under agriculture and considers natural 'resources' only within the frame of extractive industries (mining and quarrying). That standard classification has sometimes hidden the potential and structural transformation needs of African forests. Currently, Africa is gaining limited economic benefits from its forests, while, this natural capital is being depleted by deforestation, large-scale land acquisitions and extensive infrastructure developments (Nelson *et al.*, 2006).

The majority of African populations (62.7% in sub-Saharan Africa, and 46.3% in North Africa in 2010) still live in rural areas (World Bank, 2012a). They are highly dependent on natural resources including fish, agroforestry, and forest products for their livelihoods. There are many cases across Africa that have demonstrated the role these resources play in providing various economic and social benefits, including improved dietary nutrition outcomes and economic and nutritional well-being (Brashares *et al.*, 2011; Golden *et al.*, 2011; Johnson *et al.*, 2013; Ickowitz *et al.*, 2014; Fa *et al.*, 2015; Rowland *et al.*, 2015). Promoting and restoring agro-forest landscapes and increasing forest cover (and the wild foods stored within) should be emphasised for the protection of biodiversity as well as livelihood security.

Most importantly, Africa is the only region that derives most of its forest timber value (65%) from primary forestry activities, such as logging and fuelwood collection. Other regions contribute 75% or more of their economic forestry value from high-value processing activities (Diaw, 2014; FAO, 2014a). In addition, Africa has a large and extraordinarily diversified pool of non-timber forest products (NTFPs). Unfortunately, African NTFPs value chains, though essential to the income and livelihood of millions of Africans and, indeed, to their very history and culture, are still vastly underreported and misunderstood (Diaw, 2015). Currently, the global income from NTFPs is estimated to be around $88 billion (FAO, 2014a), with Africa representing just 6% of the total. But those estimates are not only underestimated, they are also uniquely based on primary NTFPs production, ignoring the considerable potential for downstream NTFPs processing and value addition in food, beverage, additives, nutraceutical, cosmetic and aromatic value chains. Paradoxically, this also reduces the agriculture and market diversification possibilities that would come with domestication and commercialisation of agroforest species taken from the wild to sustain the new industries.

1.3.4.1.2 Marine fisheries

African waters are reputed for the abundance of their fishery resources. The different sectors operating throughout Africa target 643 taxonomic groups. Over 280 taxa are exploited in the Mediterranean coast of Africa alone, with a clear dominance of small pelagic species such as sardines (*Sardina pilchardus*, Least Concern), sardinellas (*Sardinella* spp.) and anchovies (*Engraulis encrasicolus*, Least Concern) (37%) (Belhabib *et al.*, 2016). Three of the 6 large marine ecosystems (LMEs) of Africa rank within the first four most productive LMEs in the world, with the Canary Current, the Benguela Current and the Somali Coastal current ranking 2nd, 3rd and 4th globally (Rosenberg *et al.*, 2014). Not surprisingly, the fisheries of Africa provide a source of livelihood for 8 million active fishers and their families (Teh *et al.*, 2013; Belhabib *et al.*, 2015a). If all catches were landed in Africa, African fisheries could contribute a landed value of $20 billion to national economies (Belhabib *et al.*, 2016), with an additional $3.6 billion injected by the small-scale fishing sectors across the value chain (Dyck *et al.*, 2010). Overall, in Africa, industrial fisheries are almost exclusively operated and controlled by foreign interests and their catches are rarely recorded. Monitoring efforts for the artisanal sector vary from good (based on comprehensive surveys) to non-existent. Subsistence and recreational fisheries are not monitored and in many cases, are simply assumed

to be marginal. The artisanal sector, whose landed value reached $4 billion in 2010, is in decline since 2004 along with the industrial sector's catch, despite an increasing fishing effort. Illegal fishing and intense under-reporting (52%) of the total catch are exacerbated by the lack of governance, high corruption, and little transparency on fishing agreements (Belhabib *et al.*, 2015b). However, positive patterns can be observed in community-based management successes, particularly through an increasing network of Marine Protected Areas, which currently covers 22% of Africa's inshore areas, as well as initiatives to combat illegal fishing such as Fish-i Africa (https://nfds.info/experience/fish-i-africa/) and Oceans Beyond Piracy (http://oceansbeyondpiracy.org/). In addition, aid that focuses on policy development should work hand in hand with communities to integrate all dimensions of traditional knowledge and management techniques. The 'South West Indian Ocean Fisheries Governance and Shared Growth Project' is implementing this strategy in several African countries (Tanzania, Zanzibar, Mauritius, Madagascar, Seychelles) in the South Western Indian Ocean, supported by the World Bank with $150 million based on the economy of high value local fisheries (World Bank, 2015b).

Unsustainable practices such as by-catch discarding are responsible for around 20% of catch loss. Catch rate declines (Belhabib *et al.*, 2012) indicate unsustainable levels of fishing. Indeed, of the 14 most targeted fish stocks, 10 are fully or overfished, including stocks of sardines, anchovies and other small pelagics (FAO, 2015). Increasing fishing subsidies and the effects of the Arab spring have impacted on fisheries as illegal fishing increased, particularly by boats from the EU and Korea targeting tunas and billfishes (Belhabib *et al.*, 2012). Many countries have also been affected by coup d'états, civil wars, and, more recently, epidemic outbreaks, which leaves the region highly exposed to illegal fishing, and constrains small-scale fisheries to grow in size and expand their geographic and time ranges (Belhabib *et al.*, 2015c). Increasing fishing range, and hence fuel usage has contributed to increasing fishing costs and deepening the poverty trench. For instance, 143,000 artisanal fishers in the Canary Current LME find themselves with an average daily income of $13 (Belhabib *et al.*, 2015b). The same pattern is observed in the Guinea Current Large Marine Ecosystem with an even higher poverty rate within fishing communities and a daily income of $6.1 on average for over 610,000 artisanal fishers (Belhabib *et al.*, 2015b). In South Africa alone, some 700,000 recreational fishers target over 200 species and caught 5,200 tons in 2010 (Le Manach *et al.*, 2015), which is the equivalent of $79 million. Despite improved reporting in Madagascar, over-exploitation and illegal fishing fleets that catch over 70,000 tons per year threaten the livelihood of some 120,000 Malagasy small-scale fishers (Le Manach, *et al.*, 2012), a trend that is similar to their counterparts in West Africa (Belhabib *et al.*, 2015b). Similarly, small-scale artisanal and subsistence fisheries in Comoros (80% of the total catch), also noted a major decline in fish abundance and size (Le Manach *et al.*, 2015).

In 2011, the contribution of inland and marine fisheries to national and agriculture Gross Domestic Products (GDPs) and the employment generated was estimated at more than $24 billion, 1.26% of the GDP of all African countries. It includes marine capture fisheries, post-harvest, licensing of local fleets, and aquaculture. (De Graaf *et al.*, 2014). According to data presented in The State of World Aquaculture and Fisheries 2014 (FAO, 2014b), in 2014 there were about 5.9 million fishers and fish farmers in Africa **(Table 1.3)** but this figure does not include employment in post-harvest activities.

1.3.4.1.3 Freshwater fisheries

People living in rural inland fishing communities are often among the most vulnerable in developing countries. The classic view of a fishery – including the fish resource and harvest systems – brings discussion about improving well-being in these communities directly to issues of reducing fishing pressure or harmful fishing practices, to managing resources in a way that promotes sustainable use (WorldFish Center, 2010). Household vulnerability analysis in fishing communities in Nigeria and Mali revealed that, despite fishing being the primary livelihood, vulnerabilities related directly to the state of the fishery resource were ranked lower than those related to basic human needs, predominantly food insecurity and lack of access to health, education and credit services (WorldFish Center, 2010).

Table 1 3 **Number of fishers and fish farms in Africa (in thousands). Sources: FAO (2014b, 2016).**

	2000	2005	2010	2011	2012	2013	2014
Fishers	4084	4290	4796	4993	5587	6009	5674
Fish Farmers	91	140	231	257	298	279	284
Total	4175	4430	5027	5250	5885	6288	5958

The inland fisheries of the East Africa Community (EAC) Partner States of Kenya, Tanzania and Uganda are based predominantly on its major freshwater lakes, the most notable being Lake Victoria, the world's second largest freshwater lake with an area of 68,800 km^2 (Scullion, 2007). Inland fisheries contribute between 2–12% of the GDP in each country and produce fish for domestic and export markets (Scullion, 2007). The value of the catch from Lake Victoria alone is estimated at $350 million at landing sites with a further $250 million generated by the export of Nile perch (Scullion, 2007). Other dominant fish species include Nile tilapia, a small indigenous cyprinid (*Rastrineobola argentea*, Least Concern), as well as various types of catfish. These lake fisheries support the livelihoods of over 3 million people in directly dependent households by providing employment, income and high-quality food in the form of nutrients and animal protein for millions of consumers in the region (Scullion, 2007). The transition from a centralised to participatory management approach has involved many different initiatives in East Africa in recent years, most of which have been small-scale and a few large-scale. The implementation of a system of co-management for inland fisheries in the East Africa Community aims to provide direct benefits for men and women fisheries resource users and their families who are dependent on fisheries for their livelihoods.

1.3.4.2 Water in Africa

Water is vital for all life on Earth and therefore is one of nature's most important contributions to people. It is connected to the major sectors driving African economies, e.g., the urban, industrial and service sectors, and particularly agriculture and energy (see 1.3.4.1, 1.3.4.3; Molden *et al.*, 2007; Hellegers *et al.*, 2008). It is also critical to population, health and poverty, as discussed in 1.3.7 and in Chapter 4. Sub-Saharan Africa is a region with a high number of transboundary river basins. Sixty-three of the world's 261 international river basins are located on the African continent. But, as a whole, Africa is also the driest continent after Australia (Naik, 2017). This has significant economic, environmental and policy implications.

As pointed out by the Africa Water Vision 2025 (UN-Water/Africa, 2004), Africa has "highly inadequate access to basic water supply and sanitation services in Africa". About 65% of the population in rural Africa did not have access to an adequate supply of water and 73% were without access to adequate sanitation in the early 2000's. Despite the global progress made during the Millennium Development Goals, Africa, with the exception of North Africa, still faces uniquely severe water and sanitary conditions as maps in **figures 1.7 and 1.8** illustrate. Only 28% of the sub-Saharan population had access to basic sanitary conditions in 2015, and more than 40% did not have access to safe drinking water.

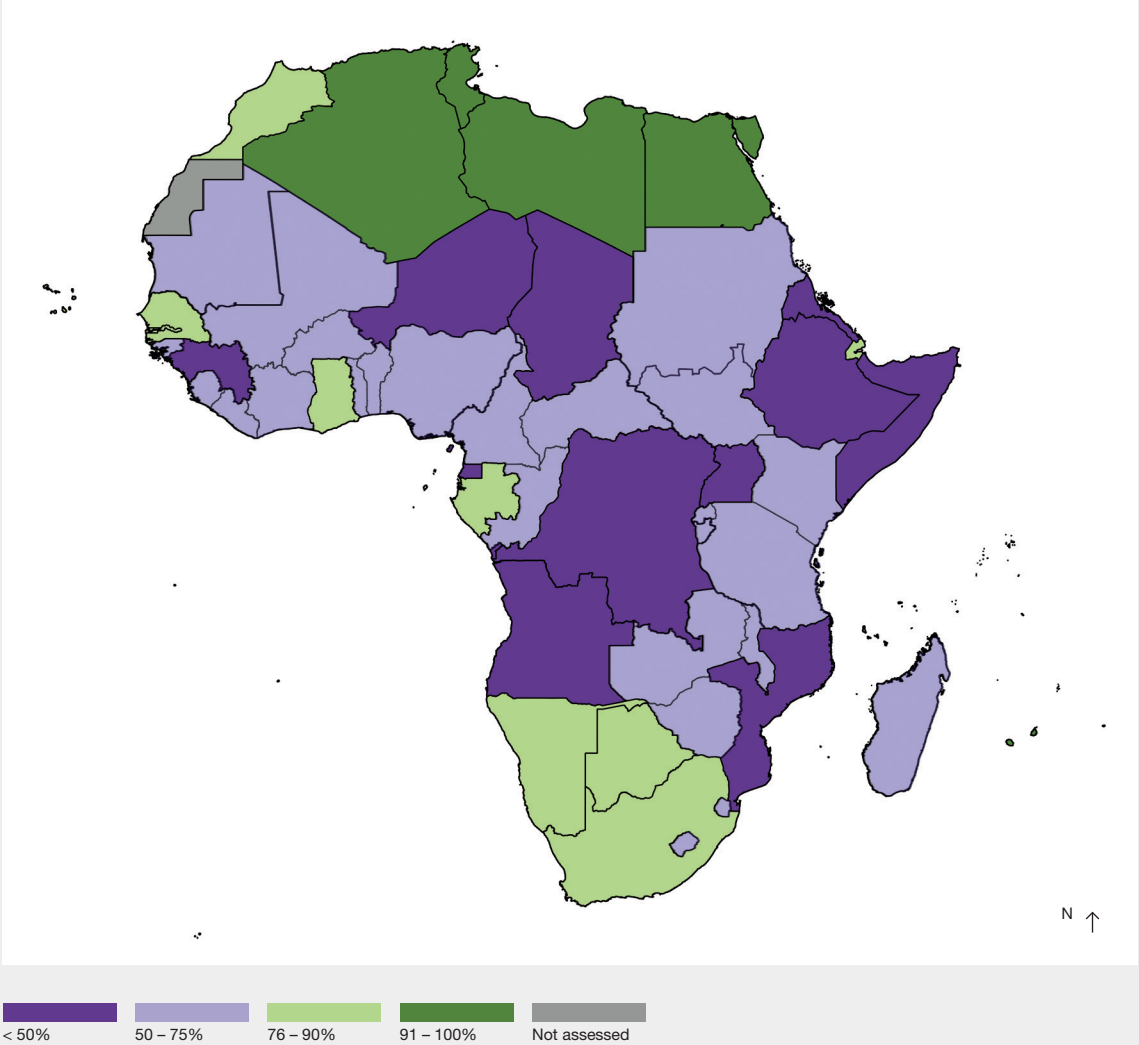
Growing water scarcity, a central issue addressed by the Africa Water Vision and a global priority expressed through SDG6, is not entirely due to natural phenomena. It is also related to water governance, investments and low levels of development and exploitation of water resources. According to the Water Vision, too much water is allowed to go to waste in Africa. "For example, the average level of unaccounted-for water is about 50% in urban areas, and as much as 70% of the water used for irrigation is lost and not used by plants." Most countries also "have substantial underutilised potential for irrigation expansion (about 45 million hectares, according to an FAO estimate). In fact, two-thirds of African countries have developed less than 20% of their potential. In the whole of Africa, about 6% of the cultivated area is irrigated… The scope for expanding irrigation is, therefore, considerable [and]… there is an even greater scope for expansion of rain-fed agriculture".

Water is an increasingly precious and coveted resource on the continent. As such, water management issues in Africa goes well beyond the production of food to involve complex governance and political issues from local to regional scales. It is necessary, therefore, to address the issue in the context of water security and in relation to the importance of water for food, energy, health and livelihood securities.

One feature typical of the hydro-geographic conditions found in Africa is the often markedly uneven distribution of water resources in the continent's basins. About 66% of Africa is arid or semi-arid, while most Africans rely on rain-fed agriculture and groundwater for domestic supply, particularly in rural areas (Faurès *et al.*, 2008). In fact, more than 300 million people in sub-Saharan Africa, from North Africa and the Sahel to East and Southern Africa, live in water-scarce environments, meaning that they have less than 1,000 m^3 per capita per year (UNEP, 2002).

This has consequences for water accessibility and use within and between subregions. Water-rich countries, i.e., those with abundant precipitation, such as Liberia, São Tome and Principe, Gabon in the Gulf of Guinea and Central Africa, contribute significantly to the volume of available water resources. On the other hand, water-scarce areas in North Africa, the Sahel and in East and Southern Africa, add little to that overall volume and, yet, draw a substantial share of the water they use from high-precipitation regions. The classic case for this is the Nile, whose upstream riparians are located in high-precipitation regions, while Egypt, the downstream riparian, is located in an arid region. A similar situation is found in the Zambezi and other river basins in southern Africa. Here the riparians to the north (Angola, Zambia, DR Congo, Mozambique) have abundant water resources, while the riparians to the south (in particular South Africa, Botswana, and Namibia) typically lack sufficient water resources and are highly reliant on water resources generated outside their borders. For instance,

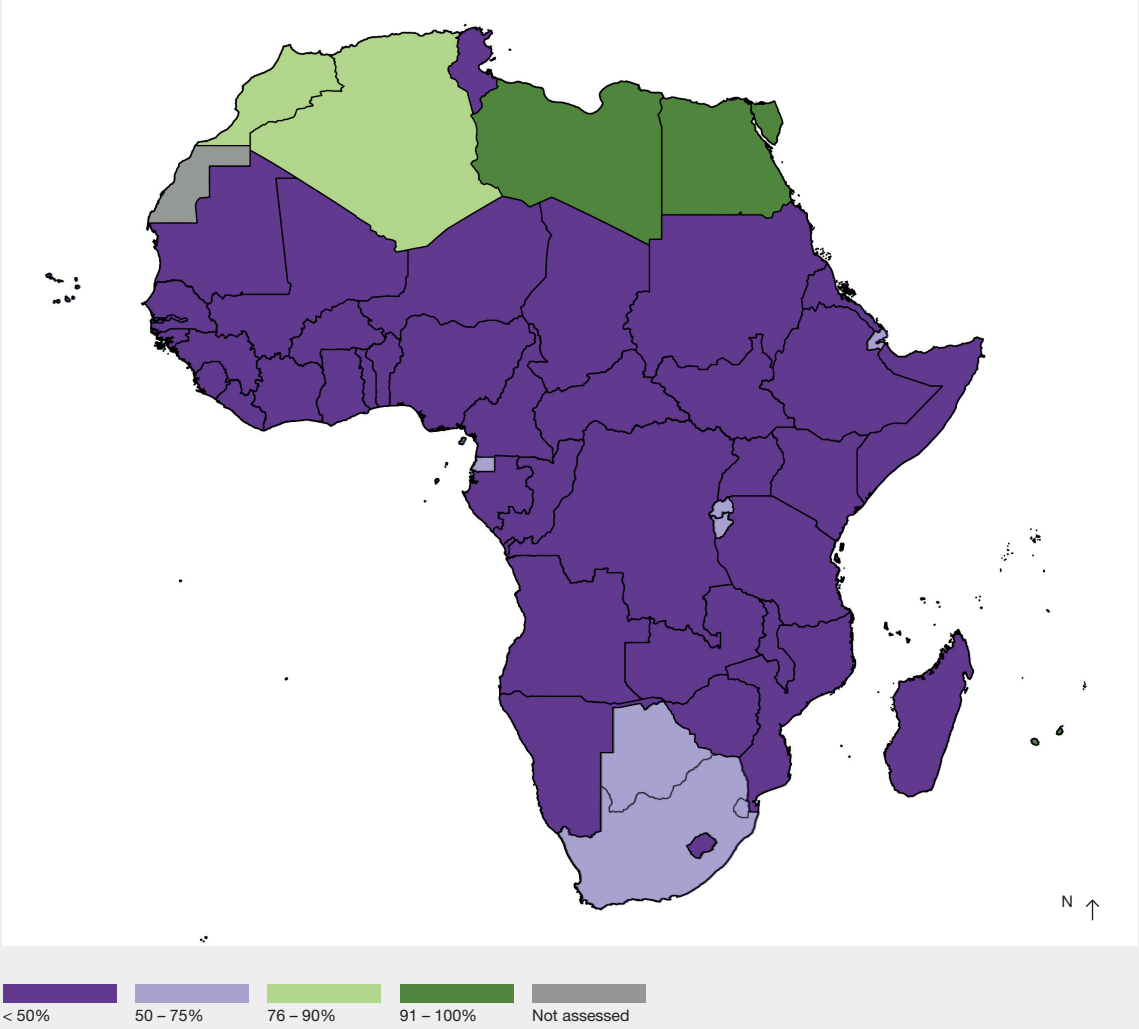
Figure 1 7 **Proportion of the population in 2015 using basic drinking water services. Source: WHO-UNICEF (2017).**



South Africa consumes 80% of all the water resources used in the SADC region, while contributing only 8% to the region's water resources (Scheumann *et al.*, 2006). Such a situation necessarily holds potential for conflict. With the impact of climate change, precipitation changes could further limit water availability in some of these regions, though, in others, such as the Horn of Africa, greater rainfall could increase groundwater levels (Thangarajan *et al.*, 2016). The combination of changes in the flow of streams and rising temperatures is further expected to have broadly negative impacts on freshwater ecosystems and water quality (APP, 2015).

Africa must ensure the availability of water resources for the population's growing needs, the protection of very fragile and vulnerable ecosystems and the preservation of economic prosperity, both within countries and across national boundaries. It must respond to the broader challenge in a way that takes into account national interest as well as transnational interdependencies and collective securities. The Africa Regional Assessment thus involves consideration of the water policies and water profiles of different subregions, while taking into account major political challenges and the effect of long-term climatic impacts on water resources. Lake Chad is a classic example of how some of these challenges can come together. Despite the desiccation of the Sahara leading to considerable shrinkage of its ancient coverage, Lake Chad still plays a vital strategic role in regional water provision, local livelihoods, and resistance to desertification. It is a meeting point of eight major African member countries of the Lake Chad Basin Commission (Chad, Cameroon, Niger, Nigeria, Algeria, Central African Republic, Libya and Sudan), supplemented by three additional countries (Congo, Democratic Republic

Figure 1 8 **Proportion of the population in 2015 using basic sanitation services. Source: WHO-UNICEF (2017).**



of Congo and Egypt), which have observer status in the Commission. It is also feeling the full impact of the insurgent terrorist movement of Boko Haram, which is causing a refugee crisis and serious water access and food supply challenges all around the Lake Chad area.

In a different but related case, Lake Malawi, also known as Lake Nyasa, has been a point of contention between Malawi and Tanzania since at least 1967. While the boundary dispute centred initially on issues of sovereignty and livelihoods and on the socio-environmental impacts (flooding) of the Kariba dam construction (Mayall, 1973), Malawi's oil exploration initiative, started in 2012, has revived tensions between the two countries. Control of the Nile River waters, e.g., through dam construction, is another important case study that is presently placing Egypt, Sudan and Ethiopia in potential opposition. It is a classic case of common property resource and collective action, magnified by international and intergovernmental complications.

The assessment will thus need to tread carefully in order to capture the critical connections that can turn into major disruptors of delicate mutual relationships between people, socio-political systems and ecosystems. Reference to existing transboundary water management initiatives and community-based water management schemes (e.g., **Box 1.8** in 1.3.8.1.1) must be made to capture all the possibilities of developing a solution. Amidst economic challenges and political turmoil, there are many promising approaches to water governance and transboundary water resources management. Sub-Saharan Africa is, for this reason, especially well-suited to identify lessons learned in the implementation of transboundary water management schemes and to derive recommendations from successes as well as failures.

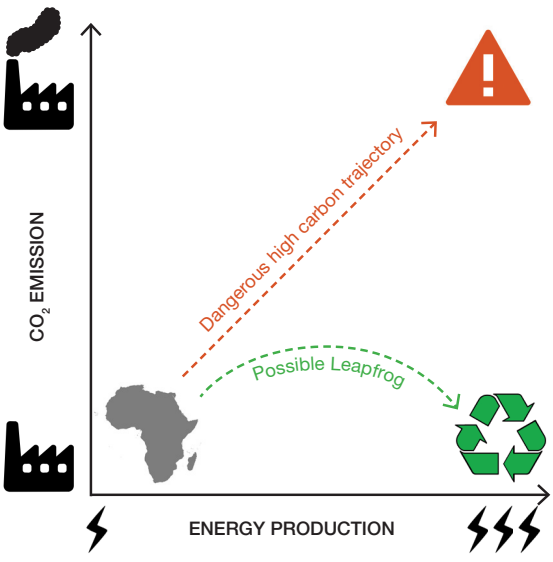
1.3.4.3 Energy in Africa

Energy comprises another critical component of the nexus. Energy is required for food production (especially irrigation) and for water supply, including the extraction, purification, and distribution of water (Bazilian *et al.*, 2011; Bach *et al.*, 2012). Woodfuel accounts for more than 80% of primary energy supply, and more than 90% of the population rely on firewood and charcoal for energy, especially for cooking (see chapters 2 & 4) Access to modern energy services is critical for socio-economic development (WEC, 2005). Africa's energy demand is expected to grow annually by 5% until 2040 and South Africa has nearly a third of the region's installed capacity (40 GW out of the 125 GW) (Fakir, 2012). Outside of South Africa, renewable hydropower provides 70% of all electricity to sub-Saharan Africa, although less than 30% of the population is connected to the grid (Fakir, 2012). In Africa, oil and gas reserves are concentrated in North and West Africa, as well as recent discoveries in East Africa. Hydroelectric potential exists in Central and Eastern Africa, as well as coal extraction in Southern Africa, cognisant of debates in this regard, however (WEC, 2005). Reliance on traditional biomass, as the main source of energy, is particularly high in Africa, where biomass accounts in some countries for 80% of primary energy supply and up to 95% of total consumption (IAEA, 2002; WEC, 2005; UNECA, 2006). The considerable solar and other renewable energy potential of Africa is yet to be fully exploited.

All methods of energy production, including renewables, have impacts on biodiversity and ecosystem services. However, the utilisation of new and renewable energies is an economically and environmentally attractive alternative to fossil fuels (Heinberg, 2016) **(Box 1.5)**. These types of energy sources are renewed within a lifetime through natural processes comprising wind, wave, solar, biomass (wood fuel, agricultural residues, animal wastes, biofuel and other bioenergy), hydropower and geothermal energy (UNECA, 2006). Sustainable energy is defined as energy which is replenishable within a human lifetime and which causes no long-term damages to the environment (UNECA, 2006).

Box 1 5 The Africa energy challenge. Source: APP (2015).

Energy is now a priority focus of infrastructural investments for a majority of countries on the continent, as well as regional bodies such as the African Development Bank and the World Bank. According to the Africa Progress Report (APP, 2015), Sub-Saharan Africa's electricity consumption is less than that of Spain. Over 600 million people still do not have access to electricity, while Africa's poorest people are paying among the world's highest prices for energy.



The energy "leapfrog"; renewable energy could do for electricity what the mobile phone did for telecommunications: provide millions of households with access to a technology that creates new opportunities (modified after APP, 2015).

For example, a woman living in a village in northern Nigeria spends around 60 to 80 times per unit more for her energy than a resident of New York City or London! Energy-sector bottlenecks and power shortages cost the region 2-4 percent of Gross Domestic Product (GDP) annually, and, on current trends, it will take until 2080 for every African to have access to electricity. This challenge in itself could be a large investment opportunity for Africa. Millions of energy-poor disconnected Africans, who earn less than US$2.50 a day, constitute a US$10-billion yearly energy market. Africa, which has enormous potential for clean energy, through natural gas, hydro, solar, wind and geothermal power, should seek ways to move towards lower carbon options, as mentioned previously.

As Koffi Annan stated in the foreword to the report: *"What would it take to expand power generation and finance energy for all? We estimate that investment of US$55 billion per year is needed until 2030 to meet demand and achieve universal access to electricity. One of the greatest barriers to the transformation of the power sector is the low level of tax collection and the failure of governments to build credible tax systems. Domestic taxes can cover almost half the financing gap in Sub-Saharan Africa. Redirecting US$21 billion spent on subsidies to wasteful utilities and kerosene to productive energy investment, social protection and targeted connectivity for the poor would show that governments are ready to do things differently. I urge African leaders to take that step"*.

Renewable energy technologies are often considered the most appropriate technology choice for most of rural Africa and they could provide a reliable and ecologically sound long-term alternative for many countries, including current oil-exporting nations, as many of them have abundant and unexploited biomass, water, solar and wind resources. There is considerable potential for hydropower development in Africa (1.5 million GWh per year according to Zarfl *et al.*, 2015), yet to date, only 7% of that potential has been harnessed (Blomfield, 2008). Unsustainable woodfuel (biomass) consumption practices have, however, locally led to deforestation (UNECA, 2006) and the planting of alien invasive trees for woodfuel has sometimes resulted in the loss of biodiversity in surrounding areas.

1.3.5 Invasive species

Thousands of species have been introduced into Africa from around the globe and many are successfully cultivated for agriculture, forestry, fisheries and horticultural purposes. These species, (animals, plants and micro-organisms), sustain human populations and bring economic benefit to the continent. Unfortunately, a small percentage of the thousands of species introduced are invasive. Invasive species can have serious negative impacts across all environments and many facets of life. The impact of invasive species in Africa has not been given adequate attention (Boy *et al.*, 2013), and despite commitment to several international agreements and targets (such as: Aichi Biodiversity Target 9, Article 8(h) of Convention of Biological Diversity, International Plant Protection Convention, Ballast Water Convention), little or no progress has been achieved to reverse the negative trends in invasive alien species (UNEP, 2012a; Tittensor *et al.*, 2014).

Invasive alien species have an extremely harmful impact on African biodiversity and on Ecosystem Services (such as the sustainable, adequate supply of usable water, fertile soil for crop farming, natural pasturage for stock farming, loss of access to fisheries and beneficial insects for pollination and natural pest control) (see **Box 1.6**).

In 2001 the cost of managing invasive species worldwide was estimated at $1.4 trillion or 5% of global GDP (Pimentel *et al.*, 2001). This percentage GDP is likely to be much higher in Africa due to the relatively *ad hoc* and reactive management approaches to biological invasions in most African countries, where the lack of available information on the financial costs of conservation is frequent (Frazee *et al.*, 2003).

Biological invasions may constitute a game changer, with unprecedented impacts that cost a great deal more to cure than prevent. Indeed, in many cases, complete “cure,” in the sense of returning to the pre-invasion state, is impossible. For example, the water hyacinth is one of the world’s most prevalent invasive aquatic plants and has invaded several freshwater systems in Africa and globally (Villamagna *et al.*, 2010). Biological invasions present a problem for many human activities, it is a threat to biodiversity and involves high costs for their control (van Wyk *et al.*, 2002). It has been calculated that in the Working for Water programme in South Africa, over 3 billion Rand (~$220 million) has been spent in dealing with the economic consequences of invasive plant species alone (Turpie, 2016). The Global Invasive Species Programme (GISP), CABI and IUCN developed a “toolkit” for the economic analysis of invasive species mostly focused on Africa (Emerton *et al.*, 2008). One of the studies cited (Wise *et al.*, 2007) assessed the economic impacts of five invasive alien species (one fish, one insect, the water hyacinth and two species of weeds) in different areas of Africa. Costs were significant at an individual level, ranging from 0.57 to over $400 per capita per year, impacting poor and vulnerable communities of farmers and fisherfolk.

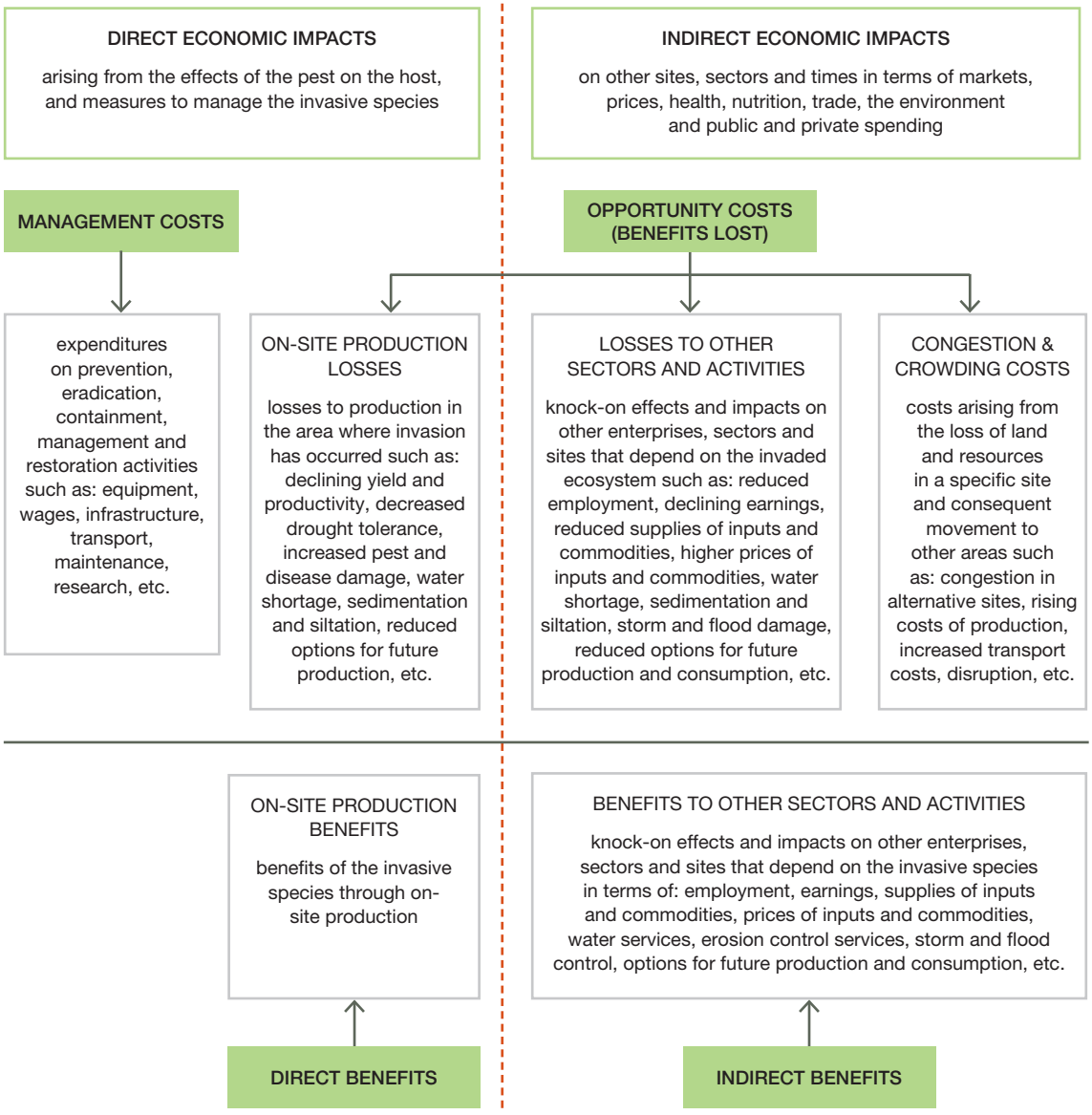
The most cost-effective, short-term actions called for are: firstly, prevention of introduction of known and potentially invasive species into each country, using screening at all points of entry, and secondly, their early detection and eradication where possible, using mechanical and chemical means (Preston *et al.*, 2000).

With increased international trade and transport, many more invasive species could still be introduced into Africa. Countries need to collaborate to manage the pathways of introduction to reduce the arrival of new potentially invasive species (international obligations to manage pathways covered in Chapter 4, section 4.2.2.4.1). Invasive species do not respect political boundaries and, thus, governments across the continent need to collaborate (see Chapter 4, section 4.2.2.4).

Efforts to protect Africa’s rich natural resources, food production and human livelihoods from the impacts of invasive species will require investment from governments. Lack of taxonomic expertise and a dwindling number of trained taxonomists employed in Africa and around the world will negatively impact efforts to address the issue of invasive species (Pyšek *et al.*, 2013). Adequate information on presence and impact of invasive species is vital for planning, but not available in many countries. Clear national and regional management plans for high-risk species need to be developed and implemented. The challenge is particularly acute for small island developing states (SIDS), and integrated coastal management is generally the recommended strategy that should help reduce the vulnerability and enhance the resilience of SIDS facing invasive species (Cohen *et al.*, 2014). Of particular interest are research initiatives and networks devoted to reducing the rates and impacts of biological invasions by furthering scientific understanding and predictive capability, and by developing research capacity (elaborated on in Chapter 4, section 4.2.2.4). South Africa, for example, has established

Box 16 Direct and indirect impacts of invasive species and the benefits of their control. Source: graphic adapted from Emerton *et al.* (2008).

Invasive species are harmful to Africa's rich biodiversity, reduce life sustaining ecosystem services and have a serious economic impact for African countries. There is an urgent need to identify their pathways to prevent invasions into new areas. It is also urgent that African countries apply risk assessment approaches to identify the needs and types of management that is relevant to combat this biological invasion. This can be accomplished by sharing good and bad experiences in invasive species management between neighbouring countries and other regional bodies inside and outside the continent; and by allocating significant funds for management of invasive species by governments rather than be left to foreign-funded projects.



scientific and participative networks (http://academic.sun.ac.za/cib/ and http://www.invasives.org.za) in order to tackle the country's environmental and socio-economic issues associated with invasive species. Such initiatives have engaged citizens in national monitoring networks and scientific knowledge on invasive species (van Wilgen *et al.*, 2014), and should be promoted across the African continent.

Protection of environmental services from invasion and management of invasions in these high biodiversity areas should be given priority. Intergovernmental sharing of

information and collaboration to prevent the introduction of invasive species into Africa should be the primary approach to limit the threat of invasive species. Such sharing of expertise and joint funding would minimise the cost and maximise the benefits of remedial environmental and socio-economic action for individual countries (Boy *et al.*, 2013). It is inefficient and ineffective to treat each invasion in isolation. It is, therefore, imperative that national governments and regional bodies adopt a biosecurity approach defined as "a strategic and integrated approach that encompasses the policy and regulatory frameworks (including instruments and activities) that analyse and manage risks in the sectors of food safety, animal life and health, and plant life and health, including associated environmental risk" (FAO, 2007b).

Some of these impacts are the unintended consequences of well-meaning development initiatives. For example, *Prosopis juliflora* (known by many in Ethiopia as the Devil Tree) was introduced through agro-forestry initiatives to many semi-arid parts of Africa. The advantages and negative impacts of introduced *Prosopis* have been explored. The negative impacts include impenetrable thickets along watercourses; invasion of pastureland; harmful effects of thorns; and reduction of growth of indigenous plants (Mwangi *et al.*, 2005; Maundu *et al.*, 2009). Through shifts in vegetation biomass and soil properties (Ilukor *et al.*, 2016) it, directly and indirectly, affects the food security of those in already economically and politically marginal situations (Maundu *et al.*, 2009; Shackleton *et al.*, 2014). It is essential that development agencies adopt a thorough risk analysis process to minimise the chances of scoring disastrous "own goals" through well-intended species introductions.

For over a hundred years, biological control, namely the introduction of host-specific natural enemies of the target invasive species, to permanently suppress the populations of invasive species to a tolerable level has been successfully practised in Africa. Despite the fact that some unintended consequences may have led to the concern that possible environmental benefits do not warrant risks (Simberloff, 2011), biological control is still considered the most cost-effective, long-term action to manage established invasive species even given costly research and investment in quarantine facilities (van Wilgen *et al.*, 2011). Yet, biological control requires flexibility in policy design and application to account for uncertainty and cost-benefit issues (Keller *et al.*, 2009; Sims *et al.*, 2016). It is mandatory to test the safety and potential effectiveness of the candidate biocontrol agents (namely whether or not they are host-specific to the target invasive species, and present no threat to indigenous or economically important species, and whether they are able, under laboratory conditions, to reduce the growth and reproduction of the invasive species). Human capital development in all fields of invasive species management is required in order for Africa to prevent new introductions and to reduce the impact of existing invasions.

1.3.6 Habitat degradation and restoration (marine and terrestrial)

Land degradation is a scientific conception, based on the idea that ecosystems tend to reach a stable stage that can be disturbed by human use of resources. But the rise of the disequilibrium concept in ecology, combined with works of archaeologists and anthropologists who described the practices of local populations related to the environment, make it possible to consider some of these practices as part of the natural functioning of ecosystems, and factors that contributed to their present state.

Land, freshwater, estuaries and the oceans are a finite, non-renewable natural capital, and the biological productivity generated is used by people for food production/harvesting and therefore the degradation of the land and water has a direct impact on agricultural and fisheries productivity (Chasek *et al.*, 2015). Land-use changes in Africa have transformed land cover to farmlands, grazing lands, human settlements and urban centres at the expense of natural vegetation. These changes are often associated with deforestation, overgrazing and deteriorating rangelands, decreased access to potable water, erosion, pollution, overfishing, biodiversity loss and land degradation (Maitima *et al.*, 2009; Nachtergaele *et al.*, 2011) (see Chapters 4 and 5). Land degradation and desertification can be defined as a persistent reduction or loss of the biological and economic productivity resulting from climatic variations and human activities (Adeel *et al.*, 2005; Bai *et al.*, 2008; Vogt *et al.*, 2011), which is sufficiently broad to also be applicable to the marine and freshwater environment.

Thirty-three terrestrial ecoregions with globally important biological values that are highly threatened were distinguished by Burgess *et al.* (2006), most of which are on offshore islands (twelve) or on mainland montane areas (fourteen) and seven in the lowlands. Endangered ecoregions are shown in **Figure 1.9.** Six marine ecoregions with the highest biodiversity significance were distinguished by Tear *et al.* (2014) among which are the Mascarene Islands of the Indian Ocean bordered by the Kenya and Tanzania coastal region and the North-western Madagascar coastal region **(Figure 1.10)**. Selig *et al.* (2013, 2014) developed an index based on a global assessment of the condition of marine biodiversity using publically available data to estimate the condition of species and habitats within 151 coastal countries. They also found a strong positive relationship between the Human Development Index and

resilience measures that could promote greater sustainability by reducing pressures. This relationship suggests that countries lacking effective governance will further jeopardize their ability to maintain species and habitats in the future.

Causes of land and water degradation in Africa include, among others, rising consumption patterns, demographic growth, conflicts and wars with internal and external displacement, inappropriate soil management, pollution, insecurity in land tenure, variation of climatic conditions and the intrinsic characteristics of fragile soils in diverse agro-ecological zones (Thiombiano *et al.*, 2007) (further information in Chapter 4, with implications considered in Chapter 5). Land degradation severity, extent and trend is variable in Africa and affects about 46% of the continent, and the semi-arid areas of Africa are particularly vulnerable, as most of the area is characterised by fragile soils, localised high population densities, and low-input agriculture (WMO 2006; Bai *et al.*, 2008).

Of the productive land area, up to two thirds are estimated to be affected by land degradation (Jones *et al.*, 2013; UNCCD, 2013), and desertification affects 45% of Africa's land area with 55% of this area at high or very high risk of further degradation (UNEP/ELD, 2015). At the same time, flora and fauna in desert areas suffer the effects of climate change (Durant *et al.*, 2014) and populations of megafauna, in particular, are collapsing.

It is expected that the interrelation between land degradation and climate change may lead to an expansion of land degradation in the future (Thiombiano *et al.*, 2007; Vu *et al.*, 2014). A strategy against land degradation has been developed for Africa in support of the United Nations Convention to Combat Desertification (UNCCD) to prevent, control and reverse land and water degradation in areas with medium to high production potential that are critical for people's livelihoods (MA, 2005; GEF, 2014; UNCCD, 2014; UNEP/ELD, 2015).

Figure 19 **Conservation status of terrestrial ecoregions of Africa. Sources: Olson *et al.* (2001); Burgess *et al.* (2006).**

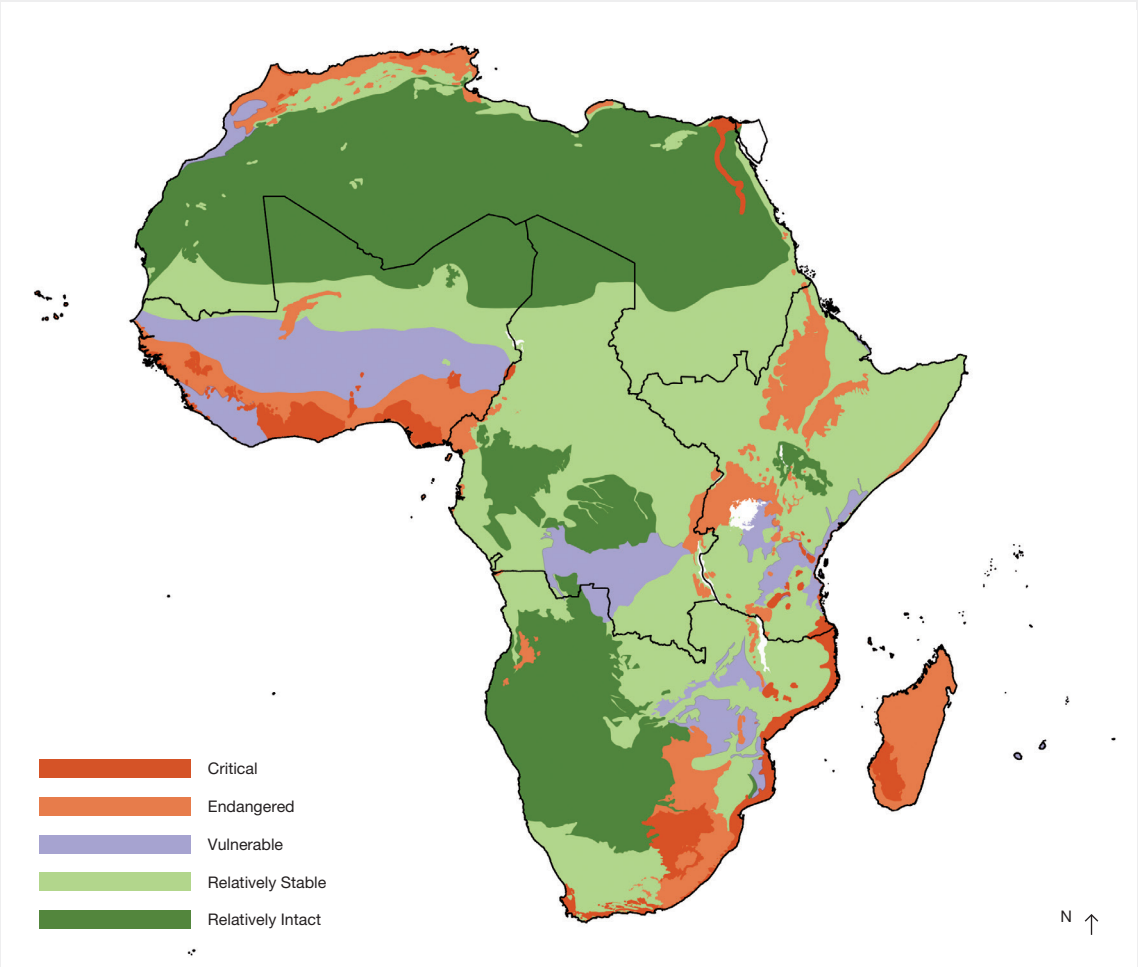
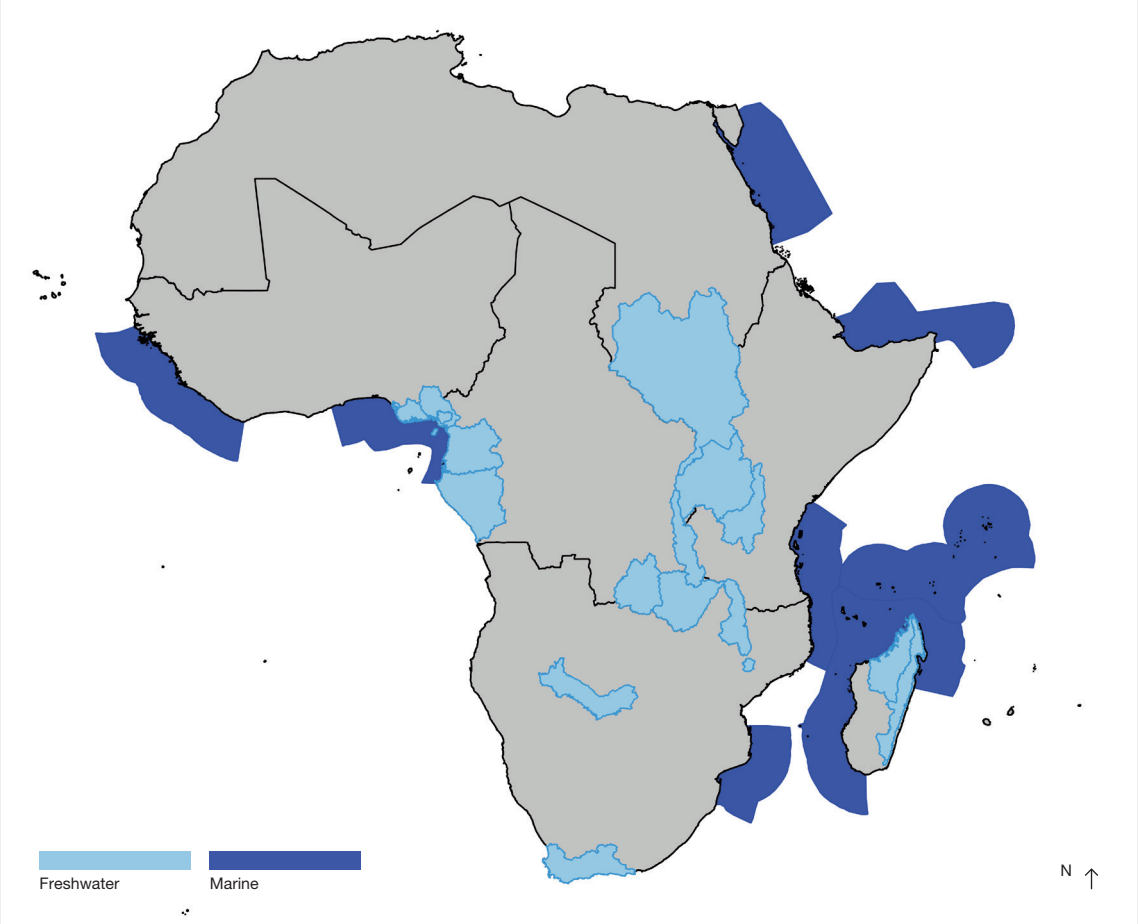


Figure 1 10 Marine and freshwater ecoregions in Africa with the highest biodiversity significance rating. Sources: Abell *et al.* (2008); Tear *et al.* (2014).



1.3.7 Population, poverty and health

1.3.7.1 Population dynamics and their implications

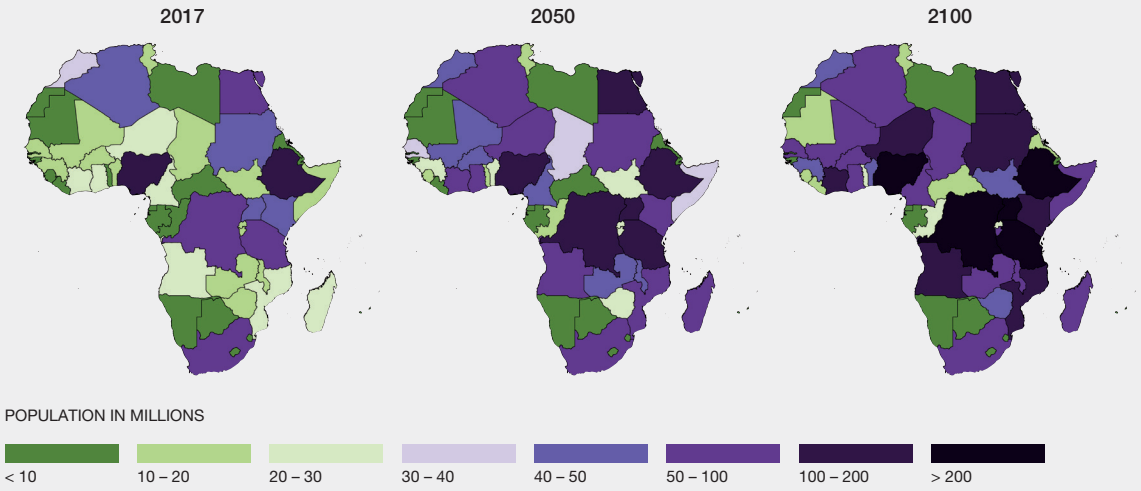
In 2017, Africa's population reached 1.25 billion[1], representing 16.4% of the world population. The UN's medium estimates suggest that population growth will remain strong in the coming decades so that by 2050, one in four people in the world will be African (26.2% of the world population). The accuracy and availability of population census data vary but the data that do exist suggest highly varied trends and prospects across the region **(Figure 1.11)**. Nevertheless, by 2100, 19 African nations are expected to reach populations of >75 million people with the total population of the four most populous African countries anticipated to be approaching 1.7 billion, considerably more than the entire population of Africa in 2015 (UN, 2015a). These estimates are highly dependent on fertility rates, but recognise that 19 of the world's 22 'high fertility' countries (where women have 5 or more children on average) are located in Africa. Africa also shows the world's greatest increases in life expectancy and reductions in child mortality, though again there are distinct regional variations (UN, 2015a).

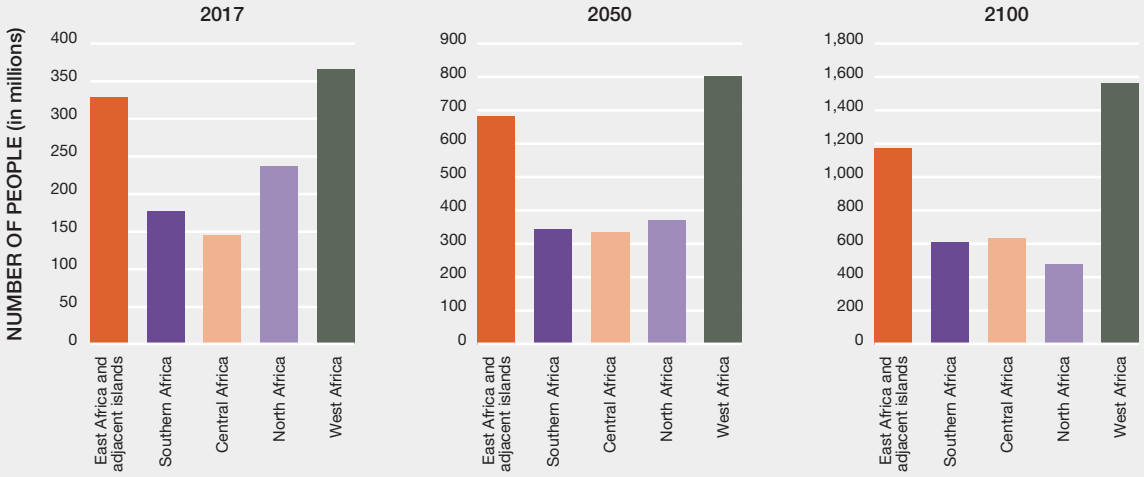
Strong population growth inevitably presents challenges which need to be effectively managed. However, it also presents opportunities. Africa's population will be relatively young **(Figure 1.11)**, with more favourable ratios between working and non-working aged people compared to certain other parts of the world – the so-called 'demographic dividend' (Canning *et al.*, 2015). By 2040, the continent will be home to the largest working-age population in the world (Roxburgh *et al.*, 2010). Furthermore, the continent still retains important global

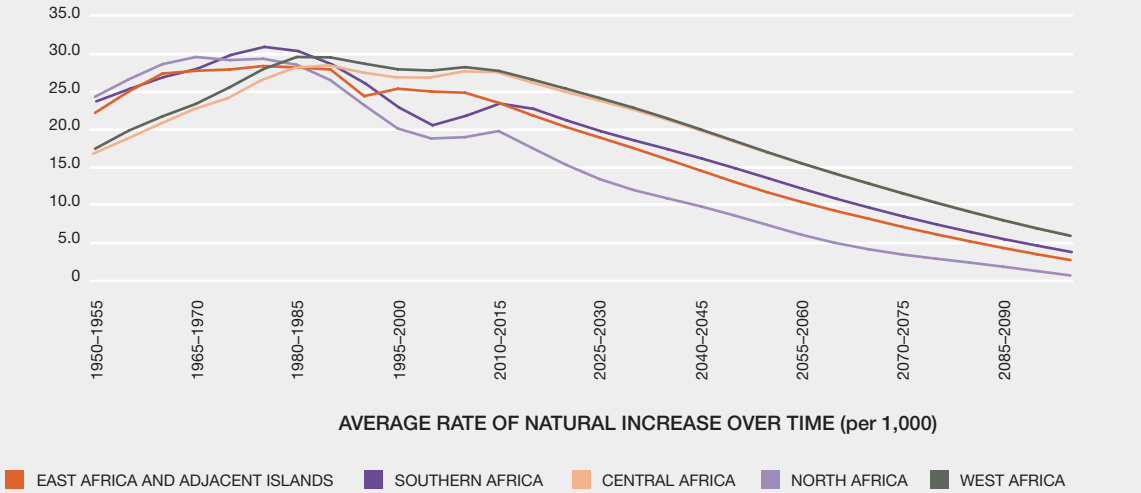
1. Based on UN estimates from http://www.worldometers.info/world-population/africa-population/ as at 18 August 2017.

Figure 1 11 **Current and projected population characteristics for Africa.**

Left top and centre: Population trends in Africa and per subregion. Left bottom: Trends in the average rate of natural increase over time. Right top: Proportion of the population dependent on working age population. Sources: UN (2017); data retrieved from https://esa.un.org/unpd/wpp/Download/Standard/Population/.







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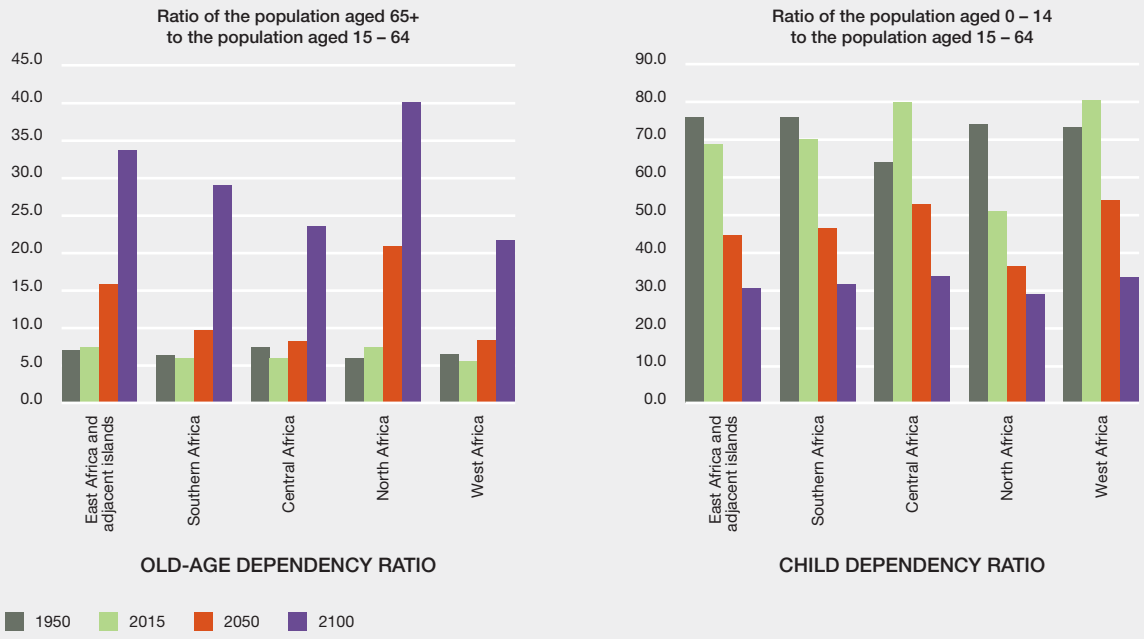
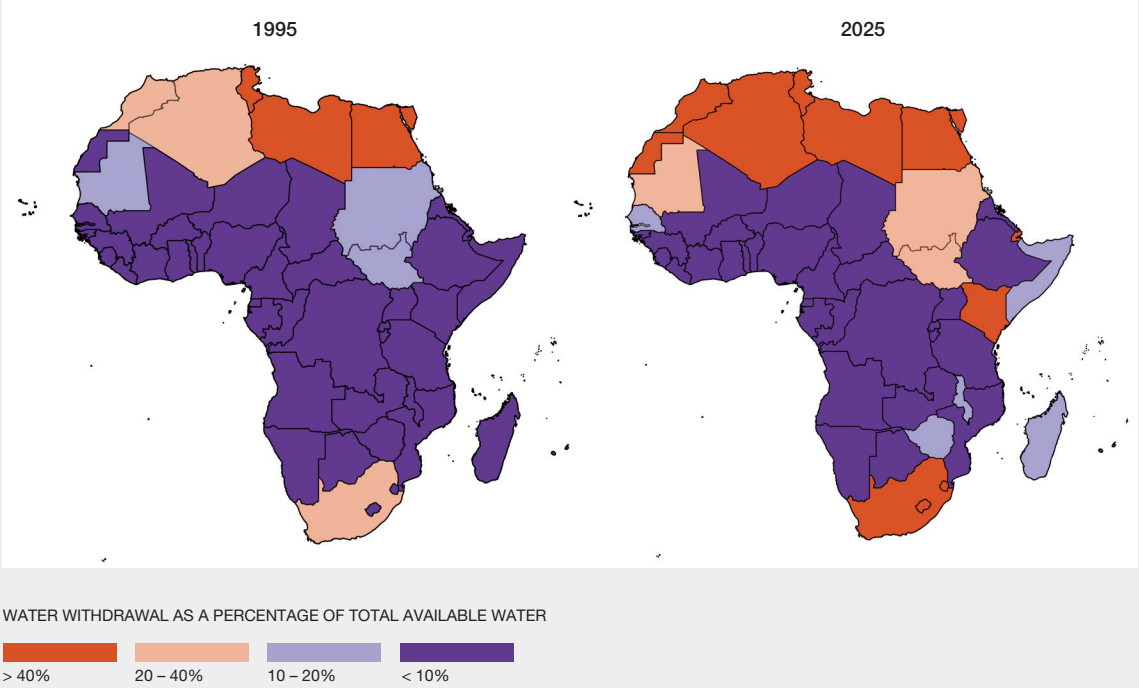


resources in terms of commodities, untapped potential for food production and latent consumer demand (UN, 2015a). These are some of the reasons why Africa has been termed the 'sleeping giant of the world economy' (Roxburgh *et al.*, 2010).

These opportunities are exciting for the future of Africa, but the process of realising them comes with challenges and risks. Innovation and technological development have proved to be strongly positive counters to early 'Malthusian' concerns of population-environment pressures, but environmental degradation and biodiversity losses remain major concerns (Canning *et al.*, 2015). Solutions need to be multi-faceted and take account of the lag between population control measures and their impact (Bradshaw *et al.*, 2014). Africa starts with the benefit of low ecological and carbon footprints compared with other parts of the world, but there are still likely to be challenges associated with balancing increasing economic growth, rising population and population densities with the need to protect, conserve and enhance biodiversity and ecosystem services (UNEP, 2016).

Chapter 4 provides an in-depth examination of anthropogenic drivers (see sections 4.2.2 and 4.3.4), their inter-connections with natural drivers and their impacts on land degradation, sustainable use, conservation and the food-energy-water-livelihood nexus. This includes consideration of uneven distributions in pressures, dependencies and outcomes. A few illustrative examples are helpful to introduce some of the complexities around population dynamics. For example, when considering population growth, trends are expected to be particularly strong in sub-Saharan Africa. Since this is also where people are most dependent on agriculture for their livelihood there is likely to be an associated pressure on material contributions from nature, both in terms of food and also water (Mutanga *et al.*, 2012). Looking at water stress more closely, it has been estimated, perhaps conservatively, that around 400 million people in Africa already live in water-stressed countries and this could double by 2050 as a result of population growth and also climate change (Mutanga *et al.*, 2012; and see **Figure 1.12**). Africa's coastline is another location already being particularly affected by population dynamics and associated drivers. Here, population pressure and the strong reliance of local populations on mangrove ecosystems are just some of the reasons behind mangrove degradation and loss, with estimates from West and Central Africa suggesting losses of up to 30% over the last 25 years (Diop *et al.*, 2016). In turn, local populations lose the protection mangroves offer against storms and sea level rise (Bosire *et al.*, 2014). The case of mangroves (see Chapter 2) also illustrates how local dynamics can have regional and global impacts, for example through the loss of nursery habitats for many fish species (Arthurton *et al.*, 2006). In rangelands, too, population pressure is considered to be at the heart of biodiversity loss and degradation, though intricately linked with other factors such as poverty, development needs and related resource extraction, conflict in the wider region, climate change and the impacts of invasive species (Kideghesho *et al.*, 2013).

Figure 1 12 **Past (1995) and future (2025) water stressed countries (water withdrawal given as a percentage of the total available water). Source: https://www.grida.no/resources/5625.**



Population dynamics are strongly connected to those of land cover and land-use (also see Chapter 4, section 4.2.2.1), including conversion of land to agricultural uses, urban settlement and the development of transport and other infrastructure. Africa's migration and urbanisation processes are complex, varied and often inter-related, though detailed analysis is often hampered by a lack of data and inconsistent definitions (Potts, 2009, 2012; de Brauw *et al.*, 2014). Nevertheless, by 2050 it is expected that more than half of all Africans will live in urban settlements of one form or another (UN, 2015b). Some of the increase will be in emerging megacities, but also through the growth of secondary and smaller settlements (UN Habitat, 2014; **Figure 1.13**). Conventionally, rural-urban migration has been seen as a major driver of the growth of urban areas, with implications for social structures and land management in rural and urban areas (de Brauw *et al.*, 2014). However, demographic factors are also important and urbanisation trends are not uniform with increasing evidence of urban-rural migration, e.g., in parts of central, eastern and western Africa (UN Habitat, 2014) and evidence too of cyclical migration patterns (Potts, 2009; Anderson *et al.*, 2013).

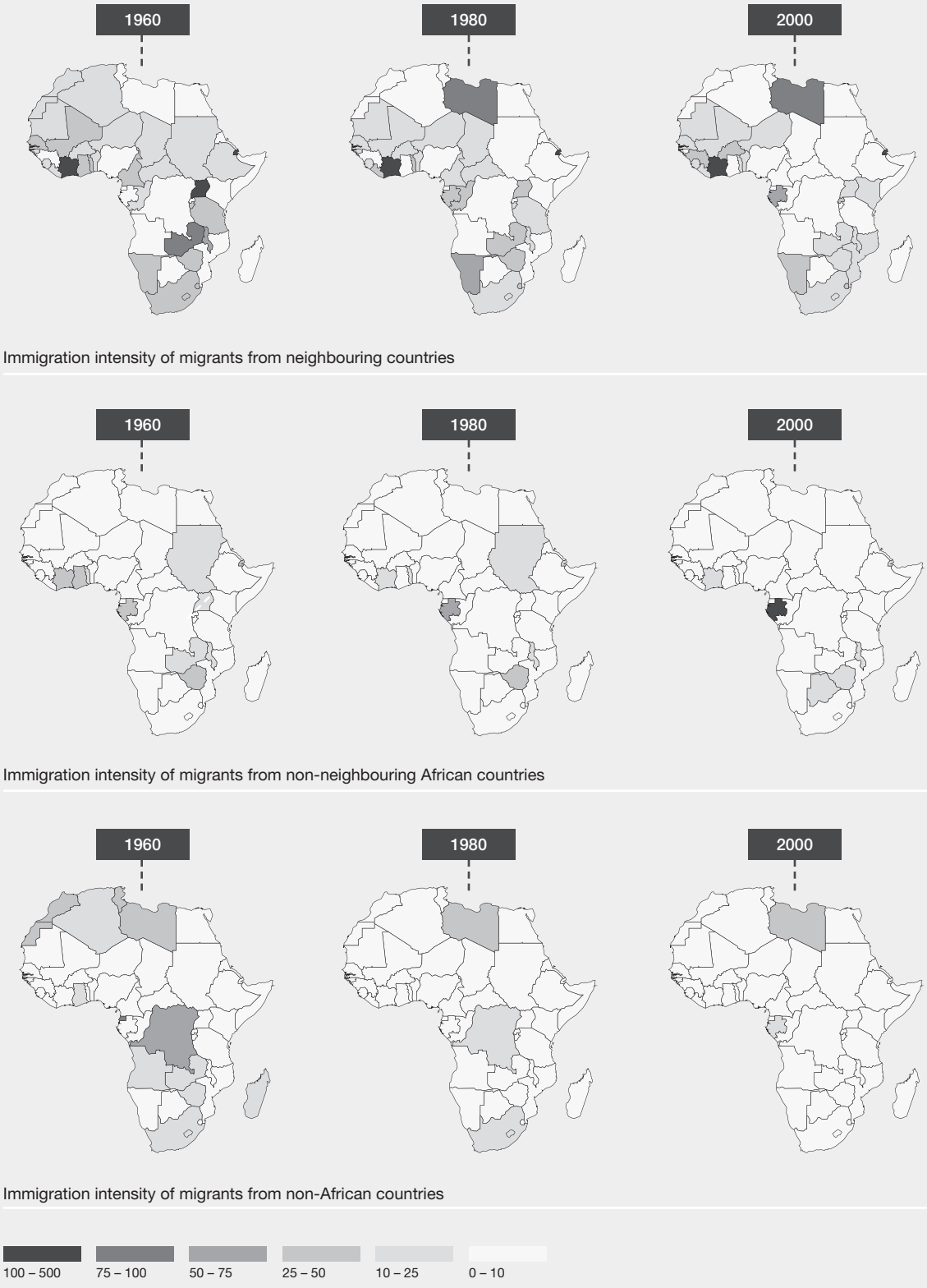
Models suggest a six-fold increase in urban land cover between 2000–2030 (Seto *et al.*, 2012; **Figure 1.14**). Despite still making up a very small proportion of overall land area, the implications are nevertheless far-reaching. West Africa's Guinean forests are expected to be among the five biodiversity hotspots most threatened by urbanisation and 30% of Africa's Alliance for Zero Extinction sites could be affected (Seto *et al.*, 2012).

Other ecologically sensitive areas are also expected to be affected by 2040, including the Nile River region, the urban West African corridor between Abidjan and Lagos, the northern fringes of Lake Victoria and Lake Tanganyika in East Africa and Nigeria's northern Kano region (Anderson *et al.*, 2013). Population-related degradation and drainage is a growing problem for Africa's important and internationally recognised wetlands (Arthurton *et al.*, 2006). Since the wider impacts of activities are currently only poorly understood and monitored, the ecosystem contributions that wetlands provide are also poorly estimated (Barbier, 2016) and governance issues prevail (Feka, 2015). Chapter 4 (section 4.2.2) demonstrates how anthropogenic drivers affect biodiversity as a result of urbanisation, land cover changes and road incursion, amongst others. Habitat fragmentation is a well-recognised outcome and the viability of animal migration corridors can also be compromised (UNEP, 2015; Watson *et al.*, 2014). Urbanisation is thus inextricably linked to land degradation, biodiversity loss and habitat fragmentation alongside the development of transport routes and other development drivers.

As well as protecting biodiversity, there is a need to understand and account for the needs of urban dwellers.

Figure 1 13 **African migration patterns.**

Left: Evolution of immigration intensity from neighbouring, non-neighbouring and non-African countries (immigrants per 1,000 inhabitants); Right: Circular plot of migration flows between and within world regions during 2005 to 2010. Tick marks show the number of migrants (inflows and outflows) in millions. Only flows containing at least 170,000 migrants are shown. Sources: Abel *et al.* (2014); Flahaux *et al.* (2016).



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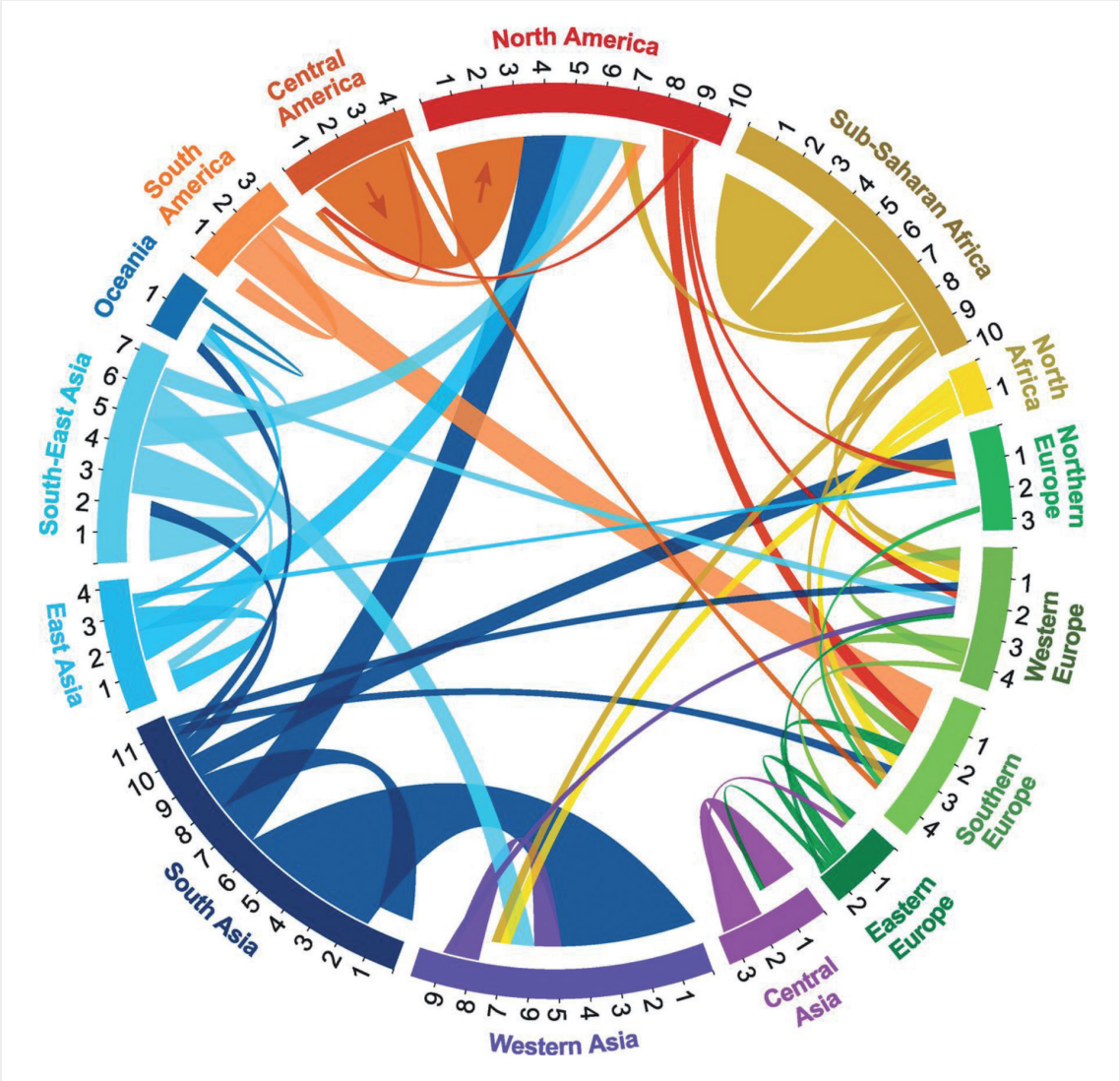
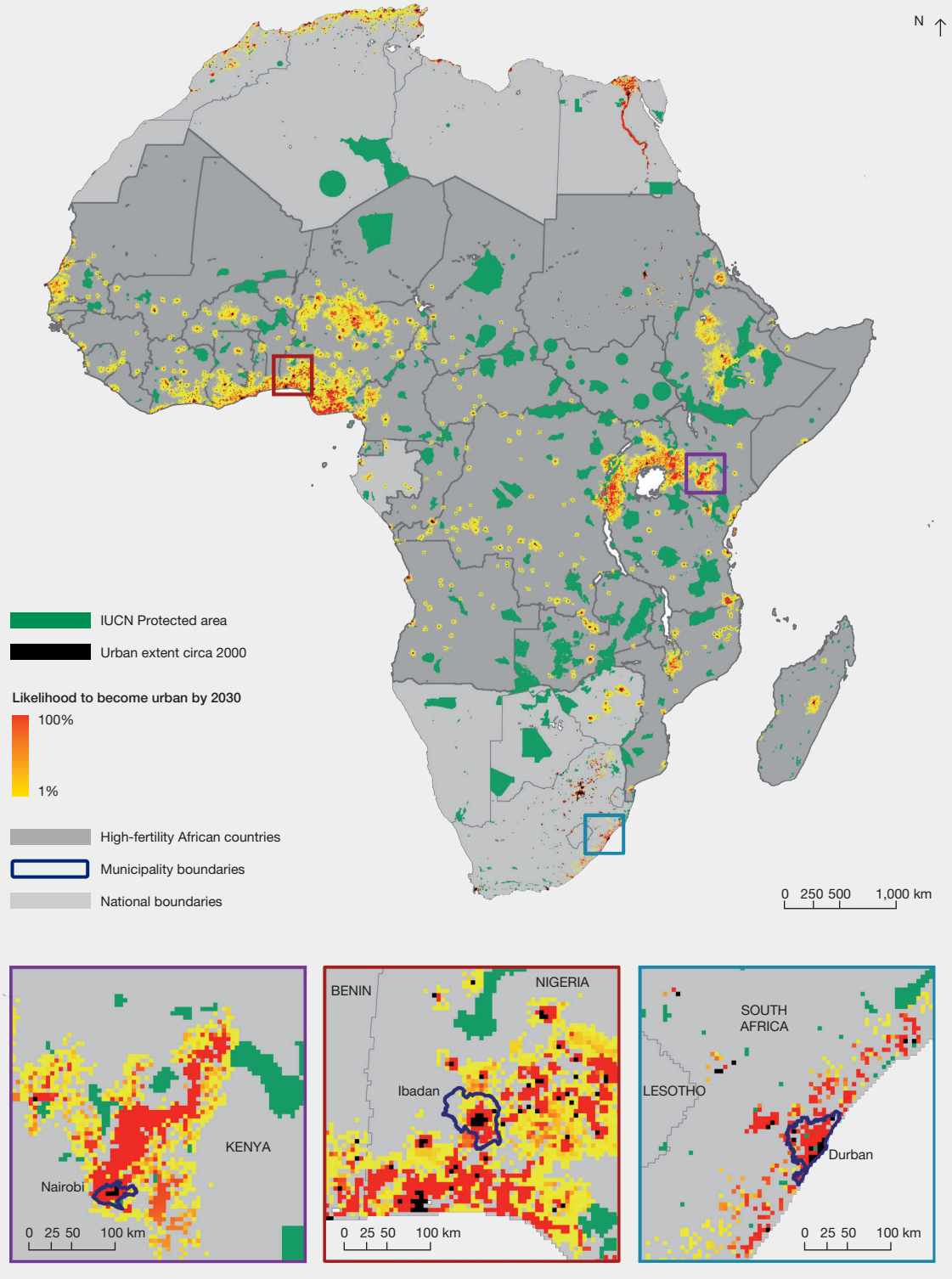


Their needs are not simply about ensuring that material requirements are met, but also that a good quality of life can be achieved as a result of other non-material and regulating functions of nature's contribution (see Chapter 2). In other words, urban dwellers do not simply require food, fuel and shelter for survival. Rather they should have the opportunity for a good quality of life, allowing for the spiritual, recreational and restorative benefits from urban nature and the chance to benefit from cool breezes, quiet spaces and shade. This inevitably requires consideration of waste and waste disposal, water, air, soil and noise pollution, urban climate and hydro-meteorological hazards all of which can impact nature and its contributions to a good quality of life, as is explored in Chapter 4 (section 4.2.2.4). Since urban areas are still largely developing, there is an opportunity to build towns and cities on the principles of sustainable resource use, including considering catchment to coastal processes, as part of a 'profound re-imagining' of existing and future urban transitions and the development of "innovations towards greener, healthier and more sustainable urban societies" (UN Habitat, 2014). Such profound re-imagining can include harnessing contributions from nature through regulation of drivers of poor health and well-being and ensuring heritage, identity and social practices are supported. While taking advantage of the opportunities that urbanisation brings, this assessment also recognises that the major part of Africa's population in 2050 will still live outside of urban areas in scattered settlements. The needs and aspirations of these people are also important, including indigenous and traditional peoples who choose to maintain their way of life (Abdel Rahman, 2009). Traditional and nomadic practices need to be recognised and supported, not least for their role in maintaining,

Figure 1 14 **Current and future urbanisation in Africa.**

Left: Probabilistic forecasts of urban expansion by 2030 in Africa. We estimate the probability for each location by calculating the percentage of 1000 spatially explicit simulations of urban growth, in which that location becomes urban. We generated the 1,000 simulations using Monte Carlo techniques. Probabilities vary from 1% to 100% from yellow to red on the maps. High rates of urban expansion are expected along the Nigerian coast and within the Lake Victoria Basin. Even in relatively lower-fertility countries such as South Africa, major urban centres are expected to grow well beyond their current municipal boundaries. Top right: Percentage urbanisation in the top 20 and bottom 10 countries and territories in Africa. Bottom right: Proportion of population in urban areas by region (2016). Sources: AU (2017); Güneralp *et al.* (2017).



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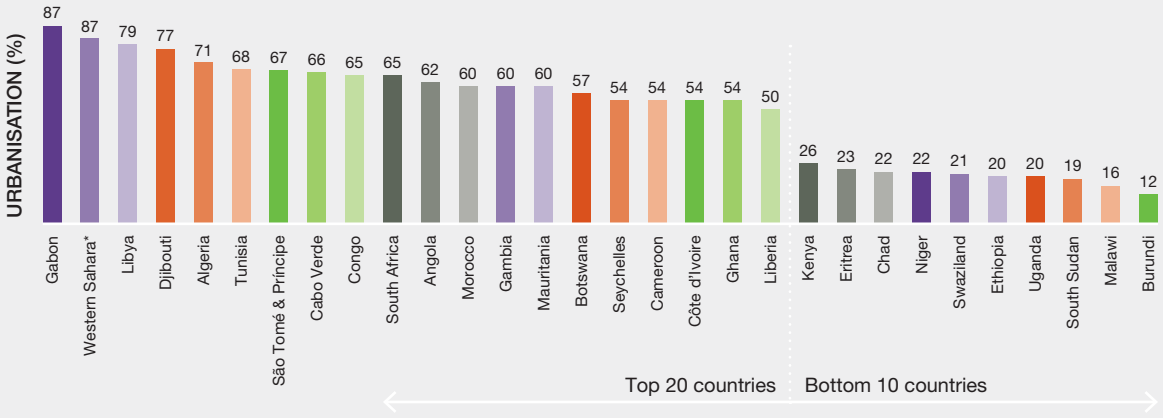
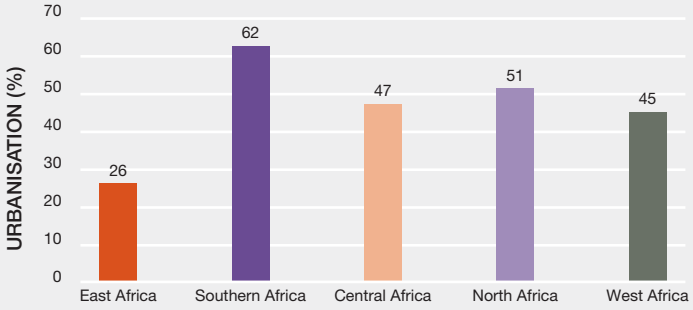


PERCENTAGE URBANISATION IN THE TOP 20 AND BOTTOM 10 COUNTRIES IN AFRICA



PERCENTAGE URBANISATION PER AFRICAN SUBREGION

conserving and supporting biodiversity. This is particularly important given that the peoples with these practices may be disconnected and marginalised from decision-making and their valuable and irreplaceable knowledge lost.

1.3.7.2 Poverty and ecosystems

Information about population numbers, densities, distributions and flows in Africa is required for this assessment, but they only provide part of the picture of the human context of assessing biodiversity and ecosystem contributions in Africa. The relationships between people, nature and nature's contributions are also strongly connected to poverty and poverty dynamics, as is explored in detail in Chapter 4 (Section 4.3.1). In some instances, great strides have been made in tackling poverty in Africa. For example, during the period 1990–2012, there has been a reduction from 56% to 43% in the proportion of people in sub-Saharan Africa living on $1.90 per day, something which has been particularly marked since the turn of the new century (World Bank, 2015a). Rapid increases in population have, however, meant that despite these reductions in proportions, there are now more people experiencing extreme poverty than ever, especially in East and Southern Africa (IFAD, 2015; World Bank, 2015a). There are suggestions that reductions in the share of people in poverty are larger than estimated in official statistics, but Africa has still not reached the Millennium Development Goal to halve its 1990 extreme poverty rate by 2015 (taken as the proportion of people living on less than $1/day) (Christiaensen *et al.*, 2015; World Bank, 2016). Successes are inevitably affected by global as well as local drivers (Chuhan-Pole *et al.*, 2015). Some commentators suggest that the world food, energy and financial crises have contributed to slowing progress in recent years in Africa (del Ninno *et al.*, 2015; Chuhan-Pole *et al.*, 2015), but there are also suggestions that the continent's economies fared relatively well, were quick to rebound and retain strong growth in many areas (AfDB, 2010; Devarajan *et al.*, 2015). Nevertheless, poverty eradication and socio-economic development remain the number one priority for developing countries in Africa (McKay *et al.*, 2015; Palmer, 2015; UN, 2015c; Oldekop *et al.*, 2016).

Income-based measures show only part of the true extent of poverty, deprivation and associated inequalities. So-called multidimensional poverty takes a wider view and

includes related characteristics such as health, education, living conditions and social inclusion (UNDP, 2016). Here too, there are many positive trends. For example rates of literacy, life expectancy and chronic malnutrition have all improved, but thresholds are very low. Indeed, according to the Millennium Development Goals report, during the period 2011–2013, sub-Saharan Africa was still the most food-deficient region in the world, with 25% of the population having faced hunger and malnutrition (AU, 2015a). One in five adults still cannot read and write (Christiaensen *et al.*, 2015). Assessment of status and trends is hampered by a lack of data, but the data which do exist show considerable variation across regions, countries and economy types, e.g., using the World Bank's country profiling and metrics (Chuhan-Pole *et al.*, 2013; HDRO, 2015; see **Figure 1.15**). Despite the data limitations, it is clear that tackling inequalities remains a considerable challenge for the future (World Bank, 2015a).

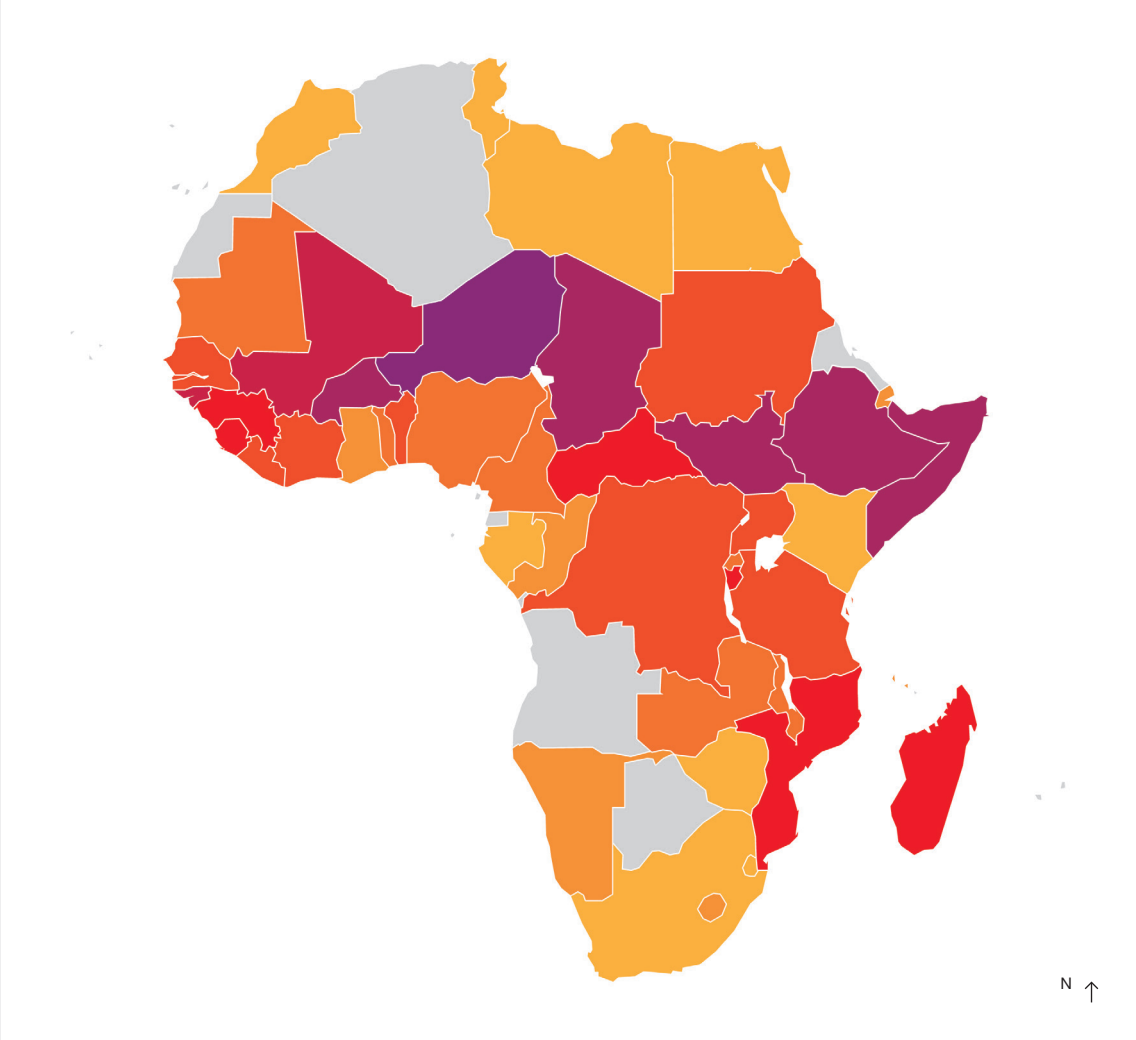
As indicated earlier, Africa is still largely agrarian and people living in rural areas experience most of the continent's poverty, both in terms of income and also through measures like the Multidimensional Poverty Index (MPI) (Christiaensen *et al.*, 2015; UNDP, 2015; World Economic Forum, 2015). The MPI itself exhibits wide variation across the continent, for example being >80% in Burkina Faso and Ethiopia and <10% in Egypt and Tunisia (UNDP, 2010, 2015). In Ethiopia, around 54% of the population living in urban households are affected by multidimensional poverty, but this reaches 96% when considering rural households. This urban-rural pattern is also seen in many other countries. While problems are greatest in rural areas, urbanisation itself certainly does not provide a route out of poverty for everyone, as is exemplified in cities all across Africa where the majority of urban settlements are associated with at least some unplanned, low-income settlements characterised by high rates of marginal economic activity (Arimah, 2011).

Much urban development in sub-Saharan Africa is informal, often characterised by a lack of basic services, poor housing, insecure tenure and overcrowding (Tibaijuka, 2007). Low-income urban settlements are likely to remain a core feature of urban Africa for some time to come and so the goals of conserving and enhancing biodiversity and ecosystem benefits must take this into account (UN Habitat 2014). Indeed, this makes the need for a serious consideration of urban ecosystem contributions all the greater, including how beneficial contributions can be yielded from informality, whether this is manifested in settlement forms or economic systems (Anderson *et al.*, 2013).

Poverty dynamics matter to this assessment in a number of ways, but there are two main ways in which poverty dynamics are connected to biodiversity and nature's contributions and therefore provide important context for this assessment. Firstly, people experiencing poverty are particularly reliant on nature's contributions (Fisher *et al.*, 2013). Given the geographical distribution of poverty, reliance can be expected to be particularly strong in rural areas, although there is also emerging evidence of increased dependence in urban areas too (Fisher *et al.*, 2013; Lindley *et al.*, 2015). In South Africa, for example, it has been suggested that even in urban and peri-urban areas, poverty rates could be 5–10% higher without the ability for people to supplement incomes from ecosystem-based resources (Ward *et al.*, 2016). Material contributions from ecosystems offer an important 'safety net' through which people can maintain a good quality of life during times of need. This can be the case for food and fuel, but also for medicinal purposes, as is further explained in the next section. As a result, material contributions from ecosystems tend to be particularly valued. There is, however, also evidence that regulating contributions play a particularly important role in helping to improve the quality of life for the poor, for example as a means of accessing fresh air, clean water, shade and tranquillity. The impacts of meeting these needs, particularly when based on harvesting material contributions, can be felt in localised areas. This can result in over-exploitation, environmental degradation and the loss of biodiversity, even in critical biodiversity hotspots (Brown *et al.*, 2013). Sometimes degraded land is the only land which is available to the poor, leading to more marginal livelihoods and precarious living conditions, for example as a result of more extreme exposure to natural hazards (IPCC, 2012). This is a considerable issue given that as of 2010, some 22% of the entire population of sub-Saharan Africa was estimated to be living on land classed as degraded (UNDP, 2016).

The second way that poverty dynamics matter is that in order to lift people out of poverty, it is necessary to use material contributions from nature, i.e., to further tap into Africa's tremendous resources in order to provide the necessary infrastructure and materials to support economic transition (World Economic Forum, 2015). In addition to catalysing large-scale overexploitation, this may also lead to indirect drivers on biodiversity losses, as is explored in Chapter 4. Poverty, both in its own right and due to its connection to poor health and education, is considered to be one of the impediments to realising Africa's potential for future economic growth and security (World Economic Forum, 2015). In turn, economic transition – in a way which is mindful of the need for modes of production and consumption which protect ecosystems – is considered paramount to the ability to weather shocks and stresses on the continent and therefore to protect against poverty (UNDP, 2016). Poverty is also tied in with conflict and instability, acting as both a driver and outcome, but difficult to disentangle from other drivers, such as those associated with the political economy of natural resource exploitation.

Figure 1 15 **Levels of multidimensional poverty in Africa. Sources: methodology based on Alkire *et al.* (2010); Alkire *et al.* (2016); Alkire *et al.* (2017); data retrieved from http://hdr.undp.org/en/data.**



Central to understanding the value of nature and the drivers of change on biodiversity and ecosystem contributions is an appreciation of who is more likely to experience poverty, the characteristics of poverty dynamics and the impacts of measures put in place to prevent or reduce poverty (an area also further explored in Chapter 6). Although a complex picture, there is evidence of the feminisation of poverty and associated characteristics such as literacy, access to information, power and influence (Chant, 2007). This is especially marked for some sub-groups – for example, widows, given that evidence suggests that the poverty rate is generally lower when the head of household is female, this is due to the high productivity of women in Africa. The only exception is found in Southern Africa since poverty rate amongst female-headed homes are higher (Christiaensen *et al.*, 2015; Beegle *et al.*, 2016). Older people are also disproportionately affected and, although there have been some improvements in intergenerational equality in Africa, this remains high. It is thus the social as well as the geographical distribution of poverty, which has implications for patterns in the demand for beneficial contributions and the potential for pressure and degradation. Poverty dynamics can be particularly marked at the level of individuals and households. Evidence from Kenya demonstrates that the most important set of factors determining a decline into poverty relate to the direct and indirect impacts of poor health (Kristjanson *et*

al., 2010). Health dynamics, trends, status and prospects together with their connections to nature and nature's contributions to a good quality of life are therefore integral to setting the scene for this assessment.

1.3.7.3 Human health and ecosystems

Good health is a central condition of a good quality of life and therefore the role of biodiversity and nature's contributions to health and well-being is critically important to understand. This is particularly so in Africa, where health challenges remain some of the most demanding in the world. The environment influences health through a range of physical, biological, social and psychosocial factors. Population health, the integrity of natural resources and development of a country are intertwined and interdependent. The final part of this section provides an outline of health issues in the African context and introduces some of the ways that nature and nature's contributions influence a good quality of life through human health. This inevitably includes discussion of some of nature's contributions to people, which require management in order to avoid having negative impacts.

Over the last decade, health outcomes in Africa have seen considerable improvement in many areas, including for some disease burdens and both childhood and adult mortality rates (WHO, 2014). This is in line with tremendous successes in global public health. For instance, there has been an estimated reduction in the incidence of malaria by 12.1% (9.7% low to 16.4% high) between 2000 and 2015, so that the Millennium Development Goal 6 "*to have halted and begun to reverse the incidence of malaria*" (Target 6C) has been achieved (WHO, 2016). There have also been improvements in responses to other important diseases, for example, through the Integrated Disease Surveillance and Response Strategy (WHO, 2014). Nevertheless, the lack of equal access to health and sanitary services is still a major threat for those affected by those epidemics which still, unfortunately, occur (e.g., ebola, yellow fever and dengue fever).

Between 1990 and 2012, all-cause mortality rates in children under 5 years old have almost halved, and maternal death rates reduced by 41% between 1990 and 2010. Some of the drivers of these changes include measures to tackle malnutrition and improve access to safe drinking water, both of which are strongly related to ecosystem-derived contributions. Although clearly important on human development and humanitarian grounds, these health improvements are also important for economic development, given that annual economic growth rates are estimated to rise by 0.4% in response to each 10% increase in life expectancy at birth (WHO, 2014). However, the 'ecological paradox' of degrading environmental conditions and improved health outcomes points to some of these successes potentially coming at the expense of future generations (Whitmee *et al.*, 2015).

There are a number of terms and conceptualisations, which are used to understand the factors which affect human health and well-being. For example, public health security is defined as *"the activities required, both proactive and reactive, to minimize vulnerability to acute public health events that endanger the collective health of national populations"* (WHO, 2007). This encompasses the emergence and spread of diseases caused by the contact between humans and nature (Eisenberg *et al.*, 2007). It also includes non-communicable disease, including the ways in which humans are subject to poor health as a result of exposure through air, water, soil and food pathways (see Chapter 4, section 4.2.2.5). Biodiversity and ecosystem contributions are also associated with other aspects of physical health like nutrition. Finally, emerging evidence strongly suggests that there are many wider influences with nature's contributions including for psychological and social well-being and for mental health. This is one of the areas in which synthesising ILK will be vital.

There are many factors explaining the emergence of infectious diseases, a major contribution of nature requiring effective management. Factors include environmental changes that have a natural origin (e.g., variations in rainfall, climate change) human-induced factors (e.g., deforestation, urbanisation, dam construction, practical food agricultural practices, trade, armed conflicts) and also the degradation or lack of availability of public health services (e.g., infrastructure and associated lack of vaccination programs). Nature's contributions are important for promoting and improving health. For example, there are many cases across Africa that demonstrate the role of forests in providing material contributions through subsistence benefits for human health. Increasing forest cover has been linked to improved dietary nutrition outcomes due to increased availability of material resources for sustenance (Johnson *et al.*, 2013, Ickowitz *et al.*, 2014, Rowland *et al.*, 2015). Moreover, wildlife consumed for food, although hosting potential for zoonotic pathogen transmission (Murray *et al.*, 2016), has also been linked to protecting human food security, and economic and nutritional well-being (Golden *et al.*, 2011; Brashares *et al.*, 2011; Fa *et al.*, 2015). The declines in fisheries, discussed in Section 1.3.4.1, have major implications for micronutrient supply. Chapter 4 (section 4.2.2.3.4) explores the impacts and illustrates how reliance on fish for nutrition and livelihood has gender and social dimensions, e.g., in the case of Senegal. At the same time that marine, freshwater and terrestrial ecosystems are coming under increasing pressure, many rural populations lack access to basic health, a situation that leads to poor health outcomes and restricts the population's ability for productivity.

Box 17 Bio-prospecting: the case of Madagascar.

The International Cooperative Biodiversity Groups (ICBG) Program was established in 1992. Madagascar ICBG program had as its focus the three major goals of drug and agrochemical discovery, biodiversity conservation, and training and economic development. The program aims to integrate improvement of human health through drug discovery mostly from plants, the creation of incentives for conservation of biodiversity, and promotion of scientific research and sustainable economic activity that focuses on environment, health, equity and democracy. Due to the unique climate, geological structure and biodiversity of Madagascar, it provides a promising site for bio-prospecting unique biological samples. Beneficiaries, mostly local communities, were infrastructure, livelihood activities, training and capacity building.

Despite the signature in 2001 of the International Treaty on Plant Genetic Resource for Food and Agriculture (ITPGRFA), backed by the FAO, implementation at the national level has been slow (Prip *et al.*, 2015). Madagascar, for instance, has ratified the treaty in 2006, has ratified the Nagoya Protocol on ABS in 2014 and both ITPGRFA and NP/ABS have each drafted laws for the implementation of these international instruments at the national level. In June 2016, regulations were drafted as interim measures but there is still no formal policy on bio-prospecting or access and benefit-sharing (ABS).

The Libreville Declaration on Health and Environment in Africa (WHO-UNEP, 2008), signed by 52 African countries (organised by WHO and UNEP), is a platform to address the link between human health, wildlife and environmental health. The Population-Health-Environment approach is implemented in many countries in Africa as the way to integrate improvement of human health and environmental conservation in remote, ecologically rich ecosystems with the most dynamic human-environment systems.

Further, the emerging field of Planetary Health is also important to note here – a novel discipline within Global Health dedicated to understanding the ways in which human alteration of earth systems has led to significant human health impacts (Whitmee *et al.*, 2015). Poverty remains an important cause of poor health in much of sub-Saharan Africa. Some of this can be linked to negative outcomes resulting from the direct use of nature's material contributions to people. To give just one example, the use of charcoal and wood for domestic energy needs can lead to high pollution exposure burdens and associated respiratory illness and mortality, especially in young children (Bailis *et al.*, 2005; Lim *et al.*, 2012). Issues associated with air pollution are discussed in more detail in Chapter 4.

Flooding and drought must also be considered, as well as their interrelation with uncontrolled urbanisation and the related obstruction of previous flows in the ecology of urban and peri-urban systems. Ecosystem changes, including deforestation and climate-related changes, influence waterborne as well as vector-borne diseases. If not sufficiently addressed, these diseases can eventually result in pandemic crises. Many water-borne and vector-borne diseases belong to a group referred to as Neglected Tropical Diseases. As the last Ebola crisis showed, there are considerable international threats around neglected tropical diseases.

One specific example of how anthropogenic drivers acting on intact landscapes have driven a proliferation of emerging infectious diseases is the increasing demand for bushmeat for food. Further, global transportation of people, wildlife and livestock, as well as blood-to-blood contact during the hunting and butchering of bushmeat increase opportunities for cross-species disease transmission in Africa such as Severe Acute Respiratory Syndrome, monkeypox, Ebola and HIV/AIDS. The Cost-effectiveness analysis conducted by WHO of environmental health interventions demonstrated that the impact of environmental health management is highly uncertain due to methodological difficulties, the lack of reliable data and the lack of data which connects to stakeholder needs (Edejer *et al.*, 2003).

In Africa, the use of medicinal plants has always been a fundamental component of traditional healthcare systems, and it is perhaps the oldest and the most varied of all therapeutic systems. This knowledge has been validated through its transmission over many generations. In many developing countries, it is believed that traditional medicine is still the main source of health care for about 80% of the population due to its cultural acceptability, affordability and accessibility (Elujoba *et al.*, 2005). Prescription of medicinal plants by traditional healers in many parts of rural Africa is the most easily accessible and affordable health resource available to local communities and at times the only therapy that exists. Studies suggest that there are 5,400 documented medicinal plants in Africa (Moyo *et al.*, 2015). Nonetheless, there is still a paucity of up-to-date and comprehensive databases of plants with known and potential medicinal properties for the African continent. This is in part due to the highly localised nature of indigenous knowledge bases.

Due to the importance of traditional health systems and related ecosystem contributions in Africa, Chapter 2 further

extends the discussion introduced here. It is clear that sustainable management of traditional medicinal plant resources is important, not only due to their value as a potential source of new drugs, but also due to reliance on traditional medicinal plants for health and in some cases for income. Examples from Sahelian countries show how wild plants play important social, cultural, aesthetic and ethical roles for rural communities, as local people depend on them for food, traditional medicine, construction, handicrafts, cosmetics, forage and revenues (Dembélé *et al.*, 2015). A recent IPBES report (Roué *et al.*, 2016) shows that 72% of Egypt's desert systems species were used for medicinal purposes, and that they also provided an income for local communities. Their use is not only due to cost but also due to perceptions of their higher effectiveness and relative ease of access (from herbal shops and directly from the environment) (Roué *et al.*, 2016). With few exceptions, traditional medicinal plants are collected from the wild as barks, roots and whole plants. Although reliance on traditional medicinal plants may decline in the long-term as alternative healthcare facilities become available, increasing demand for popular herbal medicines is expected in the foreseeable future.

1.3.8 Governance, tenure, security and trade

The way people hold, use and manage their land and natural resources; the way they produce food, consume goods, and manage their wastes and knowledge systems; their health as well as their cultures, freedoms and security-condition, and are conditioned by prevailing systems of governance. There are numerous and varied definitions of governance. In the context of this assessment, we define governance as the diverse and plural modes and processes of making decisions on society and the environment and acting upon them (see Chapter 6). This highlights some of the factors and frame conditions through which natural endowments are used, food and goods produced, and diverse socio-environmental outcomes realised (see Chapter 2). Governance is thus central to all biodiversity and ecosystem services issues, and particularly to the issues discussed across this section. Its definition can be applied to broad cross-sections of the human-ecological complex or to specific areas, as in biodiversity governance, landscape governance, tenure governance or climate governance.

Partly for editorial reasons, this subsection emphasises the specific interrelations linking governance to tenure, security and trade. This happens in extremely diverse and fundamental ways. The management of natural resources, the impacts of armed conflicts on biodiversity, and conflicts over disputed natural resources are some of the issues addressed here.

1.3.8.1 Environmental governance in Africa

There is a diversity of governance frameworks. Most emphasise one or both components of governance as a structure of normative and ethical principles **(Figure 1.16)**. For instance, many UN agencies have adopted variants of UNDP's five principles of "good" governance: (1) participation and voice, (2) accountability (including transparency), (3) equity (including rule of law), (4) direction (relating to strategic vision), and performance (including responsiveness, effectiveness and efficiency) (Buchanan-Smith *et al.*, 2013). However, there is a bias in the literature, which tends to reflect predominantly normative and hierarchical views of governance. For instance, UNESCO-IHE (Buchanan-Smith *et al.*, 2013) defines governance as the process of taking care of public interests through leading, ruling, planning and managing, controlling, and correcting (enforcing and sanctioning) organisational resources. This definition is more top-down and gives primacy to a leading, controlling agency. Other frameworks are more neutral in engaging the responsibility of a multiplicity of influential agents (see also Chapter 6).

This assessment is more in tune with that second trend. It considers that governance happens at multiple scales, involves multiple parties, not just governments, and integrate dimensions related to (i) social choices and strategic direction, (ii) norms and performance (capability, transparency, legality), and (iii) social justice (voice, equity, legitimacy). Though **Figure 1.16** does not show it, each principle is clustered with functionally related indicators. For instance, transparency is functionally related to accountability and responsibility and is sometimes interchangeable with them. The same is true, for instance, of equity, fairness and natural justice; legality, rule of law and justice (judiciary); capabilities, performance and responsiveness. It can be useful to think of those clusters as bundles of governance principles or governance norms associated with sets of governance indicators.

In a recent paper on Earth System Governance for Africa (Habtezion *et al.*, 2015), 13 scientists, mostly African, make the case that traditional environmental governance "do not adequately address the gamut of human-natural system interactions within the context of the complex bio-geophysical cycles and processes of the planet". They argue that modern and traditional governance systems in Africa have complex relations with global change dynamics and that attention must be paid to the resulting system drivers and teleconnections. Though, perhaps not at the scales and scopes of bio-geophysical integration promoted by the Earth System Governance framework, these questions have actually been extensive objects of research and policy analyses in Africa. A small cross-section is considered below in relation to the lessons that have been

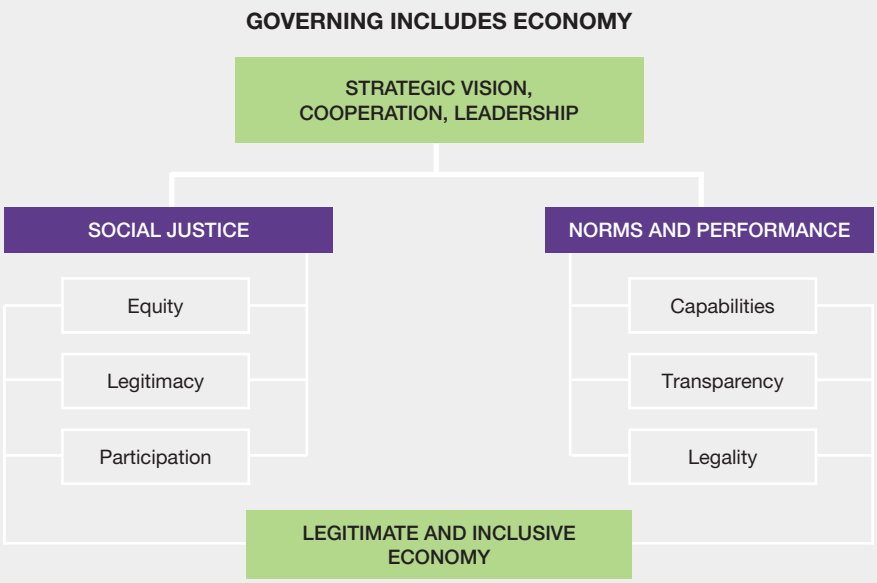
drawn from natural resources management decentralisation, participation, biodiversity governance, and integrated landscape management.

1.3.8.1.1 The decentralisation of Natural Resource Management

Very little is known and has been written about pre-colonial conservation practices in the region. A rather misplaced belief is that low population densities, 'unsophisticated' agricultural and hunting practices, and 'immobile populations' meant that ecological conservation was built into the routine economic, social and religious activities of the era. Consequently, pre-colonial societies did not need to develop sophisticated conservation mechanisms. The reality is very different. Ample evidence exists of settlements consolidated with high population densities (Murombedzi, 2003), such as in the Niger Delta and Bambara City States, in Great Zimbabwe, Kanem Bornou and the earlier empires of Ghana, Mali and Songhaï, for instance (Diaw, 1985). Agricultural and resource extraction activities were finely adapted to the requirements of specific resources and ecosystems, while the societies themselves developed sophisticated mechanisms to regulate resource use. However, much evidence of pre-colonial conservation practice has been displaced by colonial conservation practices. In Southern Africa, a significant number of contemporary protected areas were already protected under pre-colonial regimes. Examples of such pre-colonial conservation areas include Central Kalahari Game Reserve, Moremi Game Reserve and Chief's Island in Botswana; Mavhuradonha, Matopos, and Gonarezhou National Parks in Zimbabwe; Tsidilo Hills, Mamili National Park, and Salambala in Namibia; and Hluhluwe-iMfolozi Park in South Africa. However, the imposition of colonial conservation regimes on these landscapes led to conscious efforts to obliterate these pre-existing land-uses and their long-term impacts (Murombedzi, 2003; Adams, 2003).

Decentralisation in Africa started in British colonies in the 1950s. Local bodies with limited powers were then created, although newly independent governments actively seeking to reinforce nationalism and allegiance to the central State, later suppressed them in the 1960s. By contrast, Francophone countries such as Mali, Burkina Faso and Senegal started decentralisation after independence in 1960. They saw it in a different light, as a way to construct the nation-state by extending its reach through local governments (Diaw, 2010). Senegal went as far as establishing rural councils in 1972 (Jacob *et al.*, 1997). Overall, however, command and control approaches and forms of "decentralised despotism" (Mamdani, 1996) dominated the governance field at the time (Manor, 1999). The 1990 Arusha Declaration and the African Charter for Popular Participation in Development and Transformation played a key role in raising African political awareness of this "over-centralisation of power" and its "impediment to the effective participation of the overwhelming majority" (UNECA, 2010). The full growth of decentralisation policies in Africa took place in the 1980s and 1990s. This was a global

Figure 1 16 **Structure of governance principles. The economy is a key domain out of which the constitutive values of governance cannot really be expressed in the society. Source: Diaw *et al.* (2016).**



Box 1 8 Community-Based Natural Resource Management (CBNRM).

CBNRM initiatives facilitated local agreements on regulating resource use in countries such as Mali and in Madagascar where they were known as GELOSE. In Tanzania, which is described as one of the most advanced community forestry jurisdictions in Africa (Wily, 1997, 2000; Blomley, 2006), 'village governments' have significant powers to receive, raise and disburse funds based on local plans and to enact bylaws under the Village Land Act of 1999. In Niger and Ethiopia, local governments can also enact by-laws on land-use and even register common pool resources in their name. In some countries (e.g., Rwanda, Burkina Faso, Benin), local government is responsible for the management of small-scale irrigation schemes and drained wetlands in valley bottoms (Hilhorst, 2010). The Gambia offers a rare case of self-initiated CBNRM, later co-opted, after eight years, by the official community forest program (Diaw, 2009). In Central Africa this movement started in the mid-1990s with the 1994 forestry law in Cameroon, followed by most other Congo Basin countries within a decade. This included community forestry reform, as well as fiscal decentralisation of forest revenues and the establishment of municipal forests and community hunting zones and committees (e.g., Logo, 2003; Nelson *et al.,* 2003; Oyono, 2005; Oyono *et al.,* 2007). CAMPFIRE in Zimbabwe was actually the pioneer in 1989 of African community wildlife management schemes, which were later taken on by a number of other countries, including Cameroon, Rwanda and Uganda (Matose, 1997; Mandondo, 2000; Prabhu *et al.*, 2001). For their part, Burkina Faso, Ghana, Kenya, and Senegal developed advanced legislative and regulatory mechanisms for fiscal and financial decentralization. But it is noted that local governments have had limited capacity in practice due to the inadequacy of financial transfers from the central government and weak local revenue-raising capacity (Chambas *et al.*, 2012). Other natural resource management schemes also had problems, such as central retention of powers, weak local participation and accountability, conflicts with customary tenure and elite capture (Diaw, 2010). It was also noted that governments continue to appropriate valuable local commonage and lease these lands to investors for farming, logging, mining, ecotourism and carbon credits compensation schemes (Wily, 2008). Decentralisation of water management also took place in many countries, essentially under the form of integrated water resource management. Most Southern African countries have enacted or amended their water laws and policies and restructured their institutional and governance frameworks in that line over the last 20 years or so. But it is also noted that actual devolution to local institutions and local water stakeholders, which often have a better knowledge of the catchment functioning, has been unequal and wanting. In South Africa and Mozambique several years after the launch of the new water policy, the vast majority of catchment management agencies and water administration entities were not operational, while many water user associations were struggling to find their place in the water management schemes (Farolfi, 2010).

movement, closely associated with structural adjustment policies; land and fiscal reforms; and the progression of electoral democratic frames; and it took many forms in Africa (Diaw, 2010). Devolution to rural councils and urban and rural municipalities started in countries such as Mali, Niger and Burkina Faso in the aftermath of the democratic transitions of the 1990s. Mozambique, Ghana, Ethiopia, South Africa, Kenya, Uganda, DRC, and several other countries, now have decentralisation enshrined in their laws or constitutions, although often not fully effective.

In spite of diverse and elaborate typologies, a loose consensus had emerged by the late 1990s around two major forms of decentralisation: (1) deconcentration or administrative decentralisation, marked by the dispersal of state powers from higher to lower levels of administration; (2) devolution, when decision-making authority is transferred from central government to local groups and institutions. These concepts and a host of related variants where applied to dozens of reforms of the state and natural resource sectors in the developing world, particularly agriculture, forests, fisheries, water management, health, and biodiversity conservation. Natural resource management decentralisation was, in this way, the key channel by which citizens and communities became involved in the governance of biodiversity and ecosystem services in Africa. Participatory natural resource management started in Africa at the end of the 1980s in an effort to empower local resource users. Examples include 'gestion de terroir', local conventions, community-based natural resource management, community forestry, and participatory forest management (Hilhorst, 2010). This movement is still evolving today to include community wildlife management schemes, integrated conservation development projects, integrated water resource management, marine protected areas and Integrated Landscape Management (ILM), the most recent initiative.

1.3.8.1.2 The historicity and evolution of protected areas

Historically, protected areas have been the main sites of biodiversity conservation in Africa. Sabie (Kruger National Park) in South Africa and Amboseli in Kenya were established as early as 1892 and 1899 respectively. Other reserves were established in the 1920s and 1930s, often to be re-gazetted as national parks after the Second World War or after independence (Diaw, 2014). This fits the global post-war growth of protected areas, particularly after 1960. By the time of the 2003 World Parks Congress in Durban,

which was instrumental in identifying governance as "central to the conservation of protected areas" (WCPA, 2003; Borrini-Feyerabend *et al.*, 2004), Protected areas had grown from less than 10,000 in 1950 to more than 100,000 sites around the world (Diaw, 2010). They now cover over 15% of the world's terrestrial areas and inland waters and 3% of the oceans (Belle *et al.*, 2015). Through CBD Aichi Biodiversity Target 11, governments worldwide have pledged to protect at least 17% of terrestrial areas and inland water and 10% of coastal and marine areas by 2020.

Using data from the World Database on Protected Areas, augmented by records from the Indigenous and Community Conserved Areas, registry and other additional data, Belle *et al.*, (2015) found that protected areas, for which spatial data was available, cover 13.4% of sub-Saharan Africa's land area and 2.6% of the marine area. Across the four IUCN governance categories, they found that state governance (1,273,123 km^2) represents 35.6% of the total protected area coverage (or 78% of the known governance types), community governance (232,277 km^2) 6.5% of the total (or 14.2% of the known types), shared governance (117,452 km^2) 3.3% (or 7.2%), and private governance 0.3% (or 0.7%). Governance types were not recorded for 54.3% of the protected areas in sub-Saharan Africa (see **Figures 1.17 and 1.18** for representation of more recent WDPA data).

Figure 1 17 **Protected areas by governance types in Africa. Source: data from UNEP-WCMC *et al.* (2017).**

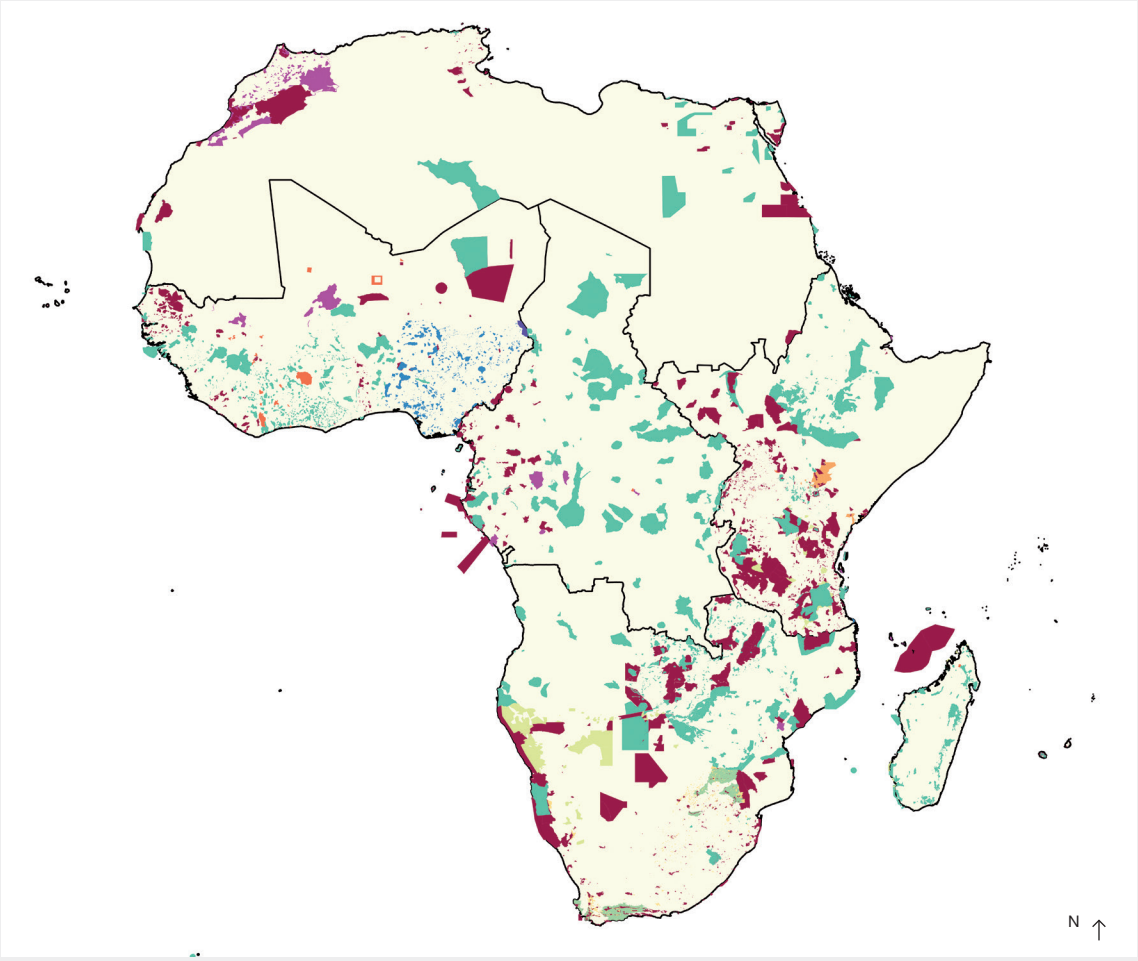
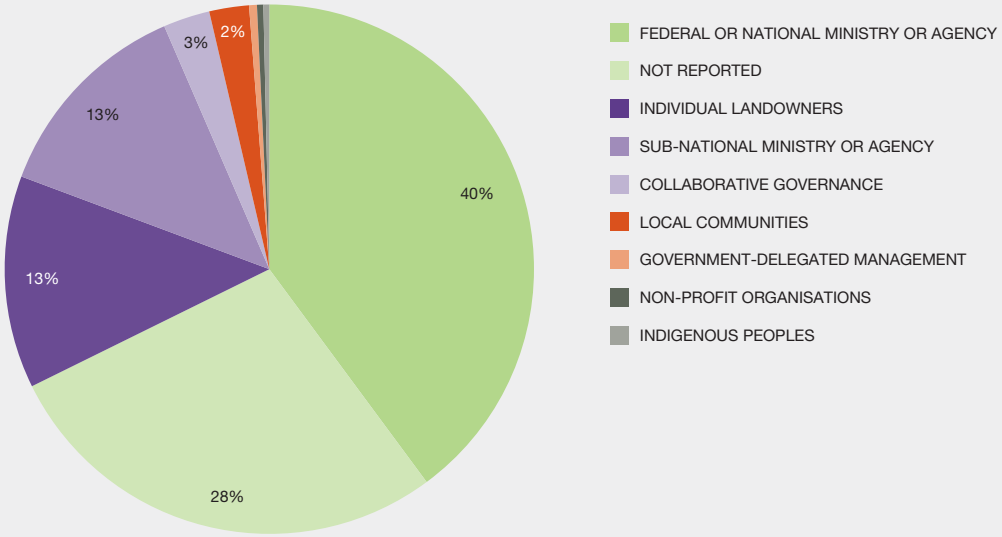


Figure 1 18 **Percentage of protected areas under different governance types in Africa. Source: data from UNEP-WCMC *et al.* (2017).**



From their origin and following a global pattern, protected areas in Africa were established under tight government control and in ways that excluded local people from their management and use. This reflected centralised concepts of State as well as the perception that it was the only way to preserve critical habitats and species representing an exceptional national heritage. These restrictive policies had severe impacts on local people, including cases of forced displacements, and were a continuous source of tensions and conflicts around protected areas (Brockington, 2002; Cernea *et al.*, 2003; Schmidt-Soltau, 2003; Tiani *et al.*, 2006; Diaw *et al.*, 2010).

Beyond terrestrial biomes, such processes also occurred in marine environments. Belle *et al.* (2015) cite the case of the South African Hangberg marine protected area, established in 1934, where 70 years of dispossession of local fishing rights "resulted in an impoverished community, a thriving informal or illegal fishery and an eroded sense of legitimacy toward the state". State-driven marine protected area planning in Mozambique is reported to have similarly harmed communities and provoked ambivalence towards marine protected areas.

Privately protected areas were the first alternative governance type to emerge in the 1950s (Langholz *et al.*, 2004). They most often take the form of private game ranches, private nature reserves and private conservancies, particularly in eastern- and southern Africa where many natural features and landscapes are favourable to developing markets for wildlife and where land tenure regimes and legislation favour private ownership of such lands. Only after the 1980s did non-state governed protected areas start to gain prominence, making up nearly half of protected areas gazetted after 2000 and the great majority after 2010. As illustrated in **Figure 1.18**, such governance is still very weakly represented in most of Africa.

1.3.8.1.3 Integrated Landscape Management (ILM)

ILM has recently emerged as a rallying point for moving beyond land-use conflicts and single-sector policy silos to address the values and interests of stakeholders across land-uses and policy domains. Landscape approaches have been around for several decades but the growing consensus that they now enjoy globally and in Africa is recent; there are now more than 500 ILM initiatives around the world, 87 of them in Africa (Scherr *et al.*, 2013; Milder *et al.*, 2014; LPFN, 2015). "Integrated landscape management encompasses agriculture, ecosystem services, biodiversity, aesthetic landscape value, cultural identity and recreational values as well as human settlements and resource extraction industries. Networks are emerging, such as International Landcare that support dozens of locally-organised landscape initiatives in Asia and Africa, and the international Model Forest Network that supports long-term multi-stakeholder initiatives in 58 landscapes in the Americas, Africa, Asia and Europe" (Scherr, 2014).

Examples include multi-objective landscape restoration in Rwanda, the Great Green Wall initiative in the Sahel, ILM in Ethiopia and Kenya, climate-smart landscape for certified cocoa in Ghana, and Model Forest landscapes in Cameroon, DRC, Central African Republic, Congo,

Rwanda, Morocco, Tunisia and Algeria (Milder *et al.*, 2014; Diaw, 2015; Kusters, 2015). Inclusive global and regional platforms have been formed to support this process, particularly the Landscape for People, Food and Nature, the Global Partnership for Forest Landscape Restoration and the Global Landscape Forum, The African Landscape Restoration Initiative (AFR100), and the African Union's Resilient Landscape Initiative. This trend is comforted by the African Landscape Action Plan, endorsed by the AU and several of its programs and supported by Landscape for People, Food and Nature. All these developments suggest that landscapes will play an increasingly important role in African countries attempts to reconcile their conservation and restoration interests with the growing demand for demand for food, consumer goods and multiple ecosystem benefits in the region.

1.3.8.2 Land tenure and tenure governance

Land tenure is an all-encompassing theme in environmental governance (see also Chapter 6). Diaw (2009) makes the case that at the heart of land and governance issues in Africa is the coexistence of, and unresolved tension between blood rights (*jus sanguinis*) and territorially based civil rights (*jus soli*). These are the two predominant forms of government in history (Morgan, 1877). In blood rights, government is exerted through descent groups, while territorially based civil rights are founded on political citizenship and membership in a territory. Thus, community and citizenship continue to coexist in tension as distinct sources of popular legitimacy in Africa. Variants of this tension still exist in other regions, including in the definition of citizenship in the West. The fundamental characteristic of tenure, as an expression of this tension in Africa, is legal pluralism, the continued coexistence of customary tenure alongside statutory tenure regimes inherited from British, French, Portuguese and Spanish colonialism.

1.3.8.2.1 The persistence of customary tenure

Colonialism introduced new dimensions of land ownership that denied pre-existing communal land rights in order to impose the sovereignty of the colonial state and the essential supremacy of private property and title (Mamdani, 1996; Berry, 1993). According to Diaw *et al.*, (1998) a major paradox of the African land tenure nationalism in the 1960s and 1970s is its origin in colonial tenure policies. In Francophone Africa, the national domain laws made the state the manager or guardian (e.g., Côte d'Ivoire, Senegal, Mali, former Haute Volta, Madagascar, Cameroon) or the owner (e.g., Guinea, Mauritania, former Zaïre) of the national estate. They sought to reduce the communal bases of African tenure in order to "detribalize" the system (Melone, 1972) and build the nation-state. A few countries, such as Kenya, and to a lesser extent, Uganda, developed strong privatisation programs while others, such as Tanzania and Ethiopia, attempted to replace customary tenure with sweeping villagization and land-to-the-tiller reforms (Bruce *et al.*, 1998). Other countries, such as Ghana and Sierra Leone, did recognise customary authority through a dual system of land administration under state guardianship. Overall, a dual, unequal and hierarchical system of land tenure was inherited, with freehold and leasehold being treated as superior to customary land rights (Shivji *et al.*, 1998).

As a whole, these policies failed to achieve the anticipated dissolution of customary tenure (Diaw, 2005). Rather, tenure tradition continues to coevolve with statutory laws, getting more complex as they intertwine over time, eroding in some places, emerging anew in others, and eluding both theoretical predictions and reform planners. Until the late 1990s, customary or community-based tenure was found to be the '*de facto* dominant tenure type' in virtually all of sub-Saharan Africa with the exception of Cape Verde, South Africa and Namibia (Bruce *et al.*, 1998). In Kenya, it was found to be co-dominant with private ownership, despite one of the most aggressive, long-standing privatisation program on the continent. The same was true of Senegal, whose privatisation scheme went as far back as the 1830s (Diaw *et al.*, 1998). The extraordinary resilience of customary tenure is a direct consequence of its "embedded" nature, that is, the way it nests private rights into the commons and collective property, and then into marriage and descent (Diaw, 1997, 2005; Agbosu, 2000). Failure to understand this blocked many attempts to change customary tenure, and the resulting legal pluralism – "the presence in a social field of more than one legal order" (Griffiths, 1986) still endures.

1.3.8.2.2 Africa's adaptations to legal pluralism

Replacement policies have now given way to "recognition that land policies and laws must build on local practice, and that there is no 'blueprint' approach that can be successfully applied to different contexts and cultures" (Buchanan-Smith *et al.*, 2013). The African adaptation to legal pluralism took many forms, alongside continuous exercise by the State of its sovereignty over the national domain through the granting of land-related concessions, the facilitation of private land acquisition schemes or occasional expropriation of communal lands for purpose of public interest. Hilhorst, (2010) notes "a general shift towards some form of legal recognition of customary rights", as countries review their land policies and legislation to secure smallholders' rights, while making land available to investors and encouraging productive land-use. Buchanan-Smith *et al.* (2013) cite the Kenya Land Policy of 2007 as an interesting example of how statutory frameworks and legislation can recognise and protect customary rights. The policy also makes unusual provision to secure pastoralist land rights and livelihoods.

In order to deal with critical land administration issues, a number of countries have developed systems for the inventory and registration of local land rights. This is the case in Madagascar, as well as Ivory Coast, Benin and Burkina Faso with their '*plans fonciers ruraux*' and Burundi with the '*guichet foncier*'. All countries established local committees for rights inventories and to mark boundaries, register land, record transactions, safeguard deeds and mediate land conflicts. In most countries, customary authorities are encouraged to become members or to collaborate with these committees. Examples of such committees are the Land Administration Committee (LAC) in Ethiopia at the *kebele* (ward) level, the *commissions foncières* at the village level in Niger, the *commission de reconnaissance locale* in Madagascar and the land adjudication committees (cell level land committees and sector level land committees) in Rwanda. Ensuring that women are part of these committees has proven to be important for equity in Ethiopia (Hilhorst, 2010). Land administration approaches also vary only slightly from one country to another. In Burkina Faso, there is an inventory of prevailing rights, followed by registration. Ethiopia and Niger follow registration with the issuance of a certificate, while Rwanda adds a light form of surveying. Some countries only register at the request of individuals (e.g., Madagascar, Burundi), communities (e.g., Benin, Niger) or if suggested by local governments (Niger). Land information archives are kept locally at the village (e.g., Tanzania, Malawi), or local government level (e.g., Burkina Faso, Ethiopia) or may be fed into a nationwide database (e.g., Madagascar). Hilhorst (2010) notes, however, that the linkage "between these 'new land policies' and existing legislation concerning forests, grazing lands, fisheries and other natural resources, or legislation related to 'community-based natural resource management', is often missing". It may be up to local governments or integrated platforms such as the ones found in ILM to bring together these various strands of legislation, policy and practice.

1.3.8.3 Policy frameworks and guidelines on tenure governance

Today, land tenure and land governance remain challenging areas of work throughout the continent. For instance, since the early 2000's, Africa has been experiencing an unprecedented wave of large-scale land acquisitions, the largest on the planet (Carmody, 2011; UNECA, 2013; Nolte *et al.*, 2016). Countries such as South Sudan, Sudan, DRC, Liberia and Guinea are at the forefront of these developments spurred largely by foreign investments. To date, Africa has a recorded a total of 422 operations, expected to cover some 35 million hectares for a range of purposes related to food and non-food agricultural commodities, such as biofuels and livestock. It has been pointed out that these developments could result in the destruction of vast natural habitats across Africa and the depletion of biodiversity (Lee *et al.*, 2011; Senelwa *et al.*, 2012) as well as the dislocation of the rights of local communities (Oyono, 2013). Thus, a number of regional and international frameworks and guidelines have emerged over time to help deal with issues such as state and foreign investments, land grabbing, agricultural growth model, or indigenous people and local communities' rights.

The Land Policy Initiative, jointly established in 2006 by the AU Commission, the United Nations Economic Commission for Africa and the African Development Bank, has been instrumental in producing a Framework and Guidelines on Land Policy in Africa, which was adopted in 2009 by African Heads of State and Government through an AU Declaration on Land Issues and Challenges in Africa. In 2006, a process of consultation and negotiation involving 190 governments was also begun at Porto Alegre, Brazil, with civil society and private sector groups. This ultimately led, on 11 May 2012, to the adoption of the VGGT – the Voluntary Guidelines on the Responsible Governance of Tenure for land, fisheries and forests in the context of national food security – by the Committee on World Food Security. These frameworks, supplemented by a host of other guidelines, for example, on the Right to Food, Responsible Agricultural Investments, Transparency and Disclosure, and Large-scale Land Acquisitions and Investments, hold much in common. They emphasise inclusiveness, participation and a multi-sector approach to land governance, reflecting lessons learnt from decades of work on land tenure and natural resources governance (Hall *et al.*, 2016).

The UK Department for International Development's LEGEND (Land: Enhancing Governance for Economic Development) project very recently published a State of the Debate Report on the implementation of the VGGT (Hall *et al.*, 2016). The report notes the similarity of principles and complementarities between existing frameworks and the World Bank's land governance analysis framework. It also identified several initiatives operating at pan African and country levels, including the New Partnership for Africa's Development (NEPAD)/Comprehensive Africa Agriculture Development Programme's joint Land Governance Program supported by the EU and a few initiatives using the World Bank's set of 27 land indicators to assess progress towards VGGT compliance. This framework "has now been implemented in 33 countries, with another 11 currently using it" (Hall *et al.*, 2016). The report also notes the land partnerships established in 2013 by G7 countries in Africa with the purpose of accelerating implementation of the VGGT in eight pilot countries: Burkina Faso, Ethiopia, Niger, Nigeria, Senegal, Sierra Leone, South Sudan and Tanzania.

Finally, a number of international and national NGOs are involved in separate campaigns for land rights and land

justice. Some have built relationships with multinational companies and assist them in operationalising the VGGT in their business operations and supply chains. Others work with communities to protect and defend customary land rights, and cover topics such as mapping and boundary agreement, community land governance rules and protecting land in investment negotiations. For instance, Namati, a global movement of grassroots legal advocates, with partners in Liberia, Mozambique and Uganda, works on the impacts of the registration of community land rights. As an alternative to individual titling, community registration of rights presents a model that is arguably more suited to forms of customary tenure (Hall *et al.*, 2016).

1.3.8.4 Conflicts, peace and security

Allocation, distribution and access to ecosystems services have been shown to play a key role in a broad range of different types of conflicts in Africa. Tenure, governance and poverty have played key roles in conflicts that spilt into devastating civil wars and armed confrontations in many parts of the continent. Collier *et al.*'s (2000) econometric model of civil war identifies two possible motives for such an aforementioned occurrence: greed or *loot-seeking*, and grievance or *justice-seeking*. Applying it to the African situation, they found that, on average over the period 1965–99, Africa had an incidence of conflict similar to that in other developing regions. The continent had, however, a very different structure of risk, essentially because of deteriorating economic performances. Their analysis suggests that the rising trend of African conflicts was not due to deep problems in the African social structure but to an atypically poor economic performance. Other contributing factors included the historical context, the existence of grievances and of large groups willing to engage in rebellion, and the availability of finance to meet payroll and buy weapons. Although Collier's greed-based theory has been criticised for reductionism (Sambanis, 2004; Bensted, 2011), such factors were indeed prominent, for instance, in the Sierra Leone rebellion and civil war.

The interrelationship between biodiversity and ecosystem services, natural resources and conflict is dynamic and multifaceted. Not all conflicts are violent and not all violent conflicts are carried out with weapons. Similarly, security does not necessarily require armed intervention. Therefore, in discussing conflict and security in the context of BES governance, this analysis takes into account three critical levels that need to be differentiated: (i) causal dynamics in the rise of conflicts that can spill over into violence and armed confrontation, including climate change; (ii) the impact of conflicts on biodiversity and ecosystem services and socioeconomic conditions; (iii) the governance configurations needed to facilitate security and peace-building.

1.3.8.4.1 The rise of conflict and violent confrontation

The drive to access natural resources may be a major cause of direct conflict, and yet it is entwined with the complex interactions of other factors, such as ethnic identity, tensions, and other historical, social, economic, legal and political factors operating at local, national and international levels (Onyige, 2011; also see Chapter 4). When not equally and evenly distributed, the allocation and distribution of, and access to ecosystems services and natural resources build up at multiple levels for a broad field of grievance and greed to gain sufficient ground to transition to armed confrontation. The new security risk driven by climate change further complicates the problem by bringing about environmental and human security variables not taken into account by Collier *et al.*'s (2000) model, which posits that armed conflicts are caused by combatants' desire for self-enrichment.

A recent study (Larcom *et al.*, 2016) has shown that "local institutions inherited from the pre-colonial era continue to play an important role in natural resource governance in Africa". Land disputes around customary land rights have been a causal factor in the majority of conflicts in Africa since the 1990s. Wily (2009) reports that only in three out of 30-plus conflicts were customary land rights disputes, not "a fundamental grievance driving people to war and emerging out of war as a concrete target of remedy". Unruh (2008) shows that land issues were a significant source of the overall conflict in Sierra Leone. The debilitation of customary and formal land institutions, as mentioned earlier, was a major cause of rural marginalisation, disenfranchisement, and poverty, all of which led to pronounced discontent. Large numbers of poor and unstable rural youth were 'spun off' from village society because of control exercised by village elders over land and marriage". In some areas of the country, land problems were so acute that joining the rebels sometimes led to the opportunity to take lands by force. In fact, land problems contributed to the eruption or exacerbation of conflicts in all the Mano River countries (Sierra Leone, Guinea, and Liberia) as well as in Côte d'Ivoire. "The chieftaincy system was one of the primary contributors to the war due to longstanding and common abuses, particularly regarding land issues. As a result, some of the worst violence was focused on certain leadership elements in the customary system, and many chiefs were targeted by the Revolutionary United Front and fled for the safety of Freetown, the capital, or abroad".

In a 2012 paper (Adano *et al.*, 2012), the Institute for Security Studies elaborates on a wide range of conditions that make climate change a major potential security threat for Africa. This owes in particular to a combination of severe climate-related impacts on economies that are highly climate-dependent and countries that currently

have the least capacity to adapt. The Institute for Security Studies notes that spatial and temporal changes in rainfall patterns and frequent droughts make the survivability of African pastoralists in arid environments, in certain areas, particularly difficult. This may be exacerbated by competition over access to pasture and water, livestock raiding and the widespread use of sophisticated firearms. This is, in part, exacerbating clashes between herders and farmers in the Sahel, fighting in the Oromia and Ogaden regions of Ethiopia and violent conflicts in northern Nigeria, Sudan and Kenya. Because security concerns are higher with the coming of the rains than during the drought, pastoral conflicts point at the strong role institutional governance can play in facilitating resource access and resource sharing to prevent and mitigate these factors of conflict.

Outside arid regions, the Albertine Rift in the DRC, one of the most biodiverse, ecologically unique regions of Africa, is also in a constant struggle to end an on-going civil war. Its abundance in mineral resources has sadly contributed to this region being "the center of some of the world's most devastating conflicts in recent history. This turbulent context can [thus] be both the seed of conflict and the foundation for peace-building and ensuing development" (Adano *et al.*, 2012, p3.). Thus, Africa, with its history of ethnic, natural resource and interstate conflicts, is seen as being particularly vulnerable to the new climate-induced security threat. "Despite being the continent least responsible for the emission of global greenhouse gases, one of the principal contributors to climate change, it will suffer the consequences of a changing climate most severely. Climate change is today being recast as a security threat, rather than being just an environmental issue" (Adano *et al.*, 2012, p.1).

1.3.8.4.2 The impact of violent conflicts and the reconstruction of society

The effects of conflict are perverse and pervasive. The most direct, of course, are the loss of human life, the destruction of wildlife from poaching or land mines, over-exploitation and degradation of natural resources, and increases in land and water pollution. Daskin *et al.* (2018), for example, showed that the frequency of conflicts can predict the severity of population declines for large mammals in protected areas in Africa. Habitats are destroyed and whole ecosystems degraded and fragmented. This has long-term implications for security, be it food security, health security, water security, or social security. In addition, a whole illegal economy tends to take root around the richest natural resources areas (with valuable, easy to move extractives), perpetuating the loot-seeking dimensions of the conflict. Buchanan-Smith *et al.* (2013) draw attention to the fact that the informal legal fields that develop during war will usually be stronger than old or new laws, which, adding to the problem of displaced populations and returnees, can complicate post-conflict reconstruction and peace-building.

Land issues, as mentioned earlier, are fundamental to reconciliation and economic rehabilitation in countries emerging from protracted conflicts: governance of the tenure regime, access to land, security of tenure and distribution of land holdings provide the building blocks for sustainable security. However, in post-conflict situations, they are also more fluid and open than perhaps at any other time and, thus, the post-conflict period poses many operational tensions (Clover, 2007 in Buchanan-Smith *et al.*, 2013). Wily (2009) makes the point that, if peace is to last, the focus must be on reforming property relations where these were at the heart of the conflict rather than focusing on post-conflict restorative justice and on restitution of property to the displaced. Valuable lessons can, indeed, be learned from what has worked or failed in peace processes around the world. A review of seven peace agreements across the African continent since the early 1990s demonstrates how inadequately issues of land and natural resources are dealt with in peace agreements (Buchanan-Smith *et al.*, 2013). However, progressive initiatives are being put forward, as in Sudan where the Darfur Land Commission undertook a major land-use mapping exercise in order to produce the "Darfur States Land-Use Mapping Database" submitted to the Darfur Regional Authority for approval and updated every five years. In addition, the Darfur Land Commission has undertaken a major exercise in documenting customary land management mechanisms, while parties to land disputes were encouraged to exhaust traditional methods of dispute settlement, including arbitration, before going to court. Therefore a system of legal plurality was built into the management of land in Darfur (Buchanan-Smith *et al.*, 2013).

1.3.8.5 Trade issues in the governance of biodiversity and ecosystem services

A good deal of the literature on biodiversity and ecosystem services related trade focuses on issues related to the illegal trade of wildlife and plant species protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (also see Chapter 4). This has been largely documented in relation to the illegal trade of ivory, rosewood or ebony, for example.

Payments for Ecosystem Services are also a growing theme in science and policy. Reducing Emissions from Deforestation and Forest Degradation (REDD+), for instance, a program to reduce emissions from deforestation and degradation of forests, is investing a few hundred million US dollars in a country such as DR Congo. One of the ultimate objectives of Payments for Ecosystem Services schemes, including carbon trading, is to develop an international

market for environmental services in which some conservation and development benefits would be traded against each other for overall mitigation of greenhouse gas emissions and/or environmental degradation. However, some of the hypotheses regarding (growing) carbon markets have not yet materialized, while payments for ecosystem services remain small globally, with global payments for ecosystem services income estimated at just over $1.9 billion per year from 2005 to 2010, and $2.5 billion in 2011 (FAO, 2014a). In addition, Africa, with only 0.9% of global payments in 2011 (and 0.2% in the five previous years), benefits the least from payments for ecosystem services. Other regions do on orders of magnitude better, with China and the United States accounting for the majority of global income (Diaw, 2014).

Strategically, a number of critical questions must be considered in the assessment of BES trade issues for Africa. Currently, only 10–13% of Africa's trade is done internally. By contrast, the proportion in Europe and Asia is close to 60%. This means that African trade is largely extroverted, including BES-related trade. The signing in early 2015 of the Tripartite Free Trade Agreement by 16 of 26 prospective members is the boldest African initiative ever taken to change the situation. The Tripartite Free Trade Agreement holds the prospect of an internal market of 26 countries and 625 million people with a combined GDP of over $1 trillion. This is staggering for Africa, but many issues will need to be resolved before it becomes a reality. For instance, Africa's most advanced and most diversified economies have significant infrastructure, manufacturing and services. Services accounted for 70% of the growth of Morocco, Tunisia, South Africa and Egypt in 2000–2010. These economies also tend, however, to have higher unit-labour and input costs than other African countries, which could require adjustments from some governments[2]. The Tripartite Free Trade Agreement is meant to be a first step in breaking the continent's notoriously disadvantageous terms of trade. It would also serve as a template for the Continental Free Trade Area, which the summit of African Union leaders endorsed in January 2012 as a 2017 target. There are clearly significant hurdles ahead, including infrastructure, rules of market integration and political stability; but the potential is clear. In that perspective, it will be important to identify and map the specific nature and importance of the BES-related goods traded both internally and as foreign exports, and their importance in global value chains. This will help support calculated shifts in reinforcing inter-African trade and trade networks for both primary and processed BES-related food and consumer goods.

2. *Weighing the options.* Financial Mail, August 6 – August 12, 2015, p. 32. On the Tripartite Free Trade Agreement, see also analyses from the Tahir Institute for Middle East Policy, http://timep.org/commentary/tripartite-free-trade-area/ and Quartz Africa, http://qz.com/424557/the-tripartite-free-trade-area-agreement-in-africa-is-bound-to-disappoint/

A characteristic of most African countries is the dominance of resource/raw material exports with little processing and downstream value addition. Cross-country differences in that regard (for instance, between North & South African industrial infrastructures and that of most other countries) have important free trade implications that, in addition to infrastructural and regulatory issues, will affect the pace of integration in the Tripartite and Continental Free Trade Areas.

A recent paper published in *Current Biology* (Laurance *et al.*, 2015) raises new issues. The authors claim to have assessed the potential environmental impacts and agricultural potential of 33 planned or existing development corridors totalling over 53,000 km in length across much of the African continent. The corridors have been proposed, or are being created, to increase agricultural production as well as inter-African trade through large-scale expansion of infrastructure such as roads, railroads, pipelines, and port facilities. According to Laurance *et al.* (2015), the corridors would bisect over 400 existing protected areas and could degrade a further ~1,800 by promoting habitat disruption near or inside the reserves. The authors conclude that many of the development corridors will promote irreversible environmental changes and that some should be "cancelled altogether" and others linked "to rigorous mitigation and protection measures". However, Africa's need to develop its infrastructure and internal market in ways that are balanced and smart and that protects its economic and environmental future, remains a major policy consideration.

Approaching from a different angle, Youm *et al.* (2011) looks at the role of trade in introducing invasive pests and disease vectors that can cause environmental damage and economic losses and pose a serious risk to biodiversity. This is a two-way problem, with non-tariff barriers being imposed on African countries under the perception that they are a source of invasive pests to other countries via trade. Fruit flies, for instance, are among the pests that cause major trade losses and agriculture-related income losses to African countries. The paper considers the phytosanitary measures African countries have, therefore, to take to reduce losses in economic and trade opportunities. On the other hand, African countries lack the full capacity to reduce trade-related pest invasions from other countries and the impact of such invasions on African economies and the environment. Other issues to address relate to food quality and costs, international standards in product quality and labelling, inflated costs of transport, the price of goods and products, and hidden trade protectionism from northern economies through the imposition of standards higher than international standards. The question of the African internal market is tightly connected to issues such as this. African bio-products in an integrated African market should enjoy a better competitive advantage, but this will require significant effort in this area.

1.3.9 Sustainable use of ecosystems and green-blue economy

The Millennium Ecosystem Assessment (MA, 2005) reported, as mentioned earlier, that over 60% of the world's ecosystem goods and services were degraded or unsustainably utilised. Sustainable economies are comprised of economic capital, social capital and environmental capital. However, if increases in economic and social capital cannot keep pace with the dwindling environmental capital, then economies will decline (UNEP, 2012b). Climate change and the demands of a growing population only serve to make more crucial the role of ecosystems and environmental capital in sustaining economic and social well-being (UNEP, 2012b). According to a recent review on how SDGs may "play out for Africa" (Nhamo, 2017) states that "issues that include gender and women, education, desire to prioritise Africa and technology emerge strongly". Nhamo (2017) concludes that "if the SDGs are to be a vehicle for poverty eradication in Africa, the continent needs to do more by itself, including domestic mobilization of financial resources".

As mentioned, Africa is endowed with rich and diverse renewable and non-renewable natural resources, yet its people remain among the poorest in the world (World Bank, 2012b). Currently, national accounting and global economic models do not account for all essential contributions of nature to people, especially in the long-term, leading to the overuse or misuse of natural resources (UNEP, 2010). Without full valuation of less-tangible benefits from ecosystems, use is likely to remain unsustainable and degradation inevitable, leading to the potential collapse of important ecosystem functions and services. Care of ecosystems and the benefits they provide can serve as the underpinning foundation on which a sustainable economic model can be developed (UNEP, 2010). One such desired model is the Green Economy, a concept that balances natural resource values with other values, and takes into account the loss in value of ecosystem services due to environmental impacts (UNEP, 2010). The decline in the ecological health and economic productivity of the world's oceans and terrestrial environments can be reversed by shifting to a greener, more sustainable economic paradigm in which human well-being and social equity are improved, while environmental risks and ecological scarcities are reduced (UNEP, 2012b).

The term Blue Economy appears in a book by Pauli (2010) and was developed as a concept to complement that of the green economy, recognising that seas and oceans are a key part of the needed transformations towards a low-carbon economy (UNEP, 2012b). The key aim for a transition to a green and blue economy is to enable economic growth and investment (characterised by reduced carbon emissions and pollution and improved energy efficiency) while increasing environmental quality (through reduced loss of biodiversity and ecosystem services) and social inclusiveness (UNEP, 2011). The concept of a green and blue economy does not replace sustainable development; since achieving sustainability depends on achieving such economic balance (UNEP, 2011). Such an approach requires including natural capital and biodiversity as the competitive edge for Africa, transforming and adding value to the green wealth in regional accounting and having inclusive investments, scalable and viable over a long time.

The Government of Botswana co-hosted the Summit for Sustainability in Africa in 2012, which resulted in the Gaborone Declaration (GDSA, 2012), a concrete set of proposals related to recognising the role of natural capital in development. In 2013, the 10 signatory countries reconvened to take stock and operationalise how to bring natural capital from the periphery to the centre of all economic decision-making.

Following this declaration, the core Wealth Accounting for Valuation of Ecosystem Services (WAVES) countries have begun implementing Natural Capital Accounting. Apart from Botswana, Madagascar and Rwanda are making progress in this program with the World Bank. The WAVES partnership include the UNEP, the UNDP, and the UN Statistical Commission (http://unstats.un.org/unsd/statcom/commission.htm); the countries of Botswana, Colombia, Costa Rica, Madagascar and the Philippines (implementing programs); as well as financial or other support from Australia, Canada, France, Japan, Norway, the United Kingdom, and several NGOs (see more details in Chapter 6).

Africa's 2050 integrated marine strategy (AU, 2013) recognised that the African Marine Domain (AMD) has vast potential for wealth creation through the Blue Economy. The Strategy provides a broad framework for the protection and sustainable exploitation of the AMD and highlights that Member States have significant responsibilities for generating the desirable political will for implementing the strategy. This was later consolidated by the African Union 2063 Agenda, which marked the member countries' political will and strategic decision to make Africa's green and blue/ocean economy a major contributor of Africa's growth and transformation (AU, 2015b).

The transition towards a green economy raises several policy questions. Specific enabling conditions, such as national regulations, policies, subsidies and incentives, as well as international market and legal infrastructure, trade and technical assistance, sustainable development strategies, poverty eradication and skills development, are required (UNEP, 2011; Nhamo, 2013). At the heart of the green economy is the need to address the negative impacts associated with climate change (Nhamo, 2013),

energy insecurity and ecological scarcity (UNEP, 2011). A green economy can meet this challenge by offering a development path that reduces carbon dependency, promotes resource and energy efficiency, lessens environmental degradation, improved equity and job creation, and adaptation to rather than mitigation of climate change (UNEP, 2011, 2012a; Nhamo, 2013). A green economy recognises that the goal of sustainable development is improving the quality of human life within the constraints of the environment (UNEP, 2011).

Actions towards harnessing the Green-Blue Economy for Africa's Development in order to exploit the abundant opportunities offered by lands, waters, seas and oceans to accelerate structural transformation in Africa also requires reconsidering several paradigms on sustainable use and poverty reduction. The paradigm shift is already being made by the governments who want to converge with the rest of the world, which means technology acquisition, innovation, investment, getting the finance and using internal means as much as possible to do so. Africa is in a unique position to undertake a more balanced approach here. Thus, instead of keeping the continent at the margin of poverty, with incredibly high international trade deficits and quasi-subsistence, low productivity, lowly competitive and weakly diversified economies, Africa can invest in structural transformation and industrialisation and invest in approaches that support green and blue economies.

REFERENCES

Abdel Rahman, Y. (2009). The contribution of indigenous knowledge to an environmental education programme: A study in St Katherine Protectorate, South Sinai, Egypt. *The International Journal of Environmental, Cultural, Economic and Social Sustainability*, *5*(3), 157–172. https://doi.org/10.18848/1832-2077/CGP/v05i03/54619

Abel, G. J., & Sander, N. (2014). Quantifying global international migration flows. *Science, 343*(6178), 1520–1522. https://doi.org/10.1126/science.1248676

Abell, R., Thieme, M. L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., Coad, B., Mandrak, N., Balderas, S. C., Bussing, W., & Stiassny, M. L. (2008). Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. *BioScience, 58*(5), 403. https://doi.org/10.1641/B580507

Adams, W. M. (2003). Nature and the colonial mind. In W. M. Adams & M. Mulligan (Eds.), *Decolonizing Nature: Strategies for conservation in a post colonial era* (pp. 16–50). London, U.K.: Earthscan. ISBN 9781849770927

Adano, W. R., & Daudi, F. (2012). Links between climate change, conflict and governance in Africa. *Institute for Security Studies Papers*, (234), 20. Retrieved from https://issafrica.s3.amazonaws.com/site/uploads/Paper_234.pdf

Adeel, Z., Safriel, U., Niemeijer, D., White, R., de Kalbermatten, G., Glantz, M., Salem, B., Scholes, R. J., Niamir-Fuller, M., Ehui, S., & Yapi-Gnaore, V. (2005). *Ecosystems and human well-being: Desertification synthesis*. Washington, DC, USA: World Resources Institute. Retrieved from http://www.millenniumassessment.org/documents/document.355.aspx.pdf

AfDB (African Development Bank). (2010). *Africa in the post-crisis global economy: Turning the recovery into strong, sustained and shared growth.* African Development Bank. Retrieved from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/C-10%20Note%201%20English%20%28final%29_for%20posting.pdf

African Centre for Biodiversity. (2017). *Against the odds, smallholder farmers maintain agricultural biodiversity in South Africa* (Field Work Report) (p. 49). Retrieved from http://acbio.org.za/sites/default/files/2017/02/South-Africa-Field-Report-2017.pdf

Agbosu, L. K. (2000). *Land law in Ghana: Contradiction between Anglo-American and customary conceptions of tenure and practices* (Working Paper No. 33). Madison, USA: Land Tenure Centre, University of Wisconsin. Retrieved from http://ageconsearch.tind.io//bitstream/12796/1/ltcwp33.pdf

Agidie, A., Ayele, B., Wassie, A., Hadgu, K. M., Aynekulu, E., & Mowo, J. (2014). Agroforestry practices and farmers' perception in Koga watershed, upper Nile Basin, Ethiopia. *Agriculture and Forestry*, *60*(2), 177. Retrieved from http://89.188.43.75/agricultforest/20140628-16%20Agidie%20et%20al.pdf

Agrawal, A. (1995). Dismantling the divide between indigenous and scientific knowledge. *Development and Change, 26*(3), 413–439. https://doi.org/10.1111/j.1467-7660.1995.tb00560.x

Alauddin, M., & Quiggin, J. (2008). Agricultural intensification, irrigation and the environment in South Asia: Issues and policy options. *Ecological Economics, 65*(1), 111–124. https://doi.org/10.1016/j.ecolecon.2007.06.004

Alkire, S., & Robles, G. (2016). Measuring multidimensional poverty: Dashboards, union identification, and the Multidimensional Poverty Index (MPI). *OPHI Research in Progress, 2*. Retrieved from http://www.ophi.org.uk/wp-content/uploads/OPHIRP046a.pdf

Alkire, S., & Santos, M. E. (2010). Acute multidimensional poverty: A new index for developing countries. *OPHI Working Paper, 38*, 1–139. Retrieved from https://www.ophi.org.uk/wp-content/uploads/OPHI-wp38_with_note.pdf

Alkire, S., Jindra, C., Aguilar, G. R., & Vaz, A. (2017). Multidimensional poverty reduction among countries in sub-Saharan Africa. *Forum for Social Economics, 46*(2), 178–191. https://doi.org/10.1080/07360932.2017.1310123

AMCEN. (2011). *Addressing climate change challenges in Africa: A practical guide towards sustainable development.* Addis Ababa, Ethiopia: AMCEN/African Union Commission. Retrieved from http://www.mtnforum.org/sites/default/files/publication/files/guidebook_climat-echange.pdf

Anderson, P. M. L., Avlonitis, G., & Ernstson, H. (2014). Ecological outcomes of civic and expert-led urban greening projects using indigenous plant species in Cape Town, South Africa. *Landscape and Urban Planning, 127*, 104–113. https://doi.org/10.1016/j.landurbplan.2014.03.007

Anderson, P. M. L., Okereke, C., Rudd, A., & Parnell, S. (2013). Regional Assessment of Africa. In T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, & C. Wilkinson (Eds.), *Urbanization, biodiversity and ecosystem services: Challenges and opportunities* (pp. 453–459). Netherlands: Springer. Retrieved from https://link.springer.com/content/pdf/10.1007%2F978-94-007-7088-1_23.pdf

APP (Africa Progress Panel). (2014). *Grain fish money: Financing Africa's green and blue revolutions: Africa Progress Report 2014.* Africa Progress Panel. Retrieved from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Africa_Progress_Report_2014.PDF

APP (Africa Progress Panel). (2015). *Power, people, planet: seizing Africa's energy and climate opportunities: Africa progress report 2015*. Africa Progress Panel. Retrieved from https://reliefweb.int/sites/reliefweb.int/files/resources/APP_REPORT_2015_FINAL_low1.pdf

Arimah, B. C. (2011). *Slums as expressions of social exclusion: Explaining the prevalence of slums in African countries.* Nairobi, Kenya: United Nations Human Settlements Programme. Retrieved from www.oecd.org/dev/pgd/46837274.pdf

Arthurton, H., & Koranteng, K. (2006). Coastal and Marine Environments. In J. C. Mohamed-Katerere, & M. Sabet (Eds.), *Africa Environment Outlook 2: Our environment, our wealth* (pp. 155–195). Nairobi, Kenya: UNEP. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/9626/-Africa%20Environment%20Outlook%202_%20Our%20Environment%2c%20Our%20Wealth-2006688.pdf?sequence=3&isAllowed=y

Asongu, S. A. (2015). *Rational asymmetric development: Transfer mispricing and sub-Saharan Africa's extreme poverty tragedy.* Rochester, NY, USA: Social Science Research Network. Retrieved from http://papers.ssrn.com/abstract=2752532

AU. (2010). *Policy framework for pastoralism in Africa: securing, protecting and improving the lives, livelihoods and rights of pastoralist communities.* Addis Ababa, Ethiopia: Department of Rural Economy and Agriculture, African Union Commission. Retrieved from http://publications.cta.int/media/publications/downloads/1735_PDF.pdf

AU. (2013). *2050 Africa's integrated marine strategy (2050 AIM Strategy)*. Addis Ababa, Ethiopia: Department of Rural Economy and Agriculture, African Union Commission.

AU. (2015a). *MDG Report 2015: Assessing Progress in Africa toward the Millennium Development Goals.* Addis Ababa, Ethiopia: Economic Commission for Africa. Retrieved from http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/MDG_Report_2015.pdf

AU. (2015b). *Agenda 2063: The Africa we want*. Addis Ababa, Ethiopia: African Union Commission. Retrieved from http://archive.au.int/assets/images/agenda2063.pdf

AU. (2017). *State of Africa's population 2017. Keeping rights of girls, adolescents and young women at the centre of Africa's demographic dividend*. (I. Nyamongo K. & D. K. Shilabukha, Eds.). Addis Ababa, Ethiopia: African Union Commission. Retrieved from https://au.int/sites/default/files/newsevents/workingdocuments/32187-wd-state_of_africas_population_-_sa19093_-e.pdf

Bach, H., Bird, J., Clausen, T. J., Jensen, K. M., Lange, R. B., Taylor, R., Viriyasakultorn, V., & Wolf, A. (2012). *Transboundary river basin management: Addressing water, energy and food security*. Vientiane, Lao: Mekong River Commission. Retrieved from http://www.mrcmekong.org/assets/Uploads/M2R-report-address-water-energy-food-security.pdf

Bai, Z. G., Dent, D. L., Olsson, L., & Schaepman, M. E. (2008). Proxy global assessment of land degradation. *Soil Use and Management, 24*(3), 223–234. https://doi.org/10.1111/j.1475-2743.2008.00169.x

Bailis, R., Ezzati, M., & Kammen, D. M. (2005). Mortality and greenhouse gas impacts of biomass and petroleum energy futures in Africa. *Science, 308*(5718), 98–103. https://doi.org/10.1126/science.1106881

Balmford, A., Moore, J. L., Brooks, T., Burgess, N., Hansen, L. A., Williams, P., & Rahbek, C. (2001). Conservation conflicts across Africa. *Science, 291*(5513), 2616–2619. https://doi.org/10.1126/science.291.5513.2616

Barbier, E. B. (2016). The protective service of mangrove ecosystems: A review of valuation methods: Marine Pollution Bulletin special issue: Turning the tide on mangrove loss. *Marine Pollution Bulletin, 109*(2), 676–681. https://doi.org/10.1016/j.marpolbul.2016.01.033

Barreiro-Hurle, J. (2012). *Analysis of incentives and disincentives for maize in the United Republic of Tanzania* (Technical notes series). Rome, Italy: MAFAP, Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/a-at481e.pdf

Bazilian, M., Rogner, H., Howells, M., Hermann, S., Arent, D., Gielen, D., Steduto, P., Mueller, A., Komor, P., Tol, R. S., & Yumkella, K. K. (2011). Considering the energy, water and food nexus: Towards an integrated modelling approach. *Energy Policy, 39*(12), 7896–7906. https://doi.org/10.1016/j.enpol.2011.09.039

Beaumont, L. J., Pitman, A., Perkins, S., Zimmermann, N. E., Yoccoz, N. G., & Thuiller, W. (2011). Impacts of climate change on the world's most exceptional ecoregions. *Proceedings of the National Academy of Sciences of the United States of America, 108*(6), 2306–2311. Retrieved from https://doi.org/10.1073/pnas.1007217108

Beegle, K., Christiaensen, L., Dabalen, A., & Gaddis, I. (2016). Poverty in a rising Africa. Washington, DC, USA: The World Bank Group. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/22575/9781464807237.pdf

Beg, N., Morlot, J. C., Davidson, O., Afrane-Okesse, Y., Tyani, L., Denton, F., Sokona, Y., Thomas, J. P., La Rovere, E. L., Parikh, J. K., & Parikh, K. (2002). Linkages between climate change and sustainable development. *Climate Policy, 2*(2–3), 129–144. Retrieved from https://doi.org/10.3763/cpol.2002.0216

Belhabib, D., & Pauly, D. (Eds.). (2015c). *Marine fisheries catches in West Africa, 1950–2010, Part II.* Vancouver, B.C., Canada: Fisheries Centre, University of British Columbia. Retrieved from https://open.library.ubc.ca/media/download/pdf/52383/1.0354314/5

Belhabib, D., Mendy, A., Subah, Y., Broh, N. T., Jueseah, A. S., Nipey, N., Boeh, W. W., Willemse, N., Zeller, D., & Pauly, D. (2016). Fisheries catch under-reporting in The Gambia, Liberia and Namibia and the three large marine ecosystems which they represent. *Environmental Development, 17*, 157–174. https://doi.org/10.1016/j.envdev.2015.08.004

Belhabib, D., Pauly, D., Harper, S., & Zeller, D. (2012). Reconstruction of marine fisheries catches for Algeria, 1950–2010. In D. Belhabib, D. Zeller, S. Harper, & D. Pauly (Eds.), *Marine fisheries catches in West Africa, 1950–2010, Part I* (pp. 1–22). Vancouver, B.C., Canada: Fisheries Centre, University of British Columbia. Retrieved from https://open.library.ubc.ca/media/download/pdf/52383/1.0354243/5

Belhabib, D., Sumaila, U. R., & Pauly, D. (2015a). Feeding the poor: Contribution of West African fisheries to employment and food security. *Ocean & Coastal Management, 111,* 72–81. https://doi.org/10.1016/j.ocecoaman.2015.04.010

Belhabib, D., Sumaila, U. R., Lam, V. W. Y., Zeller, D., Le Billon, P., Abou Kane, E., & Pauly, D. (2015b). Euros vs. Yuan: Comparing European and Chinese fishing access in West Africa. *PLoS ONE, 10*(3), e0118351. https://doi.org/10.1371/journal.pone.0118351

Belle, E., Wicander, S., Bingham, H., & Shi, Y. (2015).Governance of protected areas in Africa: A global review. Cambridge, UK: UNEP-WCMC. Retrieved from http://papaco.org/wp-content/uploads/2015/04/PAPACO-study-17_GOVERNANCE-STUDY-0-FINAL_REPORT-CONTEXT.pdf

Bensted, R. (2011). A critique of Paul Collier's 'greed and grievance' thesis of civil war. *African Security Review, 20*(3), 84–90. https://doi.org/10.1080/10246029.2011.614065

Berry, S. (1993). *No condition is permanent: The social dynamics of agrarian change in sub-Saharan Africa.* Madison, USA: University of Wisconsin Press. ISBN 9780299139346.

Blanco, J., & Carrière, S. M. (2016). Sharing local ecological knowledge as a human adaptation strategy to arid environments: Evidence from an ethnobotany survey in Morocco. *Journal of Arid Environments, 127*, 30–43. https://doi.org/10.1016/j.jaridenv.2015.10.021

Blomfield, A. (2008). Realising Africa's hydropower potential. *Infrastructure Journal*, *6*.

Blomley, T. (2006). *Mainstreaming participatory forestry within the local government reform process in Tanzania.* International Institute for Environment and Development. Retrieved from http://pubs.iied.org/pdfs/14536IIED.pdf

Bodomo, A. (2013). African diaspora remittances are better than foreign aid funds. *World Economics, 14*(4), 21–29. Retrieved from https://www.worldeconomics.com/Journal/Papers/African%20Diaspora%20Remittances%20are%20Better%20than%20Foreign%20Aid%20Funds.details?ID=570

Boffa, J. M. (2000). West African agroforestry parklands: Keys to conservation and sustainable management. *Unasylva, 51*, 11–17. Retrieved from http://www.fao.org/docrep/x3989e/x3989e04.htm

Boffa, J. M. (2015). *Opportunities and challenges in the improvement of the shea* (Vitellaria paradoxa) *resource and its management* (Occasional Paper No. 24). Nairobi, Kenya: World Agroforestry Centre. Retrieved from http://www.worldagroforestry.org/downloads/Publications/PDFS/B17800.pdf

Borrini-Feyerabend, G., Pimbert, M., Farvar, M. T., Kothari, A., & Renard, Y. (2004). *Sharing power: Learning-by-doing in co-management of natural resources throughout the world.* Cenesta, Tehran, Iran: IIED and IUCN/ CEESP/ CMWG. Retrieved from http://pubs.iied.org/pdfs/G01089.pdf

Boschetti, F., Price, J., & Walker, I. (2016). Myths of the future and scenario archetypes. *Technological Forecasting and Social Change, 111*, 76–85. https://doi.org/10.1016/j.techfore.2016.06.009

Bosire, J. O., Kaino, J. J., Olagoke, A. O., Mwihaki, L. M., Ogendi, G. M., Kairo, J. G., Berger, U., & Macharia, D. (2014). Mangroves in peril: Unprecedented degradation rates of peri-urban mangroves in Kenya. *Biogeosciences, 11*(10), 2623–2634. https://doi.org/10.5194/bg-11-2623-2014

Boy, G., & Witt, A. (2013). *Invasive alien plants and their management in Africa*. Nairobi, Kenya: CABI Africa. Retrieved from https://www.cabi.org/Uploads/CABI/publishing/promotional-materials/african-invasives-book.pdf

Bradshaw, C. J. A., & Brook, B. W. (2014). Human population reduction is not a quick fix for environmental problems. *Proceedings of the National Academy of Sciences of the United States of America, 111*(46), 16610–16615. https://doi.org/10.1073/pnas.1410465111

Brashares, J. S., Golden, C. D., Weinbaum, K. Z., Barrett, C. B., & Okello, G. V. (2011). Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences of the United States of America, 108*(34), 13931–13936. https://doi.org/10.1073/pnas.1011526108

Brockington, D. (2002). *Fortress conservation: The preservation of the Mkomazi Game Reserve, Tanzania.* Bloomington, IN, USA: Indiana University Press. ISBN 9780852554173.

Brooks, T. M., Mittermeier, R. A., da Fonseca, G. A., Gerlach, J., Hoffmann, M., Lamoreux, J. F., Mittermeier, C. G., Pilgrim, J. D.,& Rodrigues, A. S. (2006). Global biodiversity conservation priorities. *Science, 313*(5783), 58-61. https://doi.org/10.1126/science.1127609

Brown, K. A., Johnson, S. E., Parks, K. E., Holmes, S. M., Ivoandry, T., Abram, N. K.,Delmore K. E., Ludovic R., Andriamaharoa H. E., Wyman T. M., & Wright, P. C. (2013). Use of provisioning ecosystem services drives loss of functional traits across land use intensification gradients in tropical forests in Madagascar. *Biological Conservation, 161,* 118–127. https://doi.org/10.1016/j.biocon.2013.03.014

Bruce, J. W., Jensen, E., Kloeck-Jenson, S., Knox, A., Subramanian, J., & Williams, M. (1998). Synthesis of trends and issues raised by land tenure country profiles of Southern African countries, 1996. In J. W. Bruce (Ed.), *Country Profiles of Land Tenure: Africa, 1996* (pp. 201-269). Madison, WI, USA: Land Tenure Center, University of Wisconsin. Retrieved from http://pdf.wri.org/ref/elbow_98_synthesis.pdf#page=208

Buchanan-Smith, M., Bromwich, B., & Nassef, M. (2013). *Governance for Peace over Natural Resources. A review of transitions in environmental governance across Africa as a resource for peacebuilding and environmental management in Sudan.* Nairobi, Kenya: UNEP. Retrieved from http://wedocs.unep.org/handle/20.500.11822/22109

Burgess, N. D., Hales, J. D., Ricketts, T. H., & Dinerstein, E. (2006). Factoring species, non-species values and threats into biodiversity prioritisation across the ecoregions of Africa and its islands. *Biological Conservation, 127*(4), 383–401. Retrieved from https://doi.org/10.1016/j.biocon.2005.08.018

Cann, R. L., Stoneking, M., & Wilson, A. C. (1987). Mitochondrial DNA and human evolution. *Nature, 325*(6099), 31–36. Retrieved from https://doi.org/10.1038/325031a0

Canning, D., Raja, S., & Yazbeck, A. S. (2015). Africa's demographic transition: Dividend or disaster? Washington, DC, USA: The World Bank Group. https://openknowledge.worldbank.org/bitstream/handle/10986/22036/9781464804892.pdf?sequence=3&isAllowed=y

Carmody, P. (2011). *The new scramble for Africa.* Cambridge, UK , Malden, MA, USA: Polity Press. ISBN 9780745647845.

CBD Secretariat. (2013). *Report of the regional workshop on the interlinkages between human health and biodiversity for Africa.* Maputo, Mozambique: Secretariat of the Convention on Biological Diversity. Retrieved from https://www.cbd.int/doc/meetings/health/wshb-afr-01/official/wshb-afr-01-02-en.pdf

CBD Secretariat. (2014). *Global Biodiversity Outlook 4.* Montréal, Canada: Secretariat of the Convention on Biological Diversity. Retrieved from https://www.cbd.int/gbo/gbo4/publication/gbo4-en.pdf

CDKN. (2014). *The IPCC's fifth assessment report: What's in it for Africa?* Overseas development Institute and Climate & Development Knowledge Network. Retrieved from http://cdkn.org/resource/highlights-africa-ar5/

CEPF. (2015). *The biodiversity hotspots.* Critical Ecosystem Partnership Fund. Retrieved from http://www.cepf.net/resources/hotspots/Pages/default.aspxCritical

Cernea, M. M., & Schmidt-Soltau, K. (2003). The end of forcible displacements? Conservation must not impoverish people. *Policy Matters, 12*, 42–51. Retrieved from https://www.iucn.org/downloads/pm12.pdf

Chambas, G., & Audras, F. (2012). Comments and concrete ways forward. In B. Dafflon, & T. Madies (Eds), *The political economy of decentralization in sub-Saharan Africa* (pp. 287–300). Washington, DC, USA: The World Bank Group. Retrieved from http://elibrary.worldbank.org/doi/abs/10.1596/9780821396131_CH07

Chant, S. H. (2007). *Gender, generation and poverty: Exploring the feminisation of poverty in Africa, Asia and Latin America.* Cheltenham, UK: Edward Elgar Publishing. ISBN 9781847206886.

Chasek, P., Safriel, U., Shikongo, S., & Fuhrman, V. F. (2015). Operationalizing zero net land degradation: The next stage in international efforts to combat desertification? *Journal of Arid Environments, 112*, 5–13. https://doi.org/10.1016/j.jaridenv.2014.05.020

Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., & Pauly, D. (2009). Projecting global marine biodiversity impacts under climate change scenarios. *Fish and Fisheries, 10,* 235–251. Retrieved from https://doi.org/10.1111/j.1467-2979.2008.00315.x

Chibememe, G., Muboko, N., Gandiwa, E., Kupika, O. L., Muposhi, V. K., & Pwiti, G. (2014). Embracing indigenous knowledge systems in the management of dryland ecosystems in the Great Limpopo Transfrontier Conservation Area: The case of Chibememe and Tshovani communities, Chiredzi, Zimbabwe. *Biodiversity, 15*(2–3), 192–202. https://doi.org/10.1080/14888386.2014.934715

Christiaensen, L., Gaddis, I., Beegle, K. G., & Dabalen, A. L. (2015). *Poverty in a rising Africa : Overview.* Washington, DC, USA: The World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/994551467989467774/Poverty-in-a-rising-Africa-overview

Chuhan-Pole, P., Angwafo, M., Buitano, M., Dennis, A., Korman, V., & Fox, M. L. (2013). *Africa's Pulse: An analysis of issues shaping Africa's economic future (Vol. 4)*. Washington, DC, USA: The World Bank Group. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/20241/679950NEWS0no-400Box367900B00PUBLIC0.pdf

Chuhan-Pole, P., Calderon, C., Kambou, G., Boreux, S., Buitano, M. M., Korman, V., & Kubota, M. (2015). *Africa's Pulse: An analysis of issues shaping Africa's economic future (Vol. 12).* Washington, DC, USA: The World Bank Group. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/22722/9781464807381.pdf

Clover, J. L. (2007). *Framing issues of environmental security in Angola & Mozambique: The nexus of land, conflicts and sustainable livelihoods in postconflict situations.* Ph.D Thesis. Johannesburg, South Africa: University of the Witwatersrand.

Cohen, J. E., Clarke-Harris, D. O., Khan, A., & Isaac, W.-A. P. (2014). Sustainable management of invasive species for small island developing states under changing climates. In W. G. Ganpat, &W.-A. P. Isaac (Eds.), *Impacts of climate change on food security in small island developing states* (pp. 312–360). IGI Global. Retrieved from http://www.igi-global.com/chapter/sustainable-management-of-invasive-species-for-small-island-developing-states-under-changing-climates/118030

Collier, P., & Hoeffler, A. (2000). *Greed and grievance in civil war.* Washington, DC, USA: The World Bank Group. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/18853/multi_page.pdf

Costello, M. J., Michener, W. K., Gahegan, M., Zhang, Z.-Q., & Bourne, P. E. (2013). Biodiversity data should be published, cited, and peer reviewed. *Trends in Ecology & Evolution, 28*(8), 454–461. https://doi.org/10.1016/j.tree.2013.05.002

Daskin, J. H., & Pringle, R. M. (2018). Warfare and wildlife declines in Africa's protected areas. *Nature, 553*, 328–332. https://doi.org/10.1038/nature25194

de Brauw, A., Mueller, V., & Lee, H. L. (2014). The role of rural-urban migration in the structural transformation of sub-Saharan Africa. *World Development, 63,* 33–42. https://doi.org/10.1016/j.worlddev.2013.10.013

De Graaf, G., & Garibaldi, L. (2014). *The value of African fisheries.* Rome, Italy: Food and Agriculture Organization of United Nations. Retrieved from http://www.fao.org/3/a-i3917e.pdf

Dei, G. J. S. (2000). African development: The relevance and implications of 'indigenousness'. In G. J. S. Dei, B. L., Hall, & D. G. Rosenberg (Eds.), *Indigenous knowledges in global contexts: Multiple readings of our world* (pp. 70–86). Toronto, Canada: OISE/UT Books & University of Toronto Press. ISBN 9780802080592.

Del Ninno, C. & Mills, B. (Eds.). (2015). *Safety nets in Africa : effective mechanisms to reach the poor and most vulnerable.* Washington, DC, USA: The World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/869311468009642720/pdf/941170PUB-0Box300Forum09781464804359.pdf

Dembélé, U., Lykke, A. M., Koné, Y., Témé, B., & Kouyaté, A. M. (2015). Use-value and importance of socio-cultural knowledge on *Carapa procera* trees in the Sudanian zone in Mali. *Journal of Ethnobiology and Ethnomedicine, 11,* 14. https://doi.org/10.1186/1746-4269-11-14

Devarajan, S. (2013). Africa's statistical tragedy. *The Review of Income and Wealth, 59*, S9–S15. https://doi.org/10.1111/roiw.12013

Devarajan, S., Go, D. S., Maliszewska, M., Osorio-Rodarte, I., & Timmer, H. (2015). Stress-testing Africa's recent growth and poverty performance. Journal of Policy Modeling, 37(4), 521-547. Retrieved from https://doi.org/10.1016/j.jpolmod.2015.04.006

Diaw, M. C. (1985). *La pêche piroguière dans l'économie politique de l'Afrique de l'Ouest. Les formations sociales et les systèmes de production dans l'histoire*. 45th Congress of the Americanists, Bogota, July, 38 p.

Diaw, M. C. (1997). *Si, Nda Bot and Ayong: Shifting cultivation, land use and property rights in Southern Cameroon* (Network Paper No. 21e). London, UK: ODI. Retrieved from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/1156.pdf

Diaw, M. C. (2005). Modern economic theory and the challenge of embedded tenure institutions: African attempts to reform local forest policies. In S. Kant, & R. A. Berry (Eds.), *Institutions, Sustainability, and Natural Resources* (pp. 43–81). Netherlands: Springer. ISBN 9781402035197.

Diaw, M. C. (2009). Introduction: Theory and practice of adaptive collaborative management. In M. C. Diaw, T. Aseh, & R. Prabhu (Eds.), *In search of common ground: Adaptive collaborative management in Cameroon.* Bogor, Indonesia: Center for International Forestry Research (CIFOR). Retrieved from https://cgspace.cgiar.org/handle/10568/20089

Diaw, M. C. (2010). Elusive meanings: decentralization, conservation and local democracy. In L. German, A. Karsenty, & A. Tiani (Eds.), *Governing Africa's forest in a globalized world* (pp. 56–78). London, UK: Earthscan Publications. ISBN: 9781844077564.

Diaw, M. C. (2014). *Sustainable development goals and forests: Prospects, integration, priorities and experience of Africa.* London, UK: IIED. Retrieved from http://pubs.iied.org/pdfs/G03874.pdf

Diaw, M. C. (2015). *A whole-landscape approach to green development in Africa.* IIED Briefing. London, UK: IIED. Retrieved from http://pubs.iied.org/pdfs/17342IIED.pdf

Diaw, M. C., & Njomkap, J.-C. S. (1998). *La terre et le droit: Une anthropology institutionnelle de la tenure tenure coutumière, de la jurisprudence et du droit forestier chez les peuples Bantou et Pygmée du Cameroun Méridional Forestier.*Unpublished Consultancy Report. Unpublished Consultancy Report.

Diaw, M. C., & Tiani, A. M. (2010). Fences in our heads: A discourse analysis of the Korup resettlement stalemate. *Journal of Sustainable Forestry, 29*(2–4), 221–251. https://doi.org/10.1080/10549810903548138

Diaw, M., Nguiebouri, J.-C., Tchoko, J., Ngo Baneg, M.-F., Vambi, B., Nlend, E., & Keugni, M.-C. (2016). Pour une inscription du paradigme participatif dans l'économie sociale et la transformation structurelle. Le cas des forêts modèles. In G. Buttoud & J.-C. Nguinguiri (Eds.), *La gestion inclusive des forêts d'Afrique centrale. Passer de la participation au partage des pouvoirs* (pp. 189–203). Libreville-Bogor: FAO-CIFOR. Retrieved from http://www.cifor.org/publications/pdf_files/Books/FAO-CIFOR_Book-14.pdf

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Baldi, A., Baetuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M. A., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G. M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Perez, E. S., Reyers, B., Roth, E., Saito, O., Scholes, R. J., Sharmer, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z. A., Akosim, C., Al–Hafedh, Allaherdiyev, R., Amankwah, E., Asah, S. T., Asfaw, Z., Bartus, G., Brooks, L. A., Cailaux, J., Dalle, G., Darmaedi, D., Drivers, A., Erpul, G., Escobar-Eyzaguirre, P., Failier, P., Fouda, A. M. M., Fu, D., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W. A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J. P., Mikissa, J. B., Moller, H., Mooney, H. A., Mumby, P., Nagendra, H., Nesshover, C., Oteng–Yeboah, A. A., Pataki, G., Roue, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo–Chang, Y., & Zlatanova, D. (2015). The IPBES conceptual framework-connecting nature to people. *Current Opinion in Environmental Sustainability, 14,* 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Díaz, S., Pascual, U., Stenseke, M., Martin-Lopez, B., Watson, R. T., Molnár, Z., Hill, R., Chan, K. M. A., Baste, I. A., Brauman, K. A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P. A., van Oudenhoven, A. P. E., van der Plaat, F., Schröter, M., Lavorel, S., Aumeeruddy-Thomas, Y., Bukvareva, E., Davies, K., Demissew, S., Erpul, G., Failler, P., Guerra, C. A., Hewitt, C. L., Keune, H., Lindley, S., & Shirayama, Y. (2018). Assessing nature's contributions to people. *Science, 359*(6373), 270–272. https://doi.org/10.1126/science.aap8826

Diop, C. A. (1981). *Civilisation ou barbarie.* Paris, France: Présence Africaine. ISBN 2708703943.

Diop, S., & Scheren, P. A. (2016). Sustainable oceans and coasts: Lessons learnt from Eastern and Western Africa. *Estuarine, Coastal and Shelf Science, 183*, 327–339. https://doi.org/10.1016/j.ecss.2016.03.032

Durant, S. M., Wacher, T., Bashir, S., Woodroffe, R., De Ornellas, P., Ransom, C., Newby, J., Abáigar, T., Abdelgadir, M., El Alqamy, H., Baillie, J., Beddiaf, M., Belbachir, F.,

Belbachir-Bazi, A., Berbash, A. A., Bemadjim, N. E., Beudels-Jamar, R., Boitani, L., Breitenmoser, C., Cano, M., Chardonnet, P., Collen, B., Cornforth, W. A., Cuzin, F., Gerngross, P., Haddane, B., Hadjeloum, M., Jacobson, A., Jebali, A. Lamarque, F., Mallon, D., Minkowski, K., Monfort, S., Ndoassal, B., Niagate, B., Purchase, G., Samaïla, S., Samna, A. K., Sillero-Zubiri, C., Soultan, A. E., Stanley Price, M. R., Pettorelli, N. (2014). Fiddling in biodiversity hotspots while deserts burn? Collapse of the Sahara's megafauna. *Diversity and Distributions, 20*(1), 114–122. https://doi.org/10.1111/ddi.12157

Dyck, A. J., & Sumaila, U. R. (2010). Economic impact of ocean fish populations in the global fishery. *Journal of Bioeconomics, 12*(3), 227–243. https://doi.org/10.1007/s10818-010-9088-3

Edejer, T. T.-T., Baltussen, R., Adam, T., Hutubessy, R., Acharya, A., Evans, D. B., & Murray, C. J. L. (Eds.). (2003). *Making choices in health: WHO guide to cost-effectiveness analysis*. Geneva, Switzerland: World Health Organization. Retrieved from http://apps.who.int/iris/bitstream/10665/42699/1/9241546018.pdf

Eisenberg, J. N. S., Desai, M. A., Levy, K., Bates, S. J., Liang, S., Naumoff, K., & Scott, J. C. (2007). Environmental determinants of infectious disease: A framework for tracking causal links and guiding public health research. *Environmental Health Perspectives, 115*(8), 1216–1223. https://doi.org/10.1289/ehp.9806

El-Nahry, A. H., & Doluschitz, R. (2009). Climate change and its impacts on the coastal zone of the Nile Delta, Egypt. *Environmental Earth Sciences, 59*(7), 1497–1506. https://doi.org/10.1007/s12665-009-0135-0

Elujoba, A. A., Odeleye, O. M., & Ogunyemi, C. M. (2005). Traditional medicine development for medical and dental primary health care delivery system in Africa. *African Journal of Traditional, Complementary and Alternative Medicines, 2*(1), 46–61. https://tspace.library.utoronto.ca/handle/1807/9189

Emerton, L., & Howard, G. (2008). *A toolkit for the economic analysis of invasive species*. Nairobi, Kenya: Global Invasive Species Programme. Retrieved from http://www.issg.org/pdf/publications/GISP/Guidelines_Toolkits_BestPractice/Emerton%26Howard_2008_EN.pdf

Fa, J. E., Olivero, J., Farfán, M. Á., Márquez, A. L., Duarte, J., Nackoney, J., Hall, A., Dupain, J., Seymour, S., Johnson, P.J ., Macdonald, D. W., Real, R., & Vargas, J. M. (2015). Correlates of bushmeat in markets and depletion of wildlife. *Conservation Biology, 29*(3), 805–815. https://doi.org/10.1111/cobi.12441

Faith, D., Collen, B., Ariño, A., Koleff, P. K. P., Guinotte, J., Kerr, J., & Chavan, V. (2013). Bridging the biodiversity data gaps: Recommendations to meet users' data needs. *Biodiversity Informatics, 8*(2), 41–58. https://doi.org/10.17161/bi.v8i2.4126

Fakir, S. (2012). *The G20's energy infrastructure plans for Africa: What is missing?* Cape Town, South Africa: Heinrich Böll Stiftung Southern Africa. Retrieved from https://za.boell.org/2014/02/12/g20s-energy-infrastructure-plans-africa-what-missing

FAO. (2007a). *Biodiversity of microorganisms and insects for food and agriculture: Status and needs.* Rome, Italy: Food and Agriculture Organization of United Nations. Retrieved from http://www.fao.org/tempref/docrep/fao/meeting/014/j9728e.pdf

FAO. (2007b). *FAO Biosecurity toolkit.* Rome, Italy: Food and agricultural organization of the United Nations. Retrieved from http://www.fao.org/docrep/010/a1140e/a1140e00.htm

FAO. (2011). *State of the world's forests 2011*. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/013/i2000e/i2000e.pdf

FAO. (2014a). *State of the world's forests 2014: Enhancing the socioeconomic benefits from forests.* Rome, Italy: Food & Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/a-i3710e.pdf

FAO. (2014b). *The state of world fisheries and aquaculture 2014.* Rome, Italy: FAO Fisheries and Aquaculture Department. Retrieveed from http://www.fao.org/3/a-i3720e.pdf

FAO. (2015). *Report of the FAO working group on the assessment of small pelagic fish off Northwest Africa.* Rome, Italy: Food & Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/017/i3135b/i3135b.pdf

FAO. (2016). *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all.* Rome, Italy: Food & Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/a-i5555e.pdf

Farolfi, S. (2010, November 25). *Economic value of water for different uses in Southern Africa.* Presented at the Seminar Presentation, UNESCO Chair in Water Economics. Retrieved from http://www.water.anu.edu.au/UNESCOChair/20101125/slides/Stefano_Farolfi.pdf

Faurès, J. M., & Santini, G. (2008). *Water and the rural poor: interventions for improving livelihoods in sub-Saharan Africa.* Rome, Italy: International Fund for Agricultural Development (IFAD). Retrieved from https://www.cabdirect.org/cabdirect/abstract/20083156477

Feka, Z. N. (2015). Sustainable management of mangrove forests in West Africa: A new policy perspective? *Ocean & Coastal Management, 116*, 341–352. https://doi.org/10.1016/j.ocecoaman.2015.08.006

Finlayson, C. M., Horwitz, P., & Weinstein, P. (2015). A synthesis: Wetlands as settings for human health. In C. M. Finlayson, P. Horwitz, & P. Weinstein (Eds.), *Wetlands and human health* (pp. 251–263). Dordrecht, Netherlands: Springer. Retrieved from https://doi.org/10.1007/978-94-017-9609-5_12

Fisher, J. A., Patenaude, G., Meir, P., Nightingale, A. J., Rounsevell, M. D. A., Williams, M., & Woodhouse, I. H. (2013). Strengthening conceptual foundations: Analysing frameworks for ecosystem services and poverty alleviation research. *Global Environmental Change, 23*(5), 1098–1111. https://doi.org/10.1016/j.gloenvcha.2013.04.002

Flahaux, M. L., & De Haas, H. (2016). African migration: trends, patterns, drivers. *Comparative Migration Studies, 4*(1), 1. https://doi.org/10.1186/s40878-015-0015-6

Frazee, S. R., Cowling, R. M., Pressey, R. L., Turpie, J. K., & Lindenberg, N. (2003). Estimating the costs of conserving a biodiversity hotspot: a case-study of the Cape Floristic Region, South Africa. *Biological Conservation, 112*(1–2), 275–290. https://doi.org/10.1016/S0006-3207(02)00400-7

Fukuda-Parr, S., Greenstein, J., & Stewart, D. (2013). How should MDG success and failure be judged: Faster progress or achieving the targets? *World Development, 41*, 19–30. https://doi.org/10.1016/j.worlddev.2012.06.014

Gan, T. Y., Ito, M., Hülsmann, S., Qin, X., Lu, X. X., Liong, S. Y., Rutschman, P., Disse, M., & Koivusalo, H. (2016). Possible climate change/variability and human impacts, vulnerability of drought-prone regions, water resources and capacity building for Africa. *Hydrological Sciences Journal, 61*(7), 1209–1226. https://doi.org/10.1080/02626667.2015.1057143

Garrity, D. P. (2010). Hope is evergreen. *Our Planet* May: 28–30.

GDSA. (2012). *The Gaborone Declaration of the Summit for Sustainability in Africa*, 24 to 25 May 2012, Botswana (8 pp.). Adopted at the Summit for Sustainability in Africa, Gaborone, Botswana. Retrieved from http://www.gaboronedeclaration.com/s/GDSA-Declaration-2012.pdf

GEF. (2014). *GEF-6 Programming Directions* (GEF Assembly Document No. GEF/A.5/07/Rev.01) (p. 215). Global Environment Facility. Retrieved from https://www.thegef.org/gef/sites/thegef.org/files/webpage_attached/GEF6_programming_directions_final_0.pdf

Geijzendorffer, I. R., Regan, E. C., Pereira, H. M., Brotons, L., Brummitt, N., Gavish, Y., Haase, P., Martin, C. S., Mihoub, J. B., Secades, C., Schmeller, D. S., Stoll, S., Wetzel, F. T., & Walters, M. (2016). Bridging the gap between biodiversity data and policy reporting needs: An Essential Biodiversity Variables perspective. *Journal of Applied Ecology, 53*(5), 1341–1350. https://doi.org/10.1111/1365-2664.12417

Gemedo-Dalle, Isselstein, J., & Maass, B. L. (2006).Indigenous ecological knowledge of Borana pastoralists in southern Ethiopia and current challenges. *International Journal of Sustainable Development & World Ecology, 13*(2), 113–130. Retrieved from https://doi.org/10.1080/13504500609469666

Gemedo-Dalle, T., Maass, B. L., & Isselstein, J. (2005). Plant biodiversity and ethnobotany of Borana pastoralists in southern Oromia, Ethiopia. *Economic Botany, 59*(1), 43–65. https://doi.org/10.1663/0013-0001(2005)059[0043:PBAEOB]2.0.CO;2

Golden, C. D., Fernald, L. C. H., Brashares, J. S., Rasolofoniaina, B. J. R., & Kremen, C. (2011). Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proceedings of the National Academy of Sciences of the United States of America, 108*(49), 19653–19656. Retrieved from https://doi.org/10.1073/pnas.1112586108

Gómez-Baggethun, E., Corbera, E., & Reyes-García, V. (2013). Traditional ecological knowledge and global environmental change: Research findings and policy implications. *Ecology and Society, 18*(4), 1–12. https://doi.org/10.5751/ES-06288-180472

Gratani, M., Butler, J. R. A., Royee, F., Valentine, P., Burrows, D., Canendo, W., & Anderson, A. S. (2011). *Is validation of indigenous ecological knowledge a disrespectful process? A case study of traditional fishing poisons and invasive fish management from the wet tropics, Australia. Ecology and Society, 16*(3), 25. https://doi.org/10.5751/ES-04249-160325

Griffiths, J. (1986). What is legal pluralism? *The Journal of Legal Pluralism and Unofficial Law, 18*(24), 1–55. https://doi.org/10.1080/07329113.1986.10756387

Gunderson, L. H., & Holling, C. S. (Eds.). (2002). *Panarchy: understanding transformations in human and natural systems.* Washington, DC, USA: Island Press, ISBN 9781559638579.

Güneralp, B., Lwasa, S., Masundire, H., Parnell, S., & Seto, K. C. (2017). Urbanization in Africa: challenges and opportunities for conservation. *Environmental Research Letters, 13*(1), 015002. https://doi.org/10.1088/1748-9326/aa94fe

Habtezion, S., Adelekan, I., Aiyede, E., Biermann, F., Fubara, M., Gordon, C., Habtezion S, Adelekan I, Aiyede E, Biermann F, Fubara M, Gordon C, Gyekye K, Kasimbazi E, Kibugi R, Lawson E, Mensah A., Mubaya, C., Olorunfemi, F., Paterson, A., Tadesse, D., Usman, R., & Zondervan, R. (2015). Earth system governance in Africa: Knowledge and capacity needs. *Current Opinion in Environmental Sustainability, 14*, 198–205. https://doi.org/10.1016/j.cosust.2015.06.009

Haines-Young, R., & Potschin, M. (2010).The links between biodiversity, ecosystem services and human well-being. In D. Raffaelli, & C. L. J. Frid (Eds.), *Ecosystem ecology: A new synthesis* (pp. 110–139). Cambridge, UK: Cambridge University Press. Retrieved from https://doi.org/10.1017/CBO9780511750458.007

Hall, R., & Scoones, I., with Henley, G. (2016). *Strengthening land governance: Lessons from implementing the voluntary guidelines.* London, UK: LEGEND, DfID. Retrieved from https://landportal.org/file/8699/download?token=vA4Xv42W

Hammi, S., Simonneaux, V., Cordier, J. B., Genin, D., Alifriqui, M., Montes, N., & Auclair, L. (2010). Can traditional forest management buffer forest depletion? Dynamics of Moroccan High Atlas Mountain forests using remote sensing and vegetation analysis. *Forest Ecology and Management, 260*(10), 1861–1872. https://doi.org/10.1016/j.foreco.2010.08.033

Harrison, I. J., Brummett, R., & Stiassny, M. L. J. (2016). The Congo River Basin. In C. M. Finlayson, G. R. Milton, R. C. Prentice, & N. C. Davidson (Eds.), *The Wetland Book* (p. 1–18). Netherlands: Springer. https://doi.org/10.1007/978-94-007-6173-5_92-1

HDRO outreach. (2015). *What is human development?* Retrieved from http://hdr.undp.org/en/content/what-human-development

Heinberg, R. (2016). 100% Renewable energy: What we can do in 10 years. *YES! Magazine, Spring 2016 Issue.* Retrieved from https://www.yesmagazine.org/issues/life-after-oil/100-renewable-energy-what-we-can-do-in-10-years-20160222

Hellegers, P., Zilberman, D., Steduto, P., & McCornick, P. (2008). Interactions between water, energy, food and environment: Evolving perspectives and policy issues. *Water Policy, 10*(1), 1–10. https://doi.org/10.2166/wp.2008.048

Hesse, C. (2014). Valuing pastoralism: Adaptation plans must incorporate dryland communities' knowledge and needs. *Backgrounder,* February 2014 Issue. London, UK: IIED, Retrieved from http://pubs.iied.org/pdfs/17235IIED.pdf

Hiernaux, P., Dardel, C., Kergoat, L., & Mougin, E. (2016). Desertification, adaptation and resilience in the Sahel: Lessons from long term monitoring of agro-ecosystems. In R. Behnke & M. Mortimore (Eds.), *The end of desertification?* (pp. 147–178). Berlin, Germany: Springer. Retrieved from https://doi.org/10.1007/978-3-642-16014-1_6

Hilhorst, T. (2010). Decentralization, land tenure reforms and local institutional actors: building partnerships for equitable and sustainable land governance in Africa. *Land Tenure Journal*, (1), 35–59. Retrieved from http://www.fao.org/nr/tenure/land-tenure-journal/index.php/LTJ/article/view/8/2

Hoff, H. (2011). *Understanding the nexus: Background paper for the Bonn2011 Conference: The water, energy and food security nexus.* Stockholm, Sweden: Stockholm Environment Institute, Stockholm. Retrieved from http://wef-conference.gwsp.org/fileadmin/documents_news/understanding_the_nexus.pdf

Hole, D. G., Willis, S. G., Pain, D. J., Fishpool, L. D., Butchart, S. H. M., Collingham, Y. C., Rahbek, C., & Huntley, B. (2009). Projected impacts of climate change on a continent-wide protected area network. *Ecology Letters, 12*(5), 420–431. https://doi.org/10.1111/j.1461-0248.2009.01297.x

Holland, R. A., Darwall, W. R. T., & Smith, K. G. (2012). Conservation priorities for freshwater biodiversity: The Key Biodiversity Area approach refined and tested for continental Africa. *Biological Conservation, 148*(1), 167–179. https://doi.org/10.1016/j.biocon.2012.01.016

Hussey, K., & Pittock, J. (2012). The energy-water nexus: Managing the links between energy and water for a sustainable future. *Ecology and Society, 17*(1). https://doi.org/10.5751/ES-04641-170131

IAEA. (2002). Energy & poverty. *IAEA Bulletin, 44*(2), 24–29. Retrieved from https://www.iaea.org/sites/default/files/publications/magazines/bulletin/bull44-2/44204002429.pdf

Ickowitz, A., Powell, B., Salim, M. A., & Sunderland, T. C. H. (2014). Dietary quality and tree cover in Africa. *Global Environmental Change, 24*, 287–294. https://doi.org/10.1016/j.gloenvcha.2013.12.001

IFAD (International Fund for Agricultural Development). (2015). Rural Poverty Portal. Retrieved from http://www.ruralpovertyportal.org/region/home/tags/africa

Ilukor, J., Rettberg, S., Treydte, A., & Birner, R. (2016). To eradicate or not to eradicate? Recommendations on *Prosopis juliflora* management in Afar, Ethiopia, from an interdisciplinary perspective. *Pastoralism, 6*(1), 14. https://doi.org/10.1186/s13570-016-0061-1

IPBES. (2016a). *Guide on the production and integration of assessments from and across all scales.* Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from http://www.ipbes.net/sites/default/files/downloads/IPBES-4-INF-9_EN_0.pdf

IPBES. (2016b). *The methodological assessment report on scenarios and models of biodiversity and ecosystem services.* S. Ferrier, K. N. Ninan, P. Leadley, R. Alkemade, L. A. Acosta, H. R. Akçakaya, L. Brotons, W. W. L. Cheung, V. Christensen, K. A. Harhash, J. Kabubo-Mariara, C. Lundquist, M. Obersteiner, H. M. Pereira, G. Peterson, R. Pichs-Madruga, N. Ravindranath, C. Rondinini & B. A. Wintle (Eds.). Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from https://www.ipbes.net/system/tdf/downloads/pdf/2016.methodological_assessment_report_scenarios_models.pdf?file=1&type=node&id=15244

IPBES. (2016c). *The assessment report on pollinators, pollination and food production.* S. G. Potts, V. Imperatriz-Fonseca, & H. T. Ngo (Eds.). Bonn, Germany: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Retrieved from https://www.ipbes.net/sites/default/files/downloads/pdf/individual_chapters_pollination_20170305.pdf

IPCC. (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change.* C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, & P. M. Midgley (Eds.). New York, NY, USA: Cambridge University Press. Retrieved from https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf

IPCC. (2014). *Climate Change 2014: Synthesis Report. Summary for policymakers*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (Eds.)]. Geneva, Switzerland: IPCC. Retrieved from http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

Jacob, J. P., Blundo, G., Bako-Arifari, N., Børhaug, K., & Laurent, P. J. (1997). Socio-anthropologie de la décentralisation en milieu rural Africa in (bibliographie sélective et commentée). *Itinéraires. Notes et Travaux, 49*(4), 119. Retrieved from http://regards.in2p3.fr/fiche.php?id=4408

Johnson, K. B., Jacob, A., & Brown, M. E. (2013). Forest cover associated with improved child health and nutrition: evidence from the Malawi demographic and health survey and satellite data. *Global Health, Science and Practice, 1*(2), 237–248. https://doi.org/10.9745/GHSP-D-13-00055

Jones, A., Breuning-Madsen, H., Brossard, M., Dampha, A., Deckers, J., Dewitte, O., Gallali, T., Hallett, S., Jones, R., Kilasara, M., Le Roux, P., Micheli, E., Montanarella, L., Spaargaren, O., Thiombiano, L., Van

Ranst, E., Yemefack, M. , Zougmoré R. (Eds.). (2013). *Soil atlas of Africa.* Luxembourg: European Commission, Publications Office of the European Union. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/18442/av020e00.pdf

Kaimuddin, A. H., Laë, R., & Tito De Morais, L. (2016). Fish species in a changing world: The route and timing of species migration between tropical and temperate ecosystems in Eastern Atlantic. *Marine Fisheries, Aquaculture and Living Resources, 162*. https://doi.org/10.3389/fmars.2016.00162

Keller, R. P., Lodge, D. M., Lewis, M. A., & Shogren, J. F. (Eds.). (2009). Bioeconomics of invasive species: Integrating ecology, economics, policy, and management. New York, NY, USA: Oxford University Press. ISBN 9780195367980

Kideghesho, J., Rija, A., Mwamende, K., & Selemani, I. (2013). Emerging issues and challenges in conservation of biodiversity in the rangelands of Tanzania. *Nature Conservation, 6*, 1–29. https://doi.org/10.3897/natureconservation.6.5407

Kilroy, G. (2015). A review of the biophysical impacts of climate change in three hotspot regions in Africa and Asia. *Regional Environmental Change, 15*(5), 771–782. https://doi.org/10.1007/s10113-014-0709-6

Kremen, C. (2005). Managing ecosystem services: what do we need to know about their ecology? *Ecology Letters, 8*(5), 468–479. https://doi.org/10.1111/j.1461-0248.2005.00751.x

Kristjanson, P., Mango, N., Krishna, A., Radeny, M., & Johnson, N. (2010). Understanding poverty dynamics in Kenya. *Journal of International Development, 22*(7), 978–996. https://doi.org/10.1002/jid.1598

Kusters, K. (2015). *Climate-smart landscapes and the landscape approach – An exploration of the concepts and their practical implications*. Wageningen, the Netherlands: Tropenbos International. Retrieved from http://www.tropenbos.org/news/climate-smart+landscapes+and+the+landscape+approach+%E2%80%93+an+exploration+of+the+concepts+and+their+practical+implications

Langholz, J. A., & Krug, W. (2004). New forms of biodiversity governance: Non-state actors and the private protected area action plan. *Journal of International Wildlife Law & Policy, 7,* (1–2), 9–29. https://doi.org/10.1080/13880290490480112

Larcom, S., van Gevelt, T., & Zabala, A. (2016). Pre-colonial institutions and deforestation in Africa. *Land Use Policy, 51*, 150–161. https://doi.org/10.1016/j.landusepol.2015.10.030

Laurance, W. F., Sloan, S., Weng, L., & Sayer, J. A. (2015). Estimating the environmental costs of Africa's massive 'development corridors'. *Current Biology, 25*(24), 3202–3208. https://doi.org/10.1016/j.cub.2015.10.046

Le Manach, F., & Pauly, D. (Eds.). (2015). *Fisheries catch reconstructions in the Western Indian Ocean, 1950–2010.* Vancouver, B.C., Canada: Fisheries Centre, University of British Columbia. Retrieved from https://open.library.ubc.ca/media/download/pdf/52383/1.0354315/5

Le Manach, F., Gough, C., Harris, A., Humber, F., Harper, S., & Zeller, D. (2012). Unreported fishing, hungry people and political turmoil: the recipe for a food security crisis in Madagascar? *Marine Policy, 36*(1), 218–225. https://doi.org/10.1016/j.marpol.2011.05.007

Leadley, P., & Le Page, C. (2013). *Panorama de la recherche sur les scénarios de la biodiversité en Afrique.* Oral communication presented at the Atelier régional "Scénarios de la biodiversité africaine," Libreville, Gabon.

Lee, J. S. H., Garcia-Ulloa, J., & Koh, L. P. (2011). Impacts of biofuel expansion in biodiversity hotspots. In F. E. Zachos, & J. C. Habel (Eds.), *Biodiversity Hotspots* (p. 277-293). Berlin Heidelberg, Germany: Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-20992-5_15

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., Amann, M., Anderson, H. R., Andrews, K. G., Aryee, M., Atkinson, C., Bacchus, L. J., Bahalim, A. N., Balakrishnan, K., Balmes, J., Barker-Collo, S., Baxter, A., Bell, M. L., Blore, J. D., Blyth, F., Bonner, C., Borges, G., Bourne, R., Boussinesq, M., Brauer, M., Brooks, P., Bruce, N. G., Brunekreef, B., Bryan-Hancock, C., Bucello, C., Buchbinder, R., Bull F., Burnett, R. T., Byers, T. E., Calabria, B., Carapetis, J., Carnahan E., Chafe, Z., Charlson, F., Chen, H., Chen, J. S., Cheng, A. T., Child, J. C., Cohen, A., Colson, K. E., Cowie, B. C., Darby, S., Darling, S., Davis, A., Degenhardt, L., Dentener, F., Des Jarlais, D. C., Devries, K., Dherani, M., Ding, E. L., Dorsey, E. R., Driscoll, T., Edmond, K., Ali, S. E., Engell, R. E., Erwin, P. J., Fahimi, S., Falder G., Farzadfar, F., Ferrari, A., Finucane, M. M., Flaxman, S., Fowkes, F. G., Freedman, G., Freeman M. K., Gakidou, E., Ghosh, S., Giovannucci, E., Gmel, G., Graham, K., Grainger, R., Grant, B., Gunnell, D., Gutierrez, H. R., Hall, W., Hoek, H. W., Hogan, A., Hosgood 3rd, H. D., Hoy, D., Hu, H., Hubbell, B. J., Hutchings, S. J., Ibeanusi, S. E., Jacklyn, G. L., Jasrasaria, R., Jonas, J. B., Kan, H., Kanis, J. A., Kassebaum, N., Kawakami N., Khang, Y. H., Khatibzadeh, S., Khoo, J. P., Kok, C., Laden, F., Lalloo, R., Lan, Q., Lathlean, T., Leasher, J. L., Leigh, J, Li Y., Lin, J. K., Lipshultz, S. E., London S., Lozano, R., Lu, Y., Mak, J., Malekzadeh R., Mallinger, L., Marcenes, W., March, L., Marks, R., Martin, R., McGale, .P, McGrath, J., Mehta, S., Mensah, G. A., Merriman, T. R., Micha, R., Michaud, C., Mishra, V., Mohd Hanafiah, K., Mokdad, A. A., Morawska, L., Mozaffarian, D., Murphy, T., Naghavi, M., Neal, B., Nelson, P. K., Nolla, J. M., Norman, R., Olives, C., Omer, S. B., Orchard J., Osborne, R., Ostro, B., Page, A., Pandey, K. D., Parry, C. D., Passmore, E., Patra, J., Pearce, N., Pelizzari, P. M., Petzold, M., Phillips, M. R., Pope, D., Pope 3rd, C. A., Powles, J., Rao, M., Razavi, H., Rehfuess E. A., Rehm, J. T., Ritz, B., Rivara, F. P., Roberts, T., Robinson, C., Rodriguez-Portales, J. A., Romieu, I., Room, R., Rosenfeld, L. C., Roy, A., Rushton L., Salomon J. A., Sampson, U., Sanchez-Riera, L., Sanman, E., Sapkota, A., Seeda, S., Shi, P., Shield, K., Shivakoti, R., Singh, G. M., Sleet, D. A., Smith, E., Smith, K. R., Stapelberg, N. J., Steenland, K., Stöckl, H., Stovner, L. J., Straif, K., Straney, L., Thurston, G. D., Tran, J. H., Van Dingenen, R., van Donkelaar, A., Veerman, J. L., Vijayakumar, L., Weintraub, R., Weissman, M. M.,

White, R. A., Whiteford, H., Wiersma, S. T., Wilkinson, J. D., Williams, H. C., Williams, W., Wilson, N., Woolf, A. D., Yip, P., Zielinski, J. M., Lopez, A. D., Murray, C. J., Ezzati, M., Al Mazroa, M. A., Memish, Z. A. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *The Lancet, 3*80(9859), 2224–2260. https://doi.org/10.1016/S0140-6736(12)61766-8

Linder, H. P. (2014). The evolution of African plant diversity. *Evolutionary and Population Genetics, 2*, 38. https://doi.org/10.3389/fevo.2014.00038

Lindley, S. J., Gill, S. E., Cavan, G., Yeshitela, K., Nebebe, A., Woldegerima, T., Kibassa, D., Shemdoe, R., Renner, F., Buchta, K., Abo-El-Wafa, H., Printz, A., Sall, F., Coly, A., Ndour, N. M., Feumba, R. A., Zogning, M. O. M., Tonyé, E., Ouédraogo, Y., Samari, S. B., & Sankara, B. T. (2015). Green infrastructure for climate adaptation in African cities. In S. Pauleit, A. Coly, S. Fohlmeister, P. Gasparini, G. Jørgensen, S. Kabisch, W. J. Kombe, S. Lindley, I. Simonis, & K. Yeshitela (Eds.), *Urban vulnerability and climate change in Africa* (pp. 107–152). Cham, Switzerland: Springer. Retrieved from https://doi.org/10.1007/978-3-319-03982-4_4

Loarie, S. R., Duffy, P. B., Hamilton, H., Asner, G. P., Field, C. B., & Ackerly, D. D. (2009). The velocity of climate change. *Nature, 462*(7276), 1052–1055. https://doi.org/10.1038/nature08649

Logo, P. B. (2003).*The decentralized forestry taxation system in Cameroon: local management and state logic.* Environmental governance in Africa working paper series (WRI). Washington, DC, USA: World Resources Institute. http://www.cifor.org/nc/online-library/browse/view-publication/publication/1229.html

LPFN (Landscape for People, Food and Nature). (2015). Integrated landscape management: The means of implementation for the sustainable development goals. EcoAgriculture Partners. Retrieved from https://ecoagriculture.org/wp-content/uploads/2015/09/ILM-for-the-SDGs-Two-Page-Statement-Sept-21-2015-FINAL-FINAL.pdf

Lykke, A. M. (2000). Local perceptions of vegetation change and priorities for conservation of woody-savanna vegetation in Senegal. *Journal of Environmental Management, 59*(2), 107–120. https://doi.org/10.1006/jema.2000.0336

Lykke, A. M., Kristensen, M. K., & Ganaba, S. (2004). Valuation of local use and dynamics of 56 woody species in the Sahel. *Biodiversity & Conservation, 13*(10), 1961–1990. https://doi.org/10.1023/B:BIOC.0000035876.39587.1a

MA (Millennium Ecosystem Assessment). (2003). Ecosystems and human well-being. A framework for assessment. Washington, DC, USA: Island Press. Retrieved from https://millenniumassessment.org/en/Framework.html

MA (Millennium Ecosystem Assessment). (2005). *Ecosystems and human well-being: Synthesis*. Washington, DC, USA: Island Press. Retrieved from https://www.millenniumassessment.org/documents/document.356.aspx.pdf

Maitima, J. M., Mugatha, S. M., Reid, R. S., Gachimbi, L. N., Majule, A., Lyaruu, H., Pomery D., Mathai, S., & Mugisha, S. (2009). The linkages between land use change, land degradation and biodiversity across East Africa. *African Journal of Environmental Science and Technology, 3*(10), 310–325.

Malaspinas, A.-S., Westaway, M. C., Muller, C., Sousa, V. C., Lao, O., Alves, I., Bergström, A., Athanasiadis, G., Cheng, J. Y.,Crawford, J. E., Heupink, T. H., Macholdt, E., Peischl, S., Rasmussen, S., Schiffels, S., Subramanian, S., Wright, J. L., Albrechtsen, A., Barbieri, C., Dupanloup, I., Eriksson, A., Margaryan, A., Moltke, I., Pugach, I., Korneliussen, T. S., Levkivskyi, I. P., Moreno-Mayar, J. V., Ni, S., Racimo, F., Sikora, M., Xue, Y., Aghakhanian, F. A., Brucato, N., Søren Brunak, S., Campos, P. F., Clark, W., Ellingvåg, S., Fourmile, G., Gerbault, P., Injie, D., Koki, G., Leavesley, M., Logan, B., Lynch, A., Matisoo-Smith, E. A., McAllister, P. J., Mentzer, A. J., Metspalu, M., Migliano, A. B., Murgha, L., Phipps, M. E., Pomat, W., Reynolds, D., Ricaut, F-X., Siba, P., Thomas, M. G., Wales, T., Wall, C. M., Oppenheimer, S. J., Tyler-Smith, C., Durbin, R., Dortch, J., Manica, A., Schierup, M. H., Foley, R. A., Mirazón Lahr, M. M., Bowern, C., Wall, J. D., Mailund, T., Stoneking, M., Nielsen, R., Sandhu, M. S., Excoffier, L., Lambert, D. M., & Eske Willerslev, E. (2016). A genomic history of Aboriginal Australia. *Nature, 538*, 207–214 https://doi.org/10.1038/nature18299

Mallick, S., Li, H., Lipson, M., Mathieson, I., Gymrek, M., Racimo, F., Zhao, M., Chennagiri, N., Nordenfelt, S., Tandon, A., Skoglund, P., Lazaridis, I., Sankararaman, S., Fu, O., Rohland, N., Renaud, G., Erlich, Y., Willems, T., Gallo, C., Spence, J. P., Song, Y. S., Poletti, G., Balloux, F., van Driem, G., de Knijff, P., Romero, IG., Jha, A. R., Behar, D. M., Bravi, C. M., Capelli, C., Hervig, T., Moreno-Estrada, A., Posukh, OL., Balanovska, E., Balanovsky, O., Karachanak-Yankova, S., Sahakyan, H., Toncheva, D., Yepiskoposyan, L., Tyler-Smith, C., Xue, Y., Abdullah, M. S., Ruiz-Linares, A., Beall, C. M., Rienzo, A. D., Jeong, C., Starikovskaya, E. B., Metspalu, E., Parik, J., Villems, R., Henn, B. M., Hodoglugil, U., Mahley, R., Sajantila, A., Stamatoyannopoulos, G., Wee, J. T S., Khusainova, R., Khusnutdinova, E., Litvinov, S., Ayodo, G., Comas, D., Hammer, M. F., Kivisild T., Klitz, W., Winkler, C. A., Labuda, D., Bamshad, M., Jorde, L. B., Tishkoff, S. A., Watkins, W. S., Metspalu, M., Dryomov, S., Sukernik, R., Singh, L., Thangaraj K., Pääbo, S., Kelso, J., Patterson, N., & Reich, D. (2016). The Simons Genome Diversity Project: 300 genomes from 142 diverse populations. *Nature, 538*, 201–206. http://doi.org/10.1038/nature18964

Mamdani, M. (1996).Citizen and subject: Contemporary Africa and the legacy of late colonialism. Princeton University Press. ISBN 9780691180427

Mandondo, A. (2000). *Situating Zimbabwe's natural resource governance systems in history*. CIFOR Occasional Paper, 32, 20 pp. Center for International Forestry Research. Retrieved from https://doi.org/10.17528/cifor/000716

Manor, J. (1999).Civil society under different types of government *IDS Policy Briefing, 10.*

Marsh, D. M., & Sharma, D. (2007). Energy-Water Nexus: An integrated modeling approach. *International Energy Journal, 8*(4). Retrieved from http://www.rericjournal.ait.ac.th/index.php/reric/article/view/334

Matose, F. (1997). Conflicts around forest reserves in Zimbabwe: What prospects for community management? *IDS Bulletin, 28*(4), 69–78. https://doi.org/10.1111/j.1759-5436.1997.mp28004008.x

Matson, P. A., Parton, W. J., Power, A. G., & Swift, M. J. (1997). Agricultural Intensification and Ecosystem Properties. *Science, 277*(5325), 504–509. https://doi.org/10.1126/science.277.5325.504

Maundu, P., Kibet, S., Morimoto, Y., Imbumi, M., & Adeka, R. (2009). Impact of *Prosopis juliflora* on Kenya's semi-arid and arid ecosystems and local livelihoods. *Biodiversity, 10*(2–3), 33–50. https://doi.org/10.1080/14888386.2009.9712842

Mauro, F., & Hardison, P. D. (2000). Traditional knowledge of indigenous and local communities: international debate and policy initiatives. *Ecological Applications, 10*(5), 1263–1269. https://doi.org/10.1890/1051-0761(2000)010[1263:TKOIAL]2.0.CO;2

Mayall, J. (1973). The Malawi-Tanzania boundary dispute. *The Journal of Modern African Studies, 11*(4), 611–628. Retrieved from https://www.jstor.org/stable/161618

McKay, A., & Thorbecke, E. (Eds.). (2015). *Economic growth and poverty reduction in sub-Saharan Africa: Current and emerging issues*. Oxford, UK, Oxford University Press. ISBN 9780198728450

Melone, S. (1972). *La parenté et la terre dans la stratégie du développement: l'expérience camerounaise.* Cameroon: Université fédérale du Cameroun, Klincksieck.

Meyer, C., Kreft, H., Guralnick, R. P., & Jetz, W. (2015). Global priorities for an effective information basis of biodiversity distributions. *Nature Communications, 6*, 8221. https://doi.org/10.1038/ncomms9221

Milder, J. C., Hart, A. K., Dobie, P., Minai, J., & Zaleski, C. (2014). Integrated landscape initiatives for African agriculture, development, and conservation: A region-wide assessment. *World Development, 54,* 68–80. https://doi.org/10.1016/j.worlddev.2013.07.006

Mistry, J., & Berardi, A. (2016). Bridging indigenous and scientific knowledge. *Science, 352*(6291), 1274–1275. https://doi.org/10.1126/science.aaf1160

Mittermeier, R. A., Gil, P. R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C. G., lamoreux, J., & Da Fonseca, G. A. B. (2004). *Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions.* Chicago, Il, USA: University of Chicago Press for Conservation International. ISBN 9789686397772

Molden, D., Frenken, K., Barker, R., de Fraiture, C., Mati, B., Svendsen, M., Sadoff, C., Finlayson, C., & M. (2007). Trends in water and agricultural development. In D. Molden (Ed.), *Water for food, water for life : A comprehensive assessment of water management in agriculture* (pp. 57–89). London, UK: Earthscan. Retrieved from http://www.iwmi.cgiar.org/assessment/Water%20for%20Food%20Water%20for%20Life/Chapters/Chapter%202%20Trends.pdf

Moore, J. L., Manne, L., Brooks, T., Burgess, N. D., Davies, R., Rahbek, C., Williams, P., & Balmford, A. (2002). The distribution of cultural and biological diversity in Africa. *Proceedings of the Royal Society of London B: Biological Sciences, 269* (1501), 1645–1653. https://doi.org/10.1098/rspb.2002.2075

Morgan, L. H. (1877). *La société archaïque. Anthropos.* Retrieved from http://classiques.uqac.ca/classiques/morgan_lewis_henry/societe_archaique/societe_archaique.html

Moyo, M., Aremu, A. O., & van Staden, J. (2015). Medicinal plants: An invaluable, dwindling resource in sub-Saharan Africa. *Journal of Ethnopharmacology, 174,* 595–606. https://doi.org/10.1016/j.jep.2015.04.034

Muller, F. and Burkhard, B. (2012). The indicator side of ecosystem services. *Ecosystem Services, 1,* 26–30. https://doi.org/10.1016/j.ecoser.2012.06.001

Murombedzi, J. (2003). Pre-colonial and colonial conservation practices in southern Africa and their legacy today. IUCN unpublished manuscript. Gland, Switzerland: IUCN. Retrieved from http://cmsdata.iucn.org/downloads/cca_jmurombedzi.pdf

Murray, K. A., Allen, T., Loh, E., Machalaba, C., & Daszak, P. (2016). Emerging viral zoonoses from wildlife associated with animal-based food systems: Risks and opportunities. In M. Jay-Russell & M. P. Doyle (Eds.), *Food safety risks from wildlife* (pp. 31–57). Cham, Switzerland: Springer. Retrieved from https://doi.org/10.1007/978-3-319-24442-6_2

Mutanga, C., Zulu, E., & de Souza, R. (2012). *Population dynamics, climate change, and sustainable development in Africa.* African Institute for Development Policy. Retrieved from https://www.afidep.org/download/Population-Dynamics-Climate-Change-and-Sustainable-Development-in-Africa

Mwangi, E., & Swallow, B. (2005). Invasion of *Prosopis juliflora* and local livelihoods: Case study from the lake Baringo area of Kenya. Nairobi, Kenya: World Agroforestry Centre. Retrieved from http://www.worldagroforestry.org/downloads/Publications/PDFs/WP12051.PDF

Myers, S. S., Gaffikin, L., Golden, C. D., Ostfeld, R. S., Redford, K. H., Ricketts, T. H., Turner, W. R., & Osofsky, S. A. (2013). Human health impacts of ecosystem alteration. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(47), 18753–18760. https://doi.org/10.1073/pnas.1218656110

Nachtergaele, F., Biancalani, R., & Petri, M. (2011). *Land degradation: SOLAW background thematic report (No. 3).* Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved from www.fao.org/fileadmin/templates/solaw/files/thematic_reports/SOLAW_thematic_report_3_land_degradation.pdf

Naik, P. K. (2017). Water crisis in Africa: Myth or reality? *International Journal of Water Resources Development, 33*(2), 326–339. https://doi.org/10.1080/07900627.2016.1188266

Nakashima, D., & Roué, M. (2002). Indigenous knowledge, peoples and sustainable practice. In T. Munn (Ed.), *Encyclopedia of global environmental change* (Vol. 5, pp. 314–324). New York, NY, USA: John Wiley & Sons. Retrieved from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/sc_LINKS-art%20EGEC.pdf

Nelson, G. C., Bennett, E., Berhe, A. A., Cassman, K., DeFries, R., Dietz, T., Dobermann, A., Dobson, A, Janetos, A., Levy, M., Marco, D., Nakicenovic, N., O'Neill, B., Norgaard, R., Petschel-Held, G., Ojima, D., Pingali, P., Watson, R., & Zurek, M. (2006). Anthropogenic drivers of ecosystem change: An overview. *Ecology and Society, 11*(2). Retrieved from http://www.ecologyandsociety.org/vol11/iss2/art29/

Nelson, J., & Gami, N. (2003). *Enhancing equity in the relationship between protected areas and indigenous and local communities in Central Africa, in the context of global change.* TILPECA: IUCN/CEESP/WCPA theme on indigenous and local communities, equity and protected areas. TILCEPA.

Ngonkeu, M. E. L., Nwaga, D., Adamou, S., Fokom, R., Tchameni, N. S., Onguene, N. A., Nana, W. L., Chaintreuil, C., The, C., Amougou, A., Moulin, L., Prin, Y., Lebrun, M., & Dreyfus, B. (2013). Diversité des champignons mycorhiziens arbusculaires du Cameroun. In R. Duponnois, M. Hafidi, I. Ndoye, H. Ramanankierana, & A.M. Ba (Eds.), *Des Champignons Symbiotiques Contre La Desertification Ecosystemes Mediterraneens, Tropicaux Et Insulaires.* Marseille, France: IRD. Retrieved from http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers15-04/010061528.pdf

Nhamo, G. (2013). Green economy readiness in South Africa: A focus on the national sphere of government. *International Journal of African Renaissance Studies – Multi-, Inter- and Transdisciplinarity, 8*(1), 115–142. https://doi.org/10.1080/18186874.2013.834628

Nhamo, G. (2017). New global sustainable development agenda: A focus on Africa. *Sustainable Development, 25,* 227–241. https://doi.org/10.1002/sd.1648

Nielsen, J. Ø., & Reenberg, A. (2010a). Cultural barriers to climate change adaptation: A case study from Northern Burkina Faso. *Global Environmental Change, 20*(1), 142–152. https://doi.org/10.1016/j.gloenvcha.2009.10.002

Nielsen, J. Ø., & Reenberg, A. (2010b). Temporality and the problem with singling out climate as a current driver of change in a small West African village. *Journal of Arid Environments, 74*(4), 464–474. https://doi.org/10.1016/j.jaridenv.2009.09.019

Nolte, K., Chamberlain, W., & Giger, M. (2016). International land deals for agriculture. Fresh insights from the Land Matrix: Analytical Report II. Bern, Montpellier, Hamburg, Pretoria: Centre for Development and Environment, University of Bern; Centre de coopération internationale en recherche agronomique pour le développement; German Institute of Global and Area Studies; University of Pretoria: Bern Open Publishing. Retrieved from http://www.landcoalition.org/sites/default/files/documents/resources/land_matrix_2016_analytical_report_ii.pdf

Oldekop, J. A., Fontana, L. B., Grugel, J., Roughton, N., Adu-Ampong, E. A., Bird, G. K., Dorgan, A., Espinoza, M. A. V., Wallin, S., Hammett, D., Agbarakwe, E., Agrawal, A., Asylbekova, N., Azkoul, C., Craig Bardsley, C., Bebbington, A. J., Carvalho, S., Chopra, D., Christopoulos, S., Crewe, E., Dop, M-C., Fischer, J., Gerretsen, D., Glennie, J., Gois, W., Gondwe, M., Harrison, L. A., Hujo, K., Keen, M., Laserna, R., Miggiano, L., Mistry, S., Morgan, R. J., Raftree, L., Rhind, D., Rodrigues, T., Roschnik, S., Senkubuge, F., Thornton, I., Trace, S., Ore, T., Valdés, RM., Vira, B., Yeates, N., & Sutherland, W. J. (2016). 100 key research questions for the post-2015 development agenda. *Development Policy Review, 34*(1), 55–82. https://doi.org/10.1111/dpr.12147

Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J. C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Kura, Y., Lamoreux, J. F., Wettengel, W. W., Hedao, P., & Kassem, K. R. (2001). Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience, 51*(11), 933–938. https://doi.org/10.1641/0006-3568(2001)051[0933:TEOTWA]2.0.CO;2

Onyige, C. (2011). Feminist theorising of the role of women in conflict and development in the Niger Delta. *Pan African Social Science Review, 12*. ISSN 87557436.

Oyono, P. R. (2005). The social and organisational roots of ecological uncertainties in cameroon's forest management decentralisation model. In J. C. Ribot, & A. M. Larson (Eds.), *Democratic decentralisation through a natural resource lens* (pp. 174–191). Oxon, UK: Routledge. Retrieved from http://link.springer.com/article/10.1080/09578810410001688798

Oyono, P. R. (2013). The narratives of capitalist land accumulation and recognition in coastal Cameroon. The Hague, The Netherlands: Land Deal Politics Initiative. Retrieved from http://www.plaas.org.za/sites/default/files/publications-pdf/LDPI29Oyono.pdf

Oyono, P. R., Ribot, J. C., Assembe Mvondo, S., & Logo, P. B. (2007). Improving decentralized forest management in Cameroon: Options and opportunities from ten years of experience. *Center for International Forestry Research Policy Brief, 33*. https://doi.org/10.17528/cifor/002190

Pagani, L., Lawson, D. J., Jagoda, E., Mörseburg, A., Eriksson, A., Mitt, M., Clemente, F., Hudjashov, G., DeGiorgio, M., Saag, L., Wall, J. D., Cardona, A., Mägi, R., Wilson Sayres, M. A., Kaewert, S., Inchley, C., L. Scheib, C. L., Järve, M., Karmin, M., Jacobs, G. S., Antao T., Iliescu, F. M., Kushniarevich, A., Ayub, Q., Tyler-Smith, C., Xue, Y., Yunusbayev, B, Tambets, K, Mallick, C. B., Saag, L., Pocheshkhova, E., Andriadze, G., Muller, C., Westaway, M. C., Lambert, D. M., Zoraqi, G., Turdikulova, S., Dalimova, D., Sabitov, Z., Sultana, GNN., Lachance, J., Tishkoff, S., Momynaliev, K., Isakova, J., Damba, L. D., Gubina, M., Nymadawa, P., Evseeva, I., Atramentova, L., Utevska, O., Ricaut, F-X., Brucato, N., Sudoyo, H., Letellier, T., Cox, M. P., Barashkov, N. A., Škaro, V., Mulahasanović, L., Primorac, D., Sahakyan, H., Mormina, M., Eichstaedt, C. A., Daria V. Lichman, D. V., Abdullah, S., Chaubey, G., Wee, J. T. S., Mihailov,

E., Karunas, A., Litvinov, S., Khusainova, R., Ekomasova, N., Akhmetova, V., Khidiyatova, I., Marjanović, D., Yepiskoposyan, L., Behar, D. M., Balanovska, E., Metspalu, A., Derenko M., Malyarchuk, B., Voevoda, M., Fedorova, S. A., Osipova, L. P., Lahr, M. M., Gerbault, P., Leavesley, M., Migliano, AB., Petraglia, M., Balanovsky, O., Khusnutdinova, E. K., Metspalu, E., Thomas, M. G., Manica, A., Nielsen, R., Villems, R., Willerslev, E., Kivisild, T., & Metspalu, M. (2016). Genomic analyses inform on migration events during the peopling of Eurasia. *Nature, 538*, 238–242. https://doi.org/10.1038/nature19792

Palmer, E. (2015). Introduction: The 2030 Agenda. *Journal of Global Ethics, 11*, (3), 262–269. Retrieved from https://doi.org/10.1080/17449626.2015.1119928

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R. T., Dessane, E. B., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S. M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y. S., Amankwah, E., Asah, T. S., Bberry, P., Bilgin, A., Breslow, S. J., Bullock, C., Càceres, D., Daly-Hassen, H., Figueroa, E., Golden, D. C., Gòmez-Baggethum, E., Gonzàlez-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P. H., Mead, A., Pichis-Madruga, D., Popa, F., Preston, S., Pacheso-Balanza, D., Saarikoski, H., Strassburg, B. B., vanden Belt, M., Verma, M., & Maris, V. (2017). Valuing nature's contributions to people: The IPBES approach. *Current Opinion in Environmental Sustainability, 26*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Pauli, G. A. (2010). The blue economy: 10 years, 100 innovations, 100 million jobs. Paradigm Publications.

Pereira, H. M., Leadley, P. W., Proença, V., Alkemade, R., Scharlemann, J. P. W., Fernandez-Manjarrés, J. F., Araújo, M. B., Balvanera, B., Biggs, R., Cheung, W. W. L., Chini, L., Cooper, H. D., Gilman, E. L., Guénette, S., Hurtt, G. C., Huntington, H. P., Mace, G. M., Oberdorff, T., Revenga, C., Rodrigues, P., Scholes, R. J., Sumaila, U. R., & Walpole, M. (2010). Scenarios for global biodiversity in the 21st century. *Science, 330*(6010), 1496–1501. https://doi.org/10.1126/science.1196624

Pimentel, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell, C., Wong, E., Russel, L., Zern, J., Aquino, T., & Tsomondo, T. (2001). Economic and environmental threats of alien plant, animal, and microbe invasions. *Agriculture, Ecosystems & Environment, 84*(1), 1–20. https://doi.org/10.1016/S0167-8809(00)00178-X

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., Raven, H., Roberts, C. M., & Sexton, J. O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science, 344*(6187), 1246752. https://doi.org/10.1126/science.1246752

Pimm, S. L., Russell, G. J., Gittleman, J. L., & Brooks, T. M. (1995).The future of biodiversity. *Science, 269*, 347–350. https://doi.org/10.1126/science.269.5222.347

Pinkovskiy, M., & Sala-i-Martin, X. (2014). Africa is on time. *Journal of Economic Growth, 19*(3), 311–338. https://doi.org/10.1007/s10887-014-9103-y

Potts, D. (2009). The slowing of sub-Saharan Africa's urbanization: evidence and implications for urban livelihoods. *Environment and Urbanization, 21*(1), 253–259. https://doi.org/10.1177/0956247809103026

Potts, D. (2012, February 15). *Whatever happened to Africa's rapid urbanization?* Africa Research Institute. Retrieved from https://www.africaresearchinstitute.org/newsite/publications/whatever-happened-to-africas-rapid-urbanisation-new/

Prabhu, R., Colfer, C. J. P., & Diaw, C. (2001, September). *Sharing benefits from forest utilisation: Trojan horses, copy cats, blind mice and busy bees.* Paper presented at the Conference on Public Policy, Natural Resources and Equity: Development as if Equity Mattered. , Georgetown, Guyana. Cropper Foundation, Iwokrama Centre, Woods Hole Research Center.

Preston, G., Brown, G., & van Wyk, E. (2000). *Best management practices for preventing and controlling invasive alien species.* Proceedings of a Symposium of the South Africa : United States of America Bi-national Commission. Cape Town, South Africa: Working for Water Programme.

Prip, C., & Rosendal, K. (2015). *Access to genetic resources and benefit-sharing from their use (ABS): State state of implementation and research gaps.* Lysaker, Norway: Fridtjof Nansen Institute. Retrieved from http://www.fni.no/pdf/FNI-R0515.pdf

Pyšek, P., Hulme, P. E., Meyerson, L. A., Smith, G. F., Boatwright, J. S., Crouch, N. R., Figueiredo, E., Foxcroft, L. C., Jarošík, V., Richardson, D. M., Suda, J., & Wilson, J. R. U. (2013). Hitting the right target: Taxonomic challenges for, and of, plant invasions. *AoB Plants, 5*. https://doi.org/10.1093/aobpla/plt042

Quézel, P., Médail, F., Loisel, R., & Barbero, M. (1999). Biodiversity and conservation of forest species in the Mediterranean basin. *Unasylva, 50*, 21–28. Retrieved from http://www.fao.org/docrep/x1880e/x1880e05.htm

Raygorodetsky, G. (2011, December 13). *Why traditional knowledge holds the key to climate change.* United Nations University. Retrieved from https://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J. A. (2009). A safe operating space for humanity. *Nature, 461*(7263), 472–475. https://doi.org/10.1038/461472a

Rodríguez, J. P., Keith, D. A., Rodríguez-Clark, K. M., Murray, N. J., Nicholson, E., Regan, T. J., Miller, R. M., Barrow, E. G., Bland, L. M., Boe, K., Brooks, T. M., Oliveira-Miranda, M. A., Spalding, M., & Wit, P. (2015). A practical guide to the application of the IUCN Red List of Ecosystems criteria. *Philosophical Transactions of the Royal Society B: Biological Sciences, 370*(1662), 20140003. https://doi.org/10.1098/rstb.2014.0003

Rosenberg, A. A., Fogarty, M. J., Cooper, A. B., Dickey-Collas, M., Fulton, E. A., Gutiérrez, N. L., Hyde, K.

J. W., Kleisner, K. M., Kristiansen, T., Longo, C., Minte-Vera, C. V., Minto, C., Mosqueira, I., Chato-Osio, G., Ovando, D., Selig, E. R., Thorson, J. T., & Ye, Y. (2014). *Developing new approaches to global stock status assessment and fishery production potential of the seas.* Rome, Italy: Food and Agriculture Organization of the United Nations.

Roué, M., & Nakashima, D. (2002). Knowledge and foresight: The predictive capacity of traditional knowledge applied to environmental assessment. *International Social Science Journal, 54*(173), 337–347. https://doi.org/10.1111/1468-2451.00386

Roué, M., Césard, N., Adou Yao, Y. C., & Oteng-Yeboah, A. (Eds.). (2016). Indigenous and local knowledge of biodiversity and ecosystem services in Africa. Paris, France: UNESCO. Retrieved from http://unesdoc.unesco.org/images/0024/002474/247461m.pdf

Rowland, D., Blackie, R. R., Powell, B., Djoudi, H., Vergles, E., Vinceti, B., & Ickowitz, A. (2015). Direct contributions of dry forests to nutrition: A review. *International Forestry Review, 17*(S2), 4553. https://doi.org/10.1505/146554815815834804

Roxburgh, C., Dörr, N., Leke, A., Tazi-Riffi, A., van Wamelen, A., Lund, S., Chironga, M., Alatovik, T., Atkins, C., Terfous, N., & Zeino-Mahmalat, T. (2010). *Lions on the move: The progress and potential of African economies.* Washington, DC, USA: McKinsey Global Institute. Retrieved from https://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Productivity%20Competitiveness%20and%20Growth/Lions%20on%20the%20move%20The%20progress%20of%20African%20economies/MGI_Lions_on_the_move_african_economies_full_report.ashx

Sambanis, N. (2004). Using studies to expand economic models of civil war. *Perspectives on Politics, 2*(2), 259–279. https://doi.org/10.1017/S1537592704040149

Sasvari, A., Aguilar, L., Khan, M., & Schmitt, F. (2010). *Guidelines for mainstreaming gender into National Biodiversity Strategies and Action Plans*. Gland, Switzerland: IUCN. Retrieved from https://www.cbd.int/doc/publications/cbd-ts-49-en.pdf

Scherr, S. J. (2014). A decade of integrated landscape management. *Farming Matters, 30*(3), 38–40. Retrieved from https://www.ileia.org/wp-content/uploads/2017/01/30_3_Landscapes.pdf

Scherr, S. J., Shames, S., & Friedman, R. (2013). Defining integrated landscape management for policy makers. *Ecoagriculture Policy Focus, 10*. Retrieved from https://ecoagriculture.org/wp-content/uploads/2015/08/DefiningILMforPolicyMakers.pdf

Scheumann, W., & Neubert, S. (Eds.). (2006). *Transboundary water management in Africa : challenges for development cooperation.* Bonn, Germany: Ministry for Economic Cooperation and Development (BMZ) Retrieved from http://nbn-resolving.de/urn:nbn:de:0168-ssoar-109930

Schmidt-Soltau, K. (2003). Conservation–related resettlement in Central Africa: Environmental and social risks. *Development and Change, 34*(3), 525–551. https://doi.org/10.1111/1467-7660.00317

Scullion, J. (2007). *Inland fisheries co-management in East Africa* (Working Paper).The WorldFish Center. Retrieved from https://ideas.repec.org/b/wfi/wfbook/37457.html

Sekercioglu, C. H., Schneider, S. H., Fay, J. P., & Loarie, S. R. (2008).Climate change, elevational range shifts, and bird extinctions. *Conservation Biology, 22*(1), 140–150. https://doi.org/10.1111/j.1523-1739.2007.00852.x

Selig, E. R., Longo, C., Halpern B. S., Best, B. D., Hardy, D., Elfes, C. T., Scarborough, C., Kleisner, K. M., Katona, K. S., & Katona, S. K. (2013). Assessing global marine biodiversity status within a coupled socio-ecological perspective. *PLoS ONE, 8*(4), e60284. https://doi.org/10.1371/journal.pone.0060284

Selig, E. R., Turner, W. R., Troëng, S., Wallace, B. P., Halpern, B. S., Kaschner, K., Lascelles, B. G., Carpenter, K. E., Mittermeier, R. A., & Mittermeier, R. A. (2014). Global priorities for marine biodiversity conservation. *PLoS ONE, 9*(1), e82898. https://doi.org/10.1371/journal.pone.0082898

Sene, G., Thiao, M., Manga, A., Kane, A., Samba-Mbaye, R., Mbaye, M. S., Khasa, D., & Sylla, S. N. (2012). Arbuscular mycorrhizal soil infectivity and spores distribution across plantations of tropical, subtropical and exotic tree species: a case study from the forest reserve of Bandia, Senegal. *African Journal of Ecology, 50*(2), 218–232. https://doi.org/10.1111/j.1365-2028.2011.01315.x

Senelwa, K., Etiégni, L., Osano, O., Balozi, K., & Imo, M. (2012). Environmental impacts of biofuel production in Africa. In R. Janssen, & D. Rutz (Eds.), *Bioenergy for sustainable development in Africa* (p. 237–245). Dordrecht, Netherlands: Springer. Retrieved from https://doi.org/10.1007/978-94-007-2181-4_20

Seto, K. C., Güneralp, B., & Hutyra, L. R. (2012).Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences of the United States of America, 109*(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109

Shackleton, R. T., Le Maitre, C. D., Pasiecznik, N. M., & Richardson, D. M. (2014). Prosopis: A global assessment of the biogeography, benefits, impacts and management of one of the world's worst woody invasive plant taxa. *AoB PLANTS, 6*. https://doi.org/10.1093/aobpla/plu027

Shivji, I. G., Moyo, S., Gunby, D., & Ncube, W. (1998). *National land policy framework. Draft discussion paper.* Harare, Zimbabwe: Ministry of Lands and Agriculture.

Simberloff, D. (2011). Risks of biological control for conservation purposes. *BioControl, 57*(2), 263–276. https://doi.org/10.1007/s10526-011-9392-4

Sims, C., Finnoff, D., & Shogren, J. F. (2016). Bioeconomics of invasive species: using real options theory to integrate ecology, economics, and risk management. *Food* Security, 8, 61–70. https://doi.org/10.1007/s12571-015-0530-1

Soberón, J., Jiménez, R., Golubov, J., & Koleff, P. (2007). Assessing completeness of biodiversity databases at different spatial scales. *Ecography, 30*(1), 152–160. https://doi.org/10.1111/j.0906-7590.2007.04627.x

State of the Planet Declaration. (2012). State of the planet declaration. Planet under pressure: New knowledge towards solutions. London, UK: UNESCO. Retrieved from http://rio20.net/wp-content/uploads/2012/05/state_of_planet_declaration.pdf

Taylor, S. (2015). African biodiversity hotspots and other important conservation designations for unique areas which may include mountains. Pretoria, South Africa: AFroMont, Centre for Environmental Studies, University of Pretoria. Retrieved from http://mri.scnatweb.ch/en/afromontcontent/afromont-source-documents/2508-africa-mountains-hotspots/file

Tear, T. H., Stratton, B. N., Game, E. T., Brown, M. A., Apse, C. D., & Shirer, R. R. (2014). A return-on-investment framework to identify conservation priorities in Africa. *Biological Conservation, 173*, 42–52. https://doi.org/10.1016/j.biocon.2014.01.028

Teh, L. C. L., & Sumaila, U. R. (2013). Contribution of marine fisheries to worldwide employment. *Fish and Fisheries, 14*(1), 77–88. https://doi.org/10.1111/j.1467-2979.2011.00450.x

Thangarajan, M., & Singh, V. P. (Eds.). (2016). *Groundwater assessment, modeling, and management.* Boca Raton, FL, USA: CRC Press. Retrieved from https://www.crcpress.com/Groundwater-Assessment-Modeling-and-Management/Thangarajan-Singh/p/book/9781498742849

Thiombiano, L., & Tourino-Soto, I. (2007). Status and trends in land degradation in Africa. In M. V. K. Sivakumar & N. Ndiang'ui (Eds.), *Climate and land degradation* (pp. 39–53). Berlin, Germany: Springer. Retrieved from https://doi.org/10.1007/978-3-540-72438-4_2

Thomas, D. S. G., & Twyman, C. (2004). Good or bad rangeland? Hybrid knowledge, science, and local understandings of vegetation dynamics in the Kalahari. *Land Degradation & Development, 15*(3), 215–231. https://doi.org/10.1002/ldr.610

Tiani, A. M., & Diaw, C. (2006). Does resettlement contribute to conservation? The case of Ikundu-Kundu, Korup National Park, Cameroon. *Policy Matters, 14*, 113–127.

Tibaijuka, A. (2007). Statement by Dr. Anna K. Tibaijuka, Under-Secretary-General and Executive Director of UN-HABITAT made at the first plenary session of the 21st Session of the Governing Council for UN-HABITAT. UN-HABITAT. Retrieved from http://mirror.unhabitat.org/downloads/docs/4697_27825_ED-GC21-Policy%20Statement-finalApr21.pdf

Tittensor, D. P., Walpole, M., Hill, S. L. L., Boyce, D. G., Britten, G L., Burgess, N. D., Butchart, S. H. M., Leadley P. W., Regan, E. C., Alkemade, R., Baumung, R., Bellard, C., Bouwman, L., Bowles-Newark, N. J., Chenery, A. N., Cheung, W. W. L., Christensen, V., Cooper, H.D., Crowther, A. R., Dixon, M. J. R., Galli, A., Gaveau, V., Gregory, R. D., Gutierrez, N. L., Hirsch, T. L., Höft, R., Januchowski-Hartley, S. R., Karmann, M., Krug, C. B., Leverington, F. J., Loh, J., Lojenga, R. K., Malsch, K., Marques, A., Morgan, D. H. W., Mumby, P. J., Newbold, T., Noonan-Mooney, K., Pagad, S. N., Parks, B. C., Pereira, H. M., Robertson, T., Rondinini, C., Santini, L., Scharlemann, J. P. W., Schindler, S., Sumaila, U. R., Teh, L. S. L., van Kolck, J., Visconti, P., & Ye, Y. (2014). A mid-term analysis of progress toward international biodiversity targets. *Science, 346*(6206), 241–244. https://doi.org/10.1126/science.1257484

Tsui, A. S. (2004). Contributing to global management knowledge: A case for high quality indigenous research. *Asia Pacific Journal of Management, 21*(4), 491–513. https://doi.org/10.1023/B:APJM.0000048715.35108.a7

Turpie, J. (2016). The role of resource economics in the control of invasive alien plants in South Africa. *South African Journal of Science, 100*, 87–93. Retrieved from http://hdl.handle.net/10520/EJC96207

UN HABITAT. (2014). *The state of African cities 2014: Re-imagining sustainable urban transitions (The State of African Cities).* Nairobi, Kenya: United Nations Human Settlements Programme. Retrieved from http://unhabitat.org/wpdm-package/state-of-african-cities-2014-re-imagining-sustainable-urban-transitions/?wpdmdl=111948

UN. (United Nations). (1992). *Convention on biological diversity.* United Nations. Retrieved from https://www.cbd.int/doc/legal/cbd-en.pdf

UN. (United Nations). (2013). *The Millennium Development Goals Report 2013*. New York, NY, USA: United Nations. Retrieved from http://www.un.org/millenniumgoals/pdf/report-2013/mdg-report-2013-english.pdf

UN. (United Nations). (2015a). *Transforming our World: The 2030 agenda for sustainable development.* New York, NY, USA: United Nations. Retrieved from https://sustainabledevelopment.un.org/post2015/transformingourworld

UN. (United Nations). (2015b). *World population prospects. Key findings & advance tables. The 2015 revision.* New York, NY, USA: United Nations, Department of Economic and Social Affairs, Population Division. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/18246/Key_Findings_WPP_2015.pdf

UN. (United Nations). (2015c). *World urbanization prospects: The 2014 revision.* New York, NY, USA: United Nations, Department of Economic and Social Affairs, Population Division. Retrieved from http://esa.un.org/unpd/wup/FinalReport/WUP2014-Report.pdf

UN. (United Nations). (2017). *World population prospects: Key findings & advance tables. The 2017 revision.* New York, NY, USA: United Nations, Department of Economic and Social Affairs, Population Division. Retrieved from https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf

UNCCD. (2013). *The economics of desertification, land degradation and drought: Methodologies and analysis for decision-making.* W. Ammann (Ed.). Davos, Switzerland: Global Risk Forum , United Nations Convention to Combat Desertification. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?rep=rep1&type=pdf&doi=10.1.1.226.3778

UNCCD. (2014). *Land degradation neutrality: Resilience at local, national and regional levels.* United Nations Convention to Combat Desertification. Retrieved from http://catalogue.unccd.int/858_V2_UNCCD_BRO_.pdf

UNCED. (1992). *Agenda 21.* United Nations conference on environment & development. Rio de Janerio, Brazil, 3 to 14 June 1992. Rio de Janerio, Brazil: UNCED. Retrieved from https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

UNDP. (2010). *Human development report 2010: The real wealth of nations: Pathways to human development.* New York, NY, USA: United Nations Development Programme. Retrieved from http://hdr.undp.org/sites/default/files/reports/270/hdr_2010_en_complete_reprint.pdf

UNDP. (2015). *Human development report 2015: Work for human development.* New York, NY, USA: United Nations Development Programme. Retrieved from http://hdr.undp.org/sites/default/files/2015_human_development_report_0.pdf

UNDP. (2016). *Human development report 2016: human development for everyone.* New York, NY, USA: United Nations Development Programme. Retrieved from http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

UNECA. (2006). *Sustainable energy : A framework for new and renewable energy in Southern Africa*. Addis Ababa, Ethiopia: United Nations Economic Commission for Africa. Southern Africa Sub-Regional Development Centre (ECA/SA-SRDC). Retrieved from http://repository.uneca.org/handle/10855/5650

UNECA. (2010). *Popular participation & decentralization in Africa*. Addis Ababa, Ethiopia: United Nations Economic Commission for Africa. Retrieved from http://www.uneca.org/sites/default/files/PublicationFiles/popular-participation-decentralization-in-africa.pdf

UNECA. (2013). *Large-scale land based investments in Africa : Synthesis report*. Addis Ababa, Ethiopia: United Nations Economic Commission for Africa. Retrieved from http://repository.uneca.org/handle/10855/22923

UNEP. (1999). UNEP Annual Report 1998. Nairobi, Kenia: United Nations Environment Programme. Retrieved from http://old.unep-wcmc.org/medialibrary/2010/09/24/f07ef06e/Annual_Report_1998.pdf

UNEP. (2002). *Vital water graphics*: *An overview of the state of the world's fresh and marine waters.* Nairobi, Kenia: United Nations Environment Programme. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/20624/Vital_water_graphics.pdf

UNEP. (2010). *The role of ecosystems in developing a sustainable green economy.* United Nations Environment Programme. Retrieved from http://chimalaya.org/2010/12/17/the-role-of-ecosystems-in-developing-a-sustainable-green-economy/

UNEP. (2011). *Towards a green economy: Pathways to sustainable development and poverty eradication.* United Nations Environment Programme. Retrieved from http://www.unep.org/greeneconomy

UNEP. (2012a). *Green economy in a blue world: Synthesis report.* United Nations Environment Programme.

UNEP. (2012b). Measuring Progress: Environmental Goals & Gaps. Nairobi, Kenya: United Nations Environment Programme. Retrieved from http://staging.unep.org/geo/pdfs/geo5/Measuring_progress.pdf

UNEP. (2014). UNEP annual report 2014. Nairobi, Kenya: United Nations Environment Programme. Retrieved from https://www.uncclearn.org/sites/default/files/inventory/-unep_2014_annual_report-2015unep_annual_report_2014_production_lq.pdf.pdf

UNEP. (2015). UNEP Annual Report 2015. Nairobi, Kenya: United Nations Environment Programme. Retrieved from https://reliefweb.int/sites/reliefweb.int/files/resources/-UNEP_2015_Annual_Report-2016UNEP-AnnualReport-2015-EN.pdf.pdf

UNEP. (2016). GEO-6 Regional Assessment for Africa. Nairobi, Kenya: United Nations Environment Programme. Retrieved from http://wedocs.unep.org/bitstream/handle/20.500.11822/7595/GEO_Africa_201611.pdf

UNEP. (2017). The emissions gap report 2017. Nairobi, Kenya: United Nations Environment Programme. Retrieved from www.unenvironment.org/resources/emissions-gap-report

UNEP/ELD. (2015). The economics of land degradation in Africa: Benefits of action outweigh the costs. Retrieved from www.eld-initiative.org

UNEP-WCMC, & IUCN. (2017). *Protected Planet: The World Database on Protected Areas (WDPA)* [On-line], [Sept 2017]. Cambridge, UK: UNEP-WCMC and IUCN. Retrieved from https://www.protectedplanet.net

UNEP-WCMC. (2016). *The State of Biodiversity in Africa: A mid-term review of progress towards the Aichi Biodiversity Targets.* Cambridge, UK: UNEP-WCMC. Retrieved from https://wedocs.unep.org/rest/bitstreams/32269/retrieve

UNESCO. (2017). *Africa*. United Nations Educational, Scientific and Cultural Organization. Retrieved on 11 August 2017 from http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/africa/

Unruh, J. (2008). Land policy reform, customary rule of law and the peace process in Sierra Leone. *African Journal of Legal Studies, 2*(2), 94–117. https://doi.org/10.1163/221097312X13397499736507

UN-Water/Africa and AMCOW (African Ministers' Council on Water). (2004). *Outcomes and recommendations of the pan-African implementation and partnership conference on water* (PANAFCON). Presented in Addis Ababa, 8–13 December 2003.

van Wilgen, B. W., & Lange, W. J. D. (2011). The costs and benefits of biological control of invasive alien plants in South Africa. *African Entomology, 19*, 504–514. https://doi.org/10.4001/003.019.0228

van Wilgen, B. W., Davies, S. J., & Richardson, D. M. (2014). Invasion science for society: A decade of contributions from the Centre for Invasion Biology. *South African Journal of Science, 110*(7/8), 1–12. https://doi.org/10.1590/sajs.2014/a0074

van Wyk, E., & van Wilgen, B. W. (2002). The cost of water hyacinth control in South Africa: A case study of three options. *African Journal of Aquatic Science, 27*(2), 141–149. https://doi.org/10.2989/16085914.2002.9626585

Villamagna, A. M., & Murphy, B. R. (2010). Ecological and socio-economic impacts of invasive water hyacinth (*Eichhornia crassipes*): A review. *Freshwater Biology, 55*(2), 282–298. https://doi.org/10.1111/j.1365-2427.2009.02294.x

Vogt, J. V., Safriel, U., Von Maltitz, G., Sokona, Y., Zougmore, R., Bastin, G., & Hill, J. (2011). Monitoring and assessment of land degradation and desertification: Towards new conceptual and integrated approaches. *Land Degradation & Development, 22*(2), 150–165. https://doi.org/10.1002/ldr.1075

Vu, Q. M., Le, Q. B., & Vlek, P. L. G. (2014). Hotspots of human-induced biomass productivity decline and their social-ecological types toward supporting national policy and local studies on combating land degradation. *Global and Planetary Change, 121*, 64–77. https://doi.org/10.1016/j.gloplacha.2014.07.007

Ward, C. D., & Shackleton, C. M. (2016). Natural resource use, incomes, and poverty along the Rural–urban continuum of two medium-sized, South African towns. *World Development, 78*, 80–93. https://doi.org/10.1016/j.worlddev.2015.10.025

Watson, F. G. R., Becker, M. S., Milanzi, J., & Nyirenda, M. (2014). Human encroachment into protected area networks in Zambia: implications for large carnivore conservation. *Regional Environmental Change, 15*(2), 415–429. https://doi.org/10.1007/s10113-014-0629-5

WCPA. (2003). *Towards a strategy for high seas marine protected areas: Proceedings of the IUCN, WCPA and WWF Experts Workshop on High Seas Marine Protected Areas, Malaga, Spain.* K. M. Gjerde & C. Breide (Eds.). Gland, Switzerland: IUCN. Retrieved from https://www.iucn.org/sites/dev/files/import/downloads/proceedingsgjerde.pdf

WEC. (2005). *Regional energy integration in Africa.* World Energy Council. Retrieved from https://www.worldenergy.org/publications/2005/regional-energy-integration-in-africa/

Wezel, A., & Haigis, J. (2000). Farmers' perception of vegetation changes in semi-arid Niger. *Land Degradation & Development, 11*(6), 523–534. https://onlinelibrary.wiley.com/doi/abs/10.1002/1099-145X%28200011/12%2911%3A6%3C523%3A%3AAID-LDR411%3E3.0.CO%3B2-V

Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., de Souza Dias, B. F., Ezeh, A., Frumkin, H., Gong, P., Head, P., Horton, R., Mace G. M., Marten R., Myers, S. S., Nishtar S., Osofsky, S. A., Pattanayak, S. K., Pongsiri, M. J., Romanelli, C., Soucat, A., Vega, J., & Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet, 386*(10007), 1973–2028. https://doi.org/10.1016/S0140-6736(15)60901-1

WHO. (2007). *A safer future: global public health security in the 21st century*. Geneva, Switzerland: World Health Organization. Retrieved from http://www.who.int/whr/2007/en/

WHO. (2014). *Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s*. Geneva, Switzerland: World Health Organization. Retrieved from http://www.who.int/globalchange/publications/quantitative-risk-assessment/en/

WHO. (2016). *Global Health Observatory (GHO) data. Number of malaria cases*. Geneva, Switzerland: World Health Organization. Retrieved from http://www.who.int/gho/malaria/epidemic/cases/en/

WHO-UNEP. (2008). *Libreville declaration on health and environment in Africa.* Libreville, Gabon: World Health Organization (WHO) and the United Nations Environment Programme (UNEP). Retrieved from http://www.afro.who.int/sites/default/files/2017-06/decLibrevilleDeclaration.pdf

WHO-UNICEF. (2017). *Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines.* World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). Retrieved from https://washdata.org/sites/default/files/documents/reports/2018-01/JMP-2017-report-final.pdf

Wily, L. A. (1997).*Villagers as forest managers and governments: learning to let go-the case of Duru-Haitemba and Mgori Forests in Tanzania.* United Kingdom: Forestry and Land Use Programme, International Institute for Environment and Development (IIED). ISBN 9781843691136.

Wily, L. A. (2000). Forest law in eastern and southern Africa: moving towards a community-based forest future? *Unasylva, 51*(203), 19–26. Retrieved from http://www.fao.org/tempref/docrep/fao/x8080e/x8080e04.pdf

Wily, L. A. (2008). Custom and commonage in Africa rethinking the orthodoxies. *Land Use Policy, 25*(1), 43–52. https://doi.org/10.1016/j.landusepol.2007.02.002

Wily, L. A. (2009).Tackling land tenure in the emergency to development transition in post-conflict states: From restitution to reform. In S. Pantuliano (Ed.), *Uncharted territory: Land, conflict and humanitarian action* (pp. 27–50). Warwickshire, UK: Practical Action Publishing. Retrieved from https://doi.org/10.3362/9781780440408

Wise, R. M., van Wilgen, B. W., Hill, M. P., Schulthess, F., Tweddle, D., Chabi-Olay, A., & Zimmermann, H. G. (2007). *The economic impact and appropriate management of selected invasive alien species on the African continent* (Final Report).Global Invasive Species Programme. Retrieved from http://issg.org/pdf/publications/GISP/Resources/CSIRAISmanagement.pdf

WMO. (2006). *WMO statement on the status of the global climate in 2005.* World Meteorological Organization. ISBN 9789263109989.

World Bank. (1998). *Indigenous knowledge for development : A framework for action*. Washington, DC, USA: World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/388381468741607213/Indigenous-knowledge-for-development-a-framework-for-action

World Bank. (2012a). *Turn down the heat: Why a 4°C warmer world must be avoided*. Washington, DC, USA: World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/865571468149107611/pdf/NonAsciiFileName0.pdf

World Bank. (2012b). *World development indicators 2012.* Washington, DC, USA: World Bank Group. Retrieved from http://hdl.handle.net/10986/6014

World Bank. (2015a). *World development indicators 2015*. Washington, DC, USA: World Bank Group. Retrieved from http://hdl.handle.net/10986/21634

World Bank. (2015b). *Africa/AFRICA-P132123-AFCC2/RI-South West Indian Ocean fisheries governance and shared growth project 1 – Procurement Plan*. Washington, DC, USA: World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/645751526965934674/pdf/Plan-Archive-9.pdf

World Bank. (2016). *World development indicators 2016*. Washington, DC, USA: World Bank Group. Retrieved from http://dx.doi.org/10.1596/978-1-4648-0683-4

World Economic Forum. (2015). *Africa competitiveness report 2015*. Geneva, Switzerland: World Economic Forum. Retrieved from http://www3.weforum.org/docs/WEF_ACR_2015/Africa_Competitiveness_Report_2015.pdf

WorldFish Center. (2010). *Vulnerability in inland fishing communities in Africa: Lessons learned.* Penang, Malaysia: WorldFish Center. Retrieved from http://www.worldfishcenter.org/resource_centre/WF_2592.pdf

WWAP (United Nations World Water Assessment Programme). (2016). *The United Nations World water development report 2016: Water and jobs*. Paris, France: UNESCO. Retrieved from http://unesdoc.unesco.org/images/0024/002439/243938e.pdf

Youm, O., Vayssières, J. F., Togola, A., Robertson, S. P., & Nwilene, F. E. (2011). International trade and exotic pests: the risks for biodiversity and African economies. *Outlook on Agriculture, 40*(1), 59–70. https://doi.org/10.5367/oa.2011.0031