As at 15 September 2011

Global Drylands: A UN system-wide response

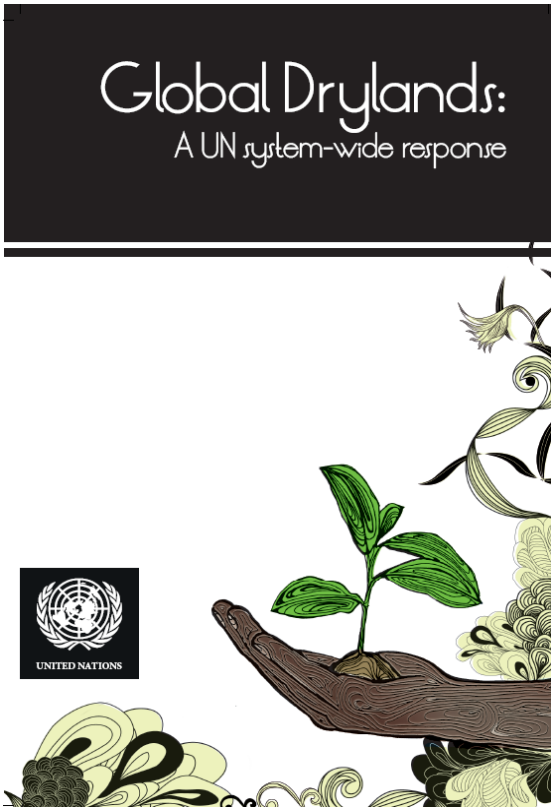

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Table of contents

Foreword by the United Nations Secretary-General

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Preface by the Chair of the Environment Management Group

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Preface by the Executive Secretary of the United Nations Convention to Combat Desertification

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Statement by the Members of the Environment Management Group

We the Executive Heads of members of the Environment Management Group are:

Conscious of the fact that drylands cover approximately 40% of the world's land area, and support around two billion people, 90%of whom live in developing countries.

Mindful of the fact that unsustainable land and water use and the impacts of climate change are driving the degradation of drylands to such an extent that approximately 6 million km^2 (about 10%) is now degraded.

Deeply concerned that human well-being—in relation to health, material needs, social relations and security—is at risk from dryland degradation which costs developing countries an estimated 4–8% of their gross domestic product each year.

Convinced that the sustainable protection and enhancement of human well-being is a common denominator for the entire UN system, and that efforts to protect drylands significantly contribute to the safeguarding of human well-being by offering opportunities for local populations and providing regional and global benefits.

Aware that the potential local, regional and global benefits that drylands may offer have not been fully utilised because of myths, market failures, a lack of public goods, weak incentives, high investment costs and gender inequalities.

Recognising that many drylands in developing countries have become investment deserts, but that sustaining higher levels of investment can enhance productivity and increase incomes.

Further recognising that the 10-year strategic plan of the United Nations Convention to Combat Desertification—which aims to forge a global partnership to reverse and prevent desertification and degradation in order to reduce poverty and support environmental sustainability—presents a major opportunity to address the underlying causes of land degradation.

Acknowledging that investments in drylands pay off if configured to the short- and long-term variability of these human-ecological systems, and that opportunities for investment in drylands exist for the public sector, the private large-scale commercial sector, the community sector, and the household or small-scale private sector.

Recalling the cooperative efforts of the international community to address the drylands agenda.

We hereby *commit* to contribute individually and collectively to the international drylands agenda by:

1. Enhancing the economic and social well-being of dryland communities in a sustainable manner.
2. Enabling dryland communities to sustain their ecosystem services and make a contribution to global public goods.
3. Strengthening the adaptive capacity of global drylands to manage environmental change, including climate change.

In particular, we *commit* to identifying opportunities to cooperate on mainstreaming the drylands agenda into our sectors within the respective mandates of our organizations. We intend to:

a. Take a functional approach to cooperation by focusing on: strengthening the science-policy interface; advancing interlinkages and synergies in the implementation of the drylands agenda; identifying opportunities for integrating the drylands targets into national development cooperation; and reviewing the effectiveness of achieving such targets.

b. Support governments to improve the enabling environment for sustainable drylands development, including improving governance, infrastructure and education; harmonising natural resource policies; and supporting appropriate investment policies.

c. Promote the concept of value chains, working with the private sector to promote toolswhich encourage sustainable production and consumption, such as eco-labelling.

d. Promote the diversification of income and livelihoods in drylands while respecting tradional knowledge, innovations and practices to remove pressure from the resource base.

e. Encourage intensification of water-efficient agriculture through approaches such as Sustainable Land Management (SLM).

f. Work towards reducing the transaction costs (including risk management) for investments into drylands, in particular, through climate-aware technologies.

g. Support public and private investment in drylands by, for example, preparing a typology of drylands investments in order to promote those which are more sustainable (in particular, focusing on carbon markets and energy).

h. Support social protection, for example, through the use of scenario modelling as a tool for considering the winners and losers, or virtuous and vicious outcomes, of various investment proposals, including gender and age considerations.

We make this commitment with the view to continuing our cooperation under the auspices of the Environment Management Group and demonstrating what a multi-sectoral approach can bring to the development and implementation of the international drylands agenda.

Executive Summary

Drylands cover approximately 40% of the world's land area, and support two billion people, 90% of whom live in developing countries. Found on all continents, but being most prevalent in Africa and Asia, drylands are the foundation for both rural and urban communities, including some of the world's biggest cities such as Cairo, Mexico City and New Delhi. Around one billion people rely directly on dryland ecosystem services for their daily survival, whether through rain-fed or irrigated farming, or through widespread pastoralism.

Human well-being is at risk from dryland degradation.

Unsustainable land and water use and the impacts of climate change are driving the degradation of drylands. Approximately 6 million km^2 of drylands (about 10%) bear a legacy of land degradation. Such degradation—sometimes also referred to as 'desertification'—can take the form of soil erosion, nutrient depletion, water scarcity, altered salinity or the disruption of biological cycles. Degradation reduces biological productivity and can impact the ability of ecosystems to absorb and use rainwater. Combined with poor crop and soil management, and the use of poorly adapted varieties of crop, this can lead to 'agricultural droughts'.

Climate change is already causing significant decreases in crop yields in some rain-fed African agricultural systems. This is likely to worsen by 2020. It is likely that climate change will cause grassland productivity to decline by between 49-90% in semi-arid and arid regions; it is also forecast that high levels of desertification and soil salinisation, and increasing water stress, will occur in parts of Asia, sub-Saharan Africa and Latin America. Climatic fluctuations may be most pronounced in the poorest regions with high levels of chronic undernourishment and a great degree of instability. Food price fluctuations already represent a risk to vulnerable populations that is expected to increase with climate change.

Dryland degradation costs developing countries an estimated 4–8% of their national gross domestic product (GDP) each year. It has been estimated that about 1–6% of dryland human populations live in desertified areas, while a much larger number is under threat from further desertification. Land degradation and poverty are mutually reinforcing, but the former has low political visibility. It is hard to deal with the problem due to cyclical swings in rainfall, land tenure which is not well adjusted to environmental conditions, and regional and global forces driving local management. Inaction would mean a cumulative addition to a long, historical legacy of degradation, from which recovery has already previously proven difficult.

Drylands offer opportunities for local populations and provide regional and global benefits.

The biodiversity of drylands provides ecosystem services which benefit local communities. Dryland forests and woodlands provide shade and moisture, are home to pollinators, protect nutrients, are fire resistant, and reduce water runoff, erosion and flooding. Life in drylands has evolved with the variable and extreme climatic conditions that present here, and includes a relatively high number of endemic species. These species represent genetic resources of importance, in particular, for adaptation to future climate change. Unique ecosystems, such as deserts (e.g. Sinai, Namib and Chihuahua deserts), steppes (e.g. Mongolia), savannas (e.g. East Africa) and drylands wetlands (e.g. Nile Delta and Okavango Delta), represent opportunities for ecotourism.

With specialised adaptations to unstable, but resilient, ecological conditions, the increasing and urbanising human populations of drylands can help to generate significant regional benefits. Drylands communities interact with adjacent communities through trade and seasonal migration. Trade in products and services related to drylands-based agriculture (rain-fed and irrigated farming, and pastoralism), ecotourism and renewable energy (solar and wind) can help to stimulate regional green economic development. The size and scale of drylands means that these areas have the potential of contributing more significantly to food and energy security. Fair trade and organic certification initiatives can increase producers' gains on internationally traded products, and can be used to target value chains as an entry point for development. Sustainable management of dryland forests and woodlands can help to stabilise regional climate patterns and can be sustained through payments for ecosystem services.

Drylands can have major global climate benefits: dryland carbon storage (mainly in the form of soil carbon) accounts for more than one third of the global stock. Drylands also have the potential to sequester more carbon than they currently store as they are far from saturated. Yet despite these potential benefits, current projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol are limited to methane capture, waste management and renewable energy. Dryland forests in México store carbon at roughly the same rate as evergreen forests. Thus, the establishment of dryland forests, coupled with dune stabilisation, savannization and rain-fed dryland agroforestry, can increase carbon storage. However, the capacity to store carbon depends on many factors including climate, history, past land use, and opportunity for management change.

The potential local, regional and global benefits of drylands have not been fully utilised because of myths, market failures, a lack of public goods, weak incentives, high investment costs and gender inequalities. Dryland ecosystems and populations face a number of risks and costs including tenure insecurity, conflict, variable weather, scarcity of human capital and high transaction costs. In many areas, it is often the women who manage the natural resources and hold knowledge of indigenous production methods, plant species and their various uses (including medicinal uses). However, women rarely own the land that they manage and, without assets, cannot access agricultural credit or extension services. On the other hand, the participation of women in often profitable trade counters this situation to some extent.

Investments in drylands pay off if configured to the short- and long-term variability of these human-ecological systems.

Many drylands in developing countries have become investment deserts, yet sustained higher levels of investment can support enhanced productivity and better incomes. The world cannot achieve the Millennium Development Goals (MDGs) without addressing the needs of people living in the drylands. Ongoing economic development provides the surest foundation for managing the risk of environmental variability, taking advantage of new or emerging opportunities, and adapting to possible negative climate change. However, such development must be done sustainably and equitably. Economic rates of return (from 12% to over 40%) have been found for a number of projects including soil and water conservation (Niger), farmer-managed irrigation (Mali), forest management (Tanzania), farmer-to-farmer extension (Ethiopia), and small-scale, valley bottom irrigation (northern Nigeria and Niger). Moreover, it is of paramount importance that traditional dryland livelihoods are supported as they play a vital role to national and local economies. For example, traditional pastoral livelihoods contribute about 10% of the Mali's Gross Domestic Product (GDP), 20% in Kyrgyzstan, 30% in Mongolia and 8.5% in Uganda (WISP 2008).

Opportunities for increased investments in drylands are coupled with global and regional trends; they include:

- Fulfilling food security commitments (at least US$20 billion[1]), in part, through the rehabilitation of the drylands resource base.
- Targeting private investment—which is often transnational—in food security, natural products, key infrastructure and services towards dryland resources.
- Targeting renewable energy opportunities within drylands, such as the European-Mediterranean thermal solar collectors plan. Utilising funds for conflict prevention and post-conflict rehabilitation to restore dryland resources.
- Supporting access for women to productive assets.
- Using climate change instruments designed for mitigation (soil carbon, bioenergy) and adaptation (small business development and home gardens and sheep) in vulnerable dryland areas.
- Encouraging research into adaptation.
- Conserving high value dryland biodiversity, such as drought resistant or heat tolerant crop and livestock varieties.
- Targeting cultural and eco-tourism opportunities within drylands as well as mining and the whole potential for 'secondary' (e.g. transformation and conservation industries) and tertiary (e.g. micro-credit and banking, telecommunication, market, etc.) sectors.

Opportunities for investment in drylands exist for the public sector, the private large-scale commercial sector, the community sector, and the household or small-scale private sector. As regards to the degradation of drylands, the result of failure to prevent dryland degradation is often the need for relief and aid; this is costly in economic terms, but even more so in terms of human suffering. This cost can be reduced by engaging dryland communities in the development process. Investments

[1] E.g. US$2 billion from the World Bank's Global Food Crisis Response Program (GFRP), US$3.5 billion within the United States' Feed the Future (FTF) pledge for agricultural development and food security over three years, US$18.5 billion estimated from other OECD countries.

can be directed towards areas such as communications; renewable energy; education; health; water; farmland, rangeland and livestock; woodland and trees; land use; conservation and tourism; urban development; markets; innovation; and risk management. For many investment areas, there are multiple opportunities for different actors and collaborations between actors.

The UN system is uniquely positioned to promote increased investments in drylands.

With its global reach and large range of activities and expertise, a coherent and holistic UN-wide response can help catalyse a transition towards increased investments in drylands. The UN system should focus its attention on the following three objectives for cooperation on drylands, which are in support of the Strategic Objectives of UNCCD's 10-year strategic plan:

1. Enhancing the economic and social well-being of dryland communities in a sustainable manner.
2. Enabling dryland communities to sustain their ecosystem services and make a contribution to global public goods.
3. Strengthening the adaptive capacity of global drylands to manage environmental change, including climate change.

The objectives will be advanced through a functional approach to cooperation, focusing on:

1) Strengthening theinterface between science and policy.
2) Advancing the interlinkages and synergies in the implementation of the drylands agenda.
3) Identifying opportunities for integrating the drylands targets into national development cooperation.
4) Reviewing the effectiveness of the achievement of targets.

A central element in the response by the UN is the address of the underlying causes of land degradation and the creation of enabling conditions for sustainable land management and the sustainable development of drylands. Different UN entities can play complementary roles in:

1) Supporting governments to improve the **enabling environment** for drylands development, including improving governance, infrastructure and education; harmonising natural resource policies; and supporting appropriate investment policies.
2) Promoting the concept of **value chains**, working with the private sector to promote tools which encourage sustainable production and consumption, such as eco-labelling.
3) Promoting the **diversification** of income and livelihoods in drylands to remove pressure from the resource base.
4) Encouraging the **intensification** of water-efficient agriculture through approaches such as SLM.
5) Working towards **reducing the transaction costs** (including risk management) for investments into drylands, including through climate-aware technologies.
6) Supporting **public and private investment in drylands** by, for example, preparing a typology of drylands investments in order to promote those which are more sustainable (in particular, focusing on carbon markets and energy).

7) Supporting **social protection,** for example, through the use of scenario modelling as a tool for considering the winners and losers, or virtuous and vicious outcomes, of various investment proposals, including gender and age considerations.

Supporting the drylands agenda by 'delivering as one'.

The UN system has come together to highlight the importance of drylands to key emerging issues on the global agenda, including climate change, food security and human settlements.
The UN views the challenge through the lens of a positive, proactive drylands development approach. The current report by the Environment Management Group (EMG) is not the end of the process. Rather, it signifies a milestone in a unique effort by the UN system to join hands in supporting the implementation of UNCCD's 10-year strategic plan by 'delivering as one'— in the areas of environment, development and humanitarian assistance by effectively bringing together the UN's normative and analytic expertise, its operational and coordination capabilities, and its advocacy role at the country level, at the regional level and at the global level.

Introduction

This report, *Global Drylands: A UN system-wide response*, focuses on the importance of the drylands issue on the global agenda and its relation to other issues, including climate change, food security and human settlements. The UN system has long been involved in drylands via the United Nations Convention to Combat Desertification (UNCCD), the United National Development Drylands Development Centre (UNDP DDC), and numerous programmes for priorities like food security, refugees and arid and sub-humid drylands biodiversity.

This report is the first time the UN has put forth a coherent strategy to address the special needs of drylands from the perspective of the environment and human settlements. The UN Environment Management Group (EMG)[2] members responded to calls by governments for a coherent UN system-wide response to land challenges by establishing the Issue Management Group (IMG) on land for a period of two years, starting in September 2009. The IMG will propose options for a coherent UN-wide contribution to land challenges, including the implementation of the 10-year strategic plan (10YSP) of the UNCCD. The current report on drylands scopes the key issues and proposes a way forward. This report shows that environmental sustainability and poverty reduction are intricately linked and must be approached holistically.

The premise of this report is that, in modern times, drylands (mainly in developing countries) have tended to be de facto 'investment deserts': that is, their environmental and human settlements challenges had their socio-economic counterparts in chronic under-investment. Where this constraint has not applied, sustained higher levels of investment have supported enhanced productivity and better incomes. Ongoing economic development provides the surest foundation for managing risk (the economic consequence of environmental variability), taking advantage of new or emerging opportunities, and adapting to possible negative climate change. However, such development must be done sustainably and equitably. The technologies for such a transition are available, and so, the question arises of identifying and overcoming the constraints or barriers to the 're-capitalisation' of drylands in poor countries.

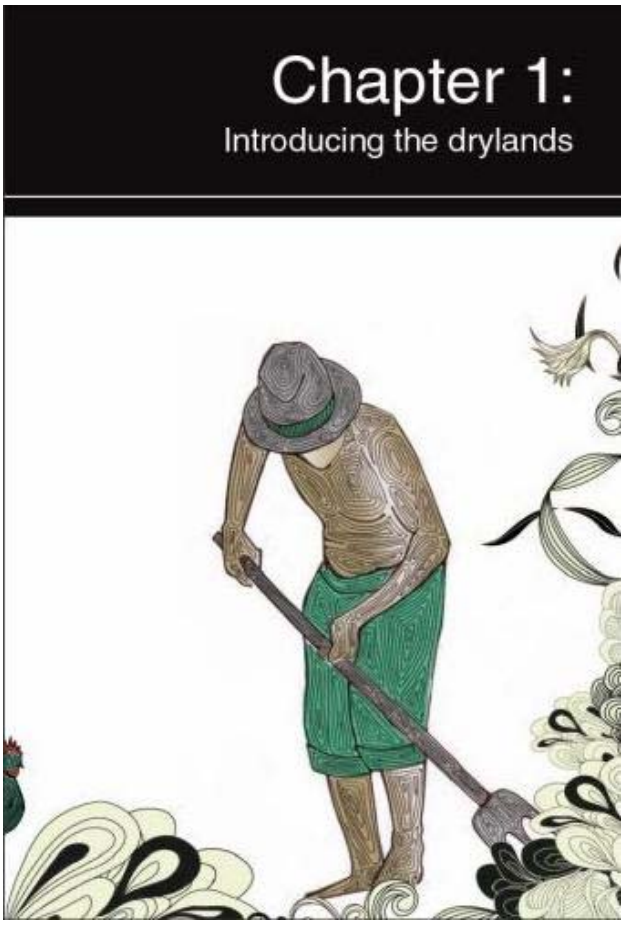
With its global reach and huge range of activities and expertise, ***the UN system is uniquely positioned to catalyse this transition.*** This report sets out a common vision and agenda for UN-wide action on dryland management, and its role in addressing climate change and food security, through a positive development and investment approach. This year will allow for further refinement of the options for the UN's drylands initiatives, resulting in an action plan by the end of 2011.

This report is aimed at a number of audiences, with certain objectives:

- UN agencies themselves, to clarify the commitment made to drylands and act as a reference guide;
- governments of developed and developing countries, as a normative guide on the UN's position on, and commitment to, the development of drylands;
- the private sector and donors, to encourage and inspire them to think about the viability and unique opportunities presented by drylands; and
- civil society, to encourage advocacy on the development of drylands, and empowerment of their populations.

[2] Its membership consists of the specialised agencies, programmes and organs of the UN including the secretariats of the Multilateral Environmental Agreements.

Chapter 1: Introducing the drylands



What and where are the drylands? This Introduction defines and maps the drylands, showing linkages to poverty and MDG achievement. It explains and characterises their unique ecosystem services and introduces the functions of dryland systems. But drylands peoples are not victim to their environment – they demonstrate extremely high levels of adaptation in their livelihoods, area highly linked to markets and trade dynamics. The drylands are already providing many important ecosystem services to the world which are currently under-valued.

Drylands are land areas with one overriding characteristic: they receive relatively low overall amounts of precipitation in the form of rainfall or snow. Although conceptually easy to grasp, it is quite hard to define them precisely. This report uses a broad definition in which drylands are land areas with an aridity index of less than 0.65. The aridity index is a measure of the ratio between average annual precipitation and total annual potential evapotranspiration. Drylands can be further subdivided (see Table 1) into: hyper-arid deserts (<0.5 index of aridity), arid (0.05–0.20 index of aridity), semi-arid (0.20–0.50 index of aridity), and dry sub-humid (0.50–0.65 index of aridity).

Arid ecosystems are annual grasslands suitable mainly for grazing animals, except where interrupted by rivers or lakes; semi-arid ecosystems are thorny savannahs with annual and perennial grass species, which may be cleared for farming and livestock and carry the highest population densities of the drylands; and sub-humid ecosystems are broad-leaved savannah woodlands with higher, denser tree canopies and perennial grasses. The drylands also contain some large, irrigated areas along perennial rivers, which are farmed intensively. Almost all drylands experience high rainfall variability within seasons (it is often concentrated in short, rainy seasons), between years and in longer-term cycles. Combined with low average rainfall, this variability is a high risk to non-irrigated agricultural enterprises.

Drylands cover about 40% of the world's land area (MA 2005). They occur on every continent, and span a diversity of cultures and landscapes. This report focuses on the drylands of developing countries as they are most strongly associated with the objectives of UN dryland intervention.

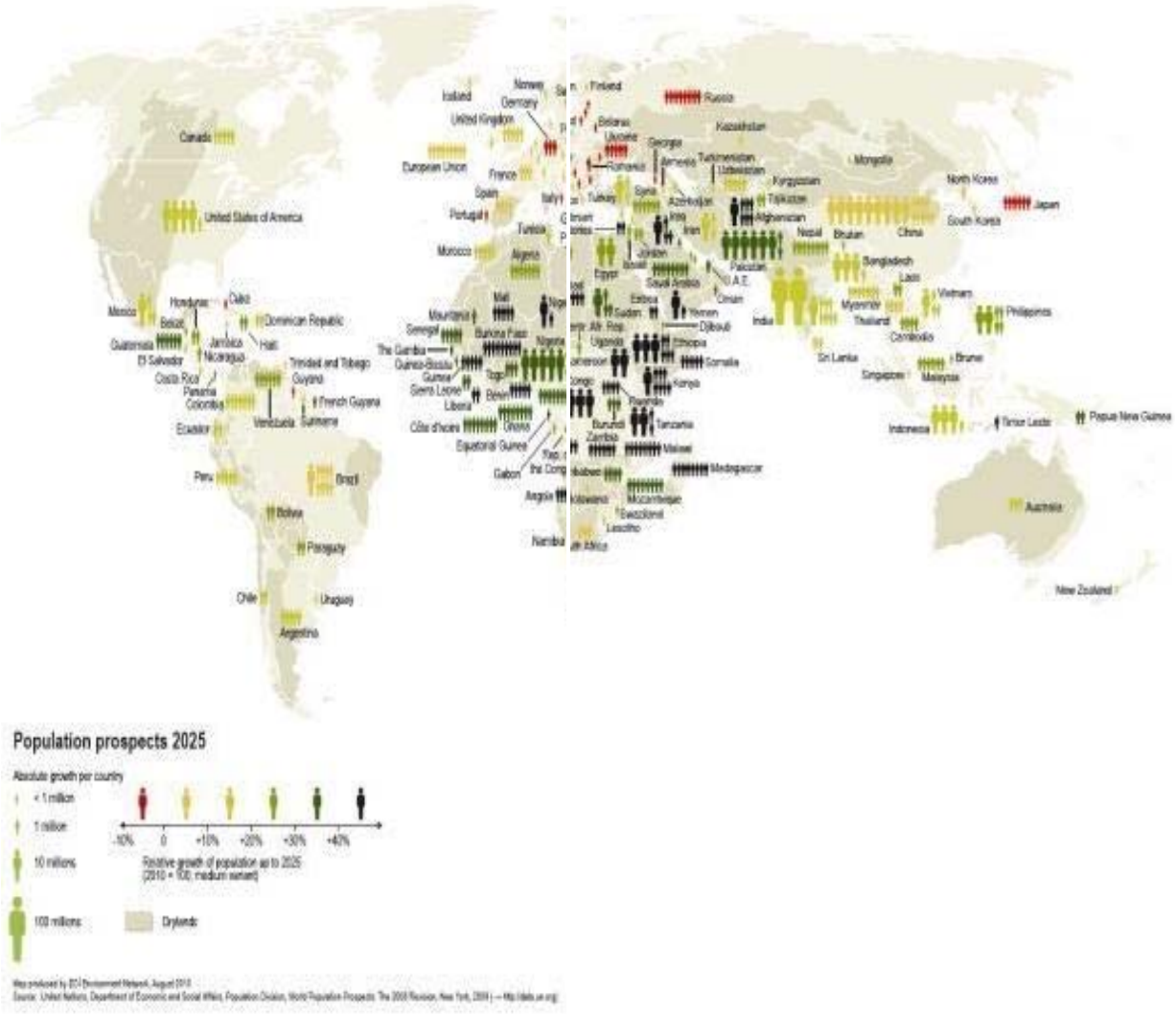
1.1 People, land and water

Drylands are home to just over 40% of the human population of both Africa and Asia, and between 25–30% of the rest of the world's population (Reynolds *et al.* 2007a) (about 2 billion people), –90% of whom live in developing countries (UNEP 2007; see Figures 1 and 2). All four of the so-called 'BRIC'[3] countries (Brazil, Russia, India and China) contain some drylands, as do other large, rapidly developing countries such as Mexico and South Africa. There are numerous dryland areas in Europe, particularly around the Mediterranean and Central Asia. But a major focus of international concern is dryland populations in poor countries, notably in Africa. Drylands are rural and urban: they are home to around one billion people who rely directly on dryland ecosystem services for their livelihoods, but they also support some of the world's biggest cities including those located in drylands such as Cairo, Mexico City and New Delhi.

[Figure on population and joining text on population prospects in the drylands]

Figure 1. Population prospects in drylands for 2025

[3] Shorthand term for Brazil, Russia, India and China—all large, rapidly developing economies.



.*Source: name year*

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[images of livelihoods in Chinese drylands]

Box 1. China—dramatic poverty reduction in the drylands

Of the four emerging global powers referred to as the 'BRIC' countries, the most dramatic reduction of poverty rates in recent decades has been in China, which is around 43% shrublands, savannah and grasslands.A policy focus on agriculture was undoubtedly a major driving force behind the decline in the proportion of the population living

in poverty: between 1981 and 2001, poverty dropped from 53% to just 8% (Ravallion and Chen 2007). Most of this reduction is attributable to targeted interventions in rural areas, where the reformation of land use rights was the key driver, supplemented by a rise in government procurement prices and subsidies on agricultural inputs including fertilisers and seeds (Montalvoa and Ravallion 2010).

An allied effect of the agricultural reforms in China has been to create the rural non-farm sector, providing employment and income to millions of people whose labour is no longer needed in farming. The growth of this sector has also benefited from infrastructure development. For the predominantly dryland western parts of China, the most effective incremental expenditures were on agricultural research and development, education, roads and electricity (Fan *et al.* 2002). Likewise, in India, the growth of rural non-farm employment, with its significant dependence on infrastructure services, has also been an important source of household poverty reduction, and areas with relatively high literacy rates have enjoyed significantly improved prospects for pro-poor growth (Ravallion and Datt 1999).

Source: UNDP and UNCCD 2010

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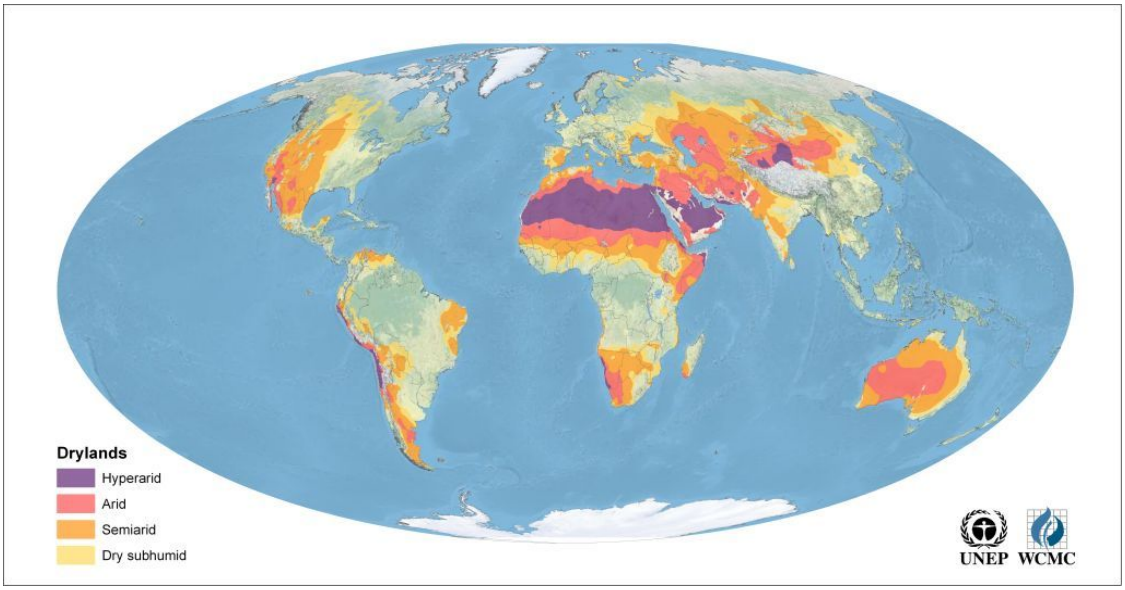
Drylands have three primary economic functions: as rangelands (65% of the global drylands including desrts); asrain-fed farmland and irrigated farmland (25%); and as forest or sites for towns and cities (10%), which are growing rapidly. They include the world's driest places (hyper-arid deserts such as the Atacama in Chile and Namib in southwest Africa) as well as the Polar Regions.

Figure 2. Distribution of global drylands



Source: UNEP-WCMC 2010

Table 1 summarises the global statistics for the four types of dryland, and the map on pages XX-XX shows their distribution. The map on pages XX-XX shows a high coincidence of water stress with drylands. This report is concerned only with drylands where there are high levels of associated poverty.

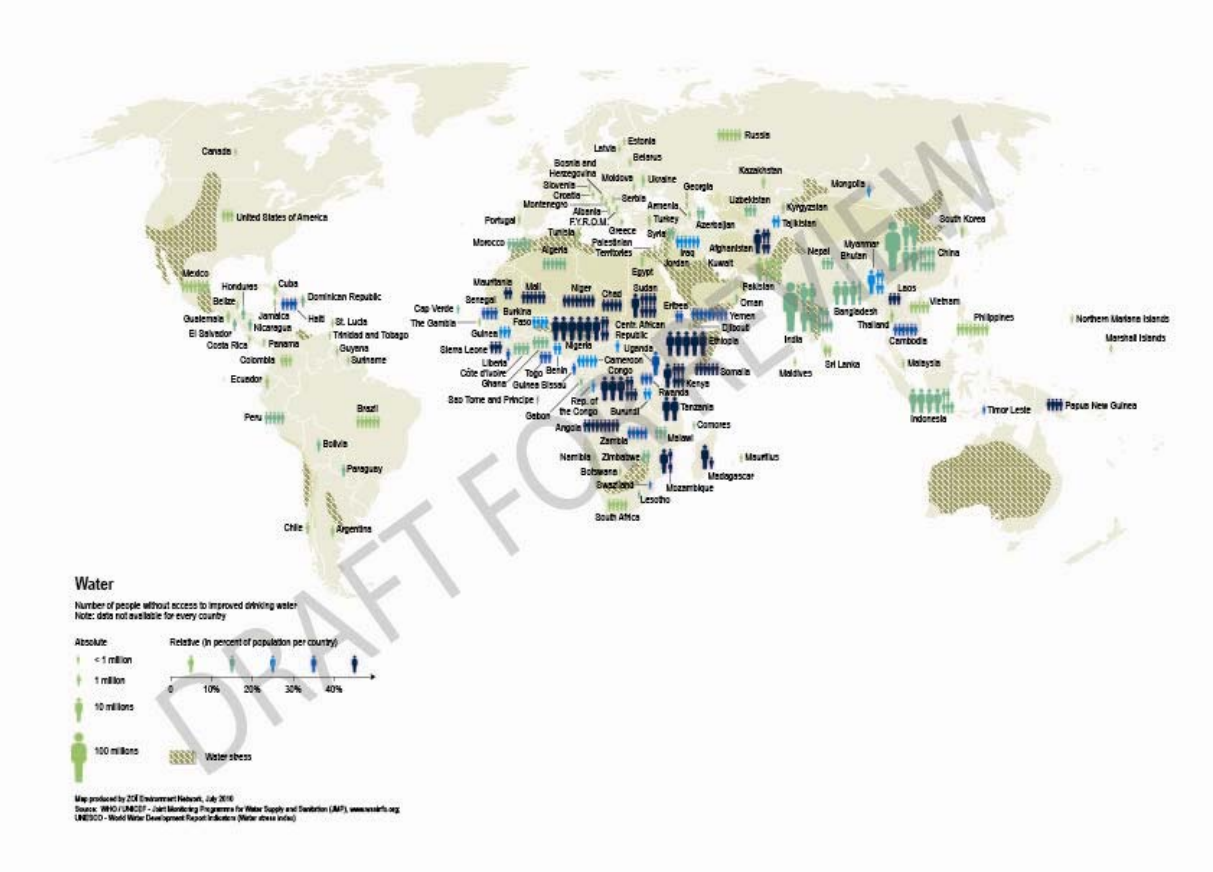
Table 1. Global figures for the four types of drylands

Dryland sub-habitat	Aridity index*	Share of global area (%)	Share of global population (%)	% rangeland	% cultivated	% other (including urban)
Hyper-arid	<0.05	6.6	1.7	97	.6	3
Arid	0.05–0.20	10.6	4.1	87	7	6
Semi-arid	0.20–0.50	15.2	14.4	54	35	10
Sub-humid	0.50–0.65	8.7	15.3	34	47	20
Total		41.3	35.5	65	25	10

* The ratio of precipitation to potential evapotranspiration.
Source: Safriel *et al*. (2005).

Water scarcity is the predominant feature of drylands. While heavy rains may occur, rainfall typically varies, sometimes dramatically, from season to season and from year to year. In hyper-arid, arid and semi-arid regions, water is scarce most of the time and human settlements may cluster around rare sources of water such as rivers, springs, wells and oases. In such areas, traditional cultures have developed ways of finding, conserving and transporting water, including specialised land management techniques and structures to capture and retain precipitation, or to encourage groundwater recharge.

Figure 3. Figure label (TBC from Zoinet)



Source: name year

Unsustainable land and water use and the impacts of climate change are driving the degradation of drylands. Approximately 6 million km^2 (about 10%) of drylands bear a legacy of land degradation. Such degradation—sometimes also referred to as 'desertification'—can take the form of soil erosion, nutrient depletion, water scarcity, altered salinity or the disruption of biological cycles (UNEP 2007). It has been estimated that about 1–6% of dryland human populations live in desertified areas, but a much larger percentage is under threat from further desertification (MA 2005). System productivity is greatly limited by inherently poor soil and/or human-induced soil degradation. On poorly managed land, the share of water that is available to plants can be as low as 40–50% of rainfall. On severely degraded land, as little as 5% of total rainfall may be used productively. 'Agricultural droughts' can emerge even when water itself is not scarce within the landscape: when low soil fertility, poor crop and soil management, and the use of poorly adapted varieties combine, the result is rainfall that is not being fully utilised for plant growth and grain filling (Humphreys *et al*. 2008).

In the wetter semi-arid and sub-humid regions, total seasonal rainfall often exceeds crop water needs. In fact, as long as appropriate levels of inputs are used, there is typically enough rainfall to double, and sometimes even quadruple, yields. In these areas, low soil fertility and a lack of inputs (particularly nitrogen) are major constraints to increasing yield and rainwater productivity—most poor, smallholder farmers in sub-Saharan Africa do not apply fertiliser, for example (Hilhorst and Muchena 2000; Morris *et al.* 2007; Twomlow *et al.* 2008). Nevertheless, there

is evidence of some positive trends in productivity in long-term data for certain African dryland countries (Box X, page XX; Map Y, page x).

Even in dry, semi-arid temperate areas, such as Central West Asia and North Africa, seasonal rainfall of only 300–400 mm is enough to produce as much as 4 tonnes per hectare (t/ha) of wheat grain because precipitation falls during the cool winter growing season and because the growing season is longer; however, yields are typically less than half of this.

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Box 2. Food production trends in Sahelian countries

In six West African countries with large dryland regions (Senegal, Mali, Ghana, Côte d'Ivoire, Niger and Nigeria), food production per capita showed positive trends from 1977 to 1999, although there was much interannual variability (FAOSTAT). The cereal crops millet and sorghum dominate food production in these drylands, while rice dominates in irrigated areas. Some of this additional output was achieved through extending the cultivated area, but it is significant that maize and millet yields per hectare remained stable (although still low by world standards) or slowly improved.

In Burkina Fasoyields of all four crops (millet, sorghum, rice and maize) more than doubled over the period 1960 to 1999 (Mazzucato and Niemeijer 2000). Rainfall was the primary determinant of yields from year to year, but the long-term trend was driven by growing demand as the population doubled between 1960 and 2000, and rapid urbanisation occurred. Structural adjustment policies – policies implemented by the International Monetary Fund (IMF) and the World Bank (the Bretton Woods Institutions) in developing countries which seeks to enhance the role of markets so as to promote development. - introduced during the 1980s reversed the previously declining trend.

In eight countries, including six East African countries, food production increased throughout the period 1961 to 2002, albeit at a slow pace (Holmén 2005).

Source: Mortimore 2003

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1.2 Dryland ecosystems—unstable, but resilient

The major characteristic of most dryland ecosystems is instability, yet they are incredibly resilient. Plant biomass in rangelands is driven by annual rainfall rather than by stocking pressure: when pasture fails, the animals die or migrate. However, seed banks in the soil ensure that vegetation recovers, although not necessarily with the same species composition. For example, on some Sahelian rangelandsthe dominant perennial grasses were replaced by annuals following the Sahel Drought of 1969 to 1974 (Mortimore 1989). This capacity of the ecosystem to maintain its functional integrity while adjusting to variable drivers justifies describing it in ecological terms as '*unstable* but *resilient'* (Holling 2001).

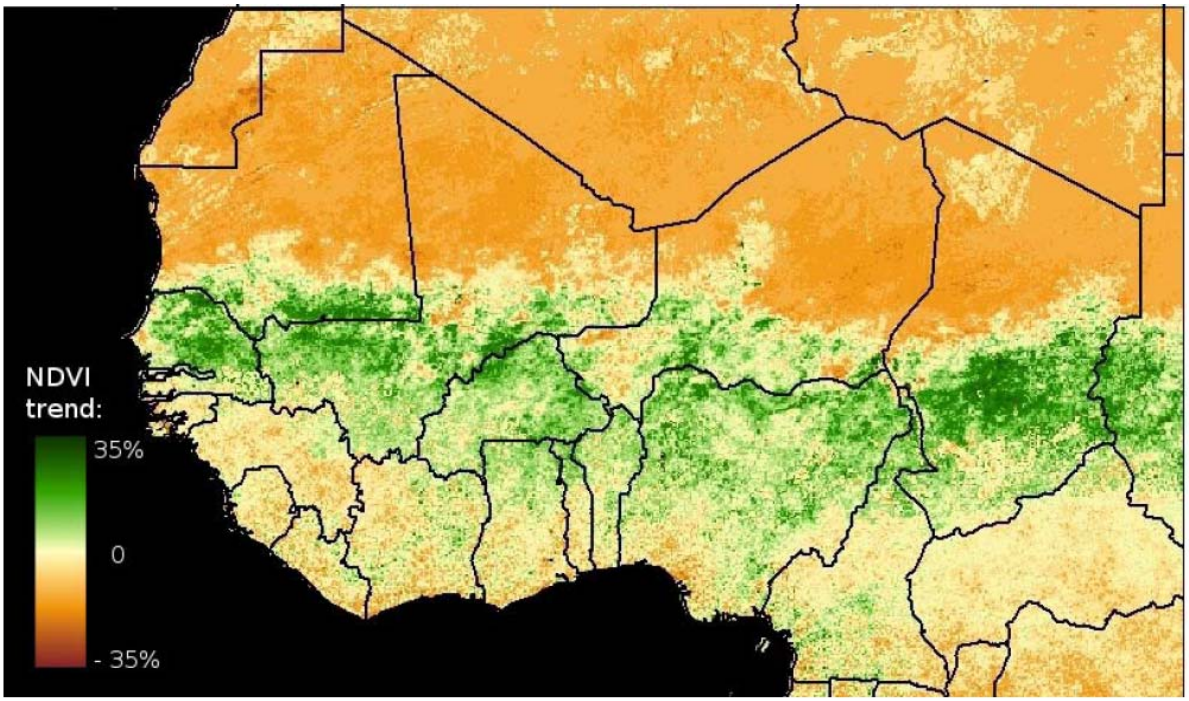
Animals have also developed unique adaptations to dryland conditions – desert toads burrow into the sand and lie dormant for months until the return of the rains.The sociable weaver of southern Africa builds communal nests

which can weigh up to 1,000 kg in order to maximize insulation from extreme temperatures Such adaptations are particularly important in domesticated dryland species which have higher drought and disease tolerance than imported livestock.

However, one out of three of every dryland species that has been assessed is classified as threatened, and one of six is classified as endangered or critically endangered. Furthermore, the Millennium Ecosystem Assessment revealed that 15 of the 24 ecosystem services studied in drylands are in decline.

This resilience can be seen, for example, in the recent 're-greening' that has occurred throughout Africa. Data obtained from earth satellites show changes of unexpected direction and magnitude of re-greening throughout Africa after 1980 (when the data series began) (Ecklundh and Olsson 2003; *Herrmann et al.* 2005; Olsson *et al.* 2005; Vlek *et al.* 2008). The reflectance values in key parts of the spectrum can be used as proxy indicators of biological productivity. Applying this principle to the African Sahel by using the Normalised Difference Vegetation Index (NDVI), or 'greenness' index, produced a strongly significant increase throughout this agro-ecological zone between 1980 and 2003.

Figure 4. The 'greening' of the Sahel, 1982 to 2006



Source: IUCN 2009 (extended from work previously reported in Herrmann et al. 2005)

Technical note: Linear trends in the NDVI are shown in percentages. Trends were computed from monthly 8 km resolution Advanced Very High Resolution Radiometer NDVI time series produced by the Global Inventory Modeling and Mapping Studies group, NASA Goddard Space Flight Center, USA.

This trend was found to have a positive relationship with rainfall, which was increasing after the drought cycle of the 1980s. However, there were some localised exceptions to the general trend, and the strength of the association with rainfall was variable. This suggests a role for another driver—perhaps management—producing either a positive or negative trend. In order to determine what other drivers might be affecting the general trend, studies are needed of land use change, in context, on the ground. Nevertheless, studies and data for other regions tend to strengthen the evidence of a relationship between vegetation 'greenness' and rainfall, leaving less space for the management drivers so often blamed for dryland degradation. A global synthesis of data on rapid land use change failed to confirm that the African Sahel was a 'hotspot' of desertification, and concluded that Asia has the greatest concentration of dryland degradation (Lepers *et al.* 2005). A study covering China-Mongolia, the Mediterranean, the Sahel, Southern Africa and South America found that "a strong general relationship between NDVI and rainfall over time is demonstrated for considerable parts of the drylands….a 'greening up' seems to be evident over large regions"(Helldén and Tottrup 2009).

Using NDVI data to estimate net primary productivity (NPP), the approach has been applied at a global scale (Bai *et al.* 2008). This study found that during the period 1981 to 2003, global drylands contributed only 22% of the world's degrading areas. Drylands do not figure strongly in ongoing land degradation, except in Australia. These authors caution that since degradation is cumulative, areas degraded before 1981 may not show up in the NDVI data series (Mortimore *et al*.2009).

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Box 3. Unique character description of drylands.

In an email on 30th June 2011. H. Prins stated that dryland vegetation is prone to what ecologists call 'flip-flop behaviour': in other words, state-and-transition models are a good description of the behaviour of these systems and the transitions are well-described by hysteresis models. This means that the vegetation cover in dryland systems can suddenly 'collapse' into a undesired state—from perennial grasslands to annual grasslands, or from annual grasslands to a bare state—due to, for example, overgrazing. If the barren state is subsequently rested, a 'normal' succession back to the desired state may not necessarily occur; indeed, the trajectory back to the desired state can mean that destocking has to be much more severe and for a longer period than expected (this difference in the trajectories from 'desired state' to 'bad state' and from 'bad state' back to 'desired state' is called 'hysteresis').

Since livestock and wild herbivores are dependent on the vegetation, this flip-flop behaviour can have devastating consequences for their population dynamics (and thus for 'off take'), and so-called 'carrying capacity models' fundamentally have no meaning. Management lessons from more mesic systems or from the temperate zone are of little relevance in these dryland systems with their fundamental flip-flop behaviour, and non-equilibrium dynamics prevail. Since most management theory is based on equilibrium models instead of non-equilibrium models, managers have been singularly unsuccessful in dryland systems.

Herbert concluded that drylands are governed by six fundamental characteristics:

1) State-and-transition models apply.
2) Transitions between states are controlled by what is called 'chaos mathematics'.
3) Flip-flop behaviour governs.

4) Systems have hysteresis (and vegetation succession theory does not help to understand this).
5)
a. Non-equilibrium dynamics prevail (and carrying capacity models do not apply)
b. Multi-species off take models apply, which have unpredictable outcomes.
6) Human use strategies should recognise these characteristics (the Ecosystem Approach of the UN Convention on Biological Diversity (CBD) describes this 'unpredictability' and determines that 'surprises may occur'.

Source: H Prins 2011, pers. comm. 30 June 2011.

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1.3 Dryland biodiversity and ecosytem services

As drylands are so extensive, their biodiversity and the continuity of their ecosystems matter to the world as a whole. Dryland biodiversity is important, not least for adaptation to future climate change. Drylands are home to a relatively high number of endemic species: plants and animals uniquely adapted to the variable and extreme conditions of these areas, including diverse habitats, such as deserts, forests and woodlands, savannahs and steppes, wetlands, ponds, and lakes and rivers. In addition to providing a large proportion of the world's food, drylands have contributed much to ecosystem services including pharmaceuticals and raw materials, and cultural and aesthetic benefits. Furthermore, dryland biodiversity has a significant direct economic value from eco-tourism, especially in sub-Saharan Africa. On the other hand, dryland biodiversity faces high risks from habitat change, overuse, the introduction of invasive alien species and other anthropogenic pressures. There is a growing recognition of the need to conserve dryland biodiversity, not only for its own sake, but also because biodiversity helps provide ecosystem services on which people depend.

The Millennium Ecosystem Assessment (MA) (2005) defines ecosystem services as the benefits people obtain from ecosystems. These benefits are the multiple commodities that are supplied by ecosystems as a result of their structure and function; the conditions and processes through which nature sustains human life on earth (Daily 1997); the life support systems, those that we cannot live without. From the functional point of view, the MA classifies these services into four broad categories: *provisioning*, such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and crop pollination; and *cultural*, such as spiritual and recreational benefits. Ecosystem services can also be classified according to their geographical scale (local, regional, global), value to society (direct and indirect), or the type of the natural ecosystems providing the service (forest, coral reef, wetlands, for example; WRI 2009).

Table 2. Key dryland ecosystem services

Provisioning Services Goods produced or provided by ecosystems	**Regulating Services** Benefits obtained from the regulation of ecosystem processes	**Cultural Services** Non-material benefits obtained from ecosystems
Provisions derived from biological productivity: food, fibre, forage, wood	Water purification and regulation. Pollination and seed dispersal.	Recreation and tourism. Cultural identity and diversity. Cultural landscapes and

fuel and biochemical; fresh water; hydrocarbons (oil and gas); metals and metallic minerals; precious minerals; construction and industrial minerals.	Soil protection and protection against desertification. Climate regulation (local through vegetation cover and global through carbon sequestration).	heritage values. Indigenous knowledge systems. Spiritual, aesthetic and inspirational services.
Supporting Services (underpining others) Services that maintain the conditions for life on earth		
• Soil development (conservation, formation). • Primary production. • Nutrient cycling.		

Source: Linares-Palomino in Mortimore et al. 2009

Currently, nationally designated protected areas cover 9% (or 5.4 million km^2) of the world's drylands. Thus, protected drylands make up 3.6% of the world's land area, or 31.1% of the world's protected land area outside Antarctica. This sounds a lot; however, considering that overall protected areas currently cover 12.9% of the world's land area outside Antarctica, drylands are relatively less well protected than other terrestrial environments. Among different dryland types, sub-humid areas are relatively well protected (10.8%), closely followed by hyper-arid areas (10.3%); semi-arid and arid areas are less well protected (8.1% and 8.0% respectively).

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Box 3. Protected area coverage in drylands

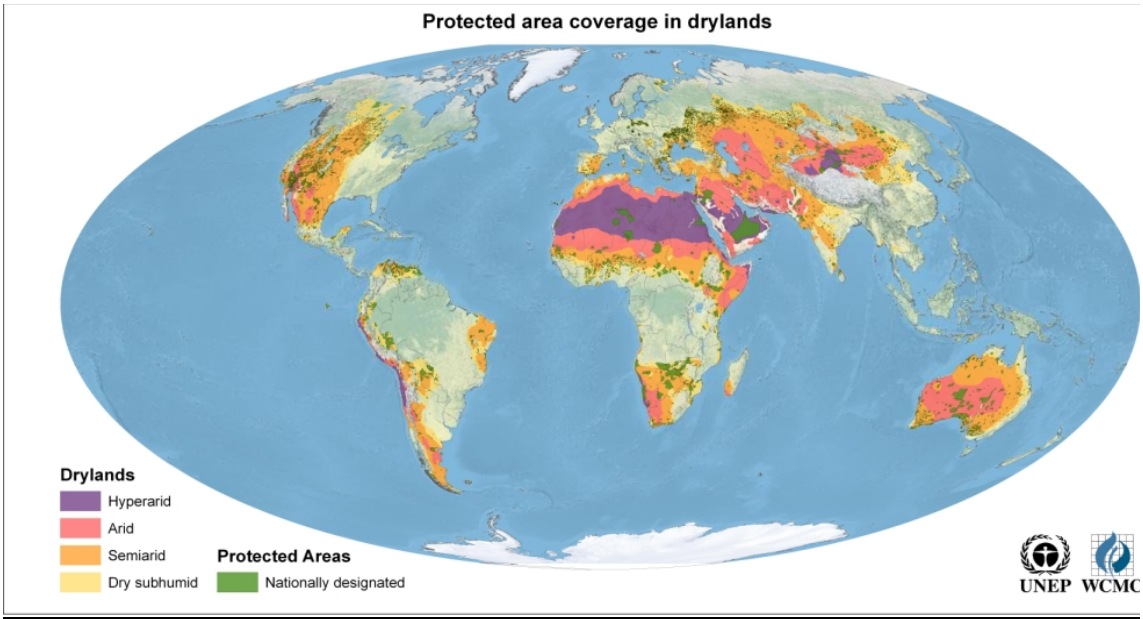

Figure 5. Protected areas in drylands. Source: UNEP-WCMC 2010.

Nationally designated protected areas in drylands were identified by overlaying the 2010 annual release of the World Database on Protected Areas (WDPA: www.wdpa.org) with a map of the world's drylands. These protected areas were then mapped together with different dryland types (hyper-arid, arid, semi-arid and sub-humid) and protected area coverage was mapped and analysed.

Table 3. Figures for nationally protected areas in drylands. The table shows how well different dryland types are covered by nationally designated protected areas included in the 2010 annual release of the WDPA.

Dryland type	Total area (km^2)	Protected area (km^2)	Protected area (%)
Hyper-arid	8,969,237	927,435	10.3
Arid	15,169,575	1,219,185	8.0
Semi-arid	22,673,686	1,840,242	8.1
Sub-humid	12,962,403	1,399,659	10.8
Total	**59,774,901**	**5,386,521**	**9.0**

Source: UNEP-WCMC 2010

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Box 4. Examples of regulating services from Mexico

Regulating services are often the most difficult of the four categories of ecosystem services to illustrate and comprehend. The following are four examples from the Chamela drylands, western Mexico: *Climate regulation:* Dryland forests provide shade and moisture to farmers and their animals. At a regional scale, changes in albedo (the surface reflectivity of the sun's radiation) as a result of large-scale forest transformation can change regional energy and water budgets significantly. Dryland forests in Mexico store carbon at about the same rate as evergreen forests (Jaramillo *et al.* 2003).

- *Soil fertility maintenance:* The forest has evolved tight recycling mechanisms to avoid nutrient loss from the system, including a dense leaf litter layer, microbial immobilisation of nutrients during the dry season, forest resistance to fires, and high soil aggregate stability. When the forest is transformed, these fertility maintenance mechanisms are weakened.
- *Flood control:* The region is exposed to highly erosive storms, but there is always a leaf litter layer on the forest floor that protects the soil, keeps high infiltration rates, reduces runoff and erosion, and reduces flooding. When the forest is transformed into agriculture and pasture fields, soil cover decreases and infiltration rates diminish, resulting in higher rates of erosion and sediment transport downstream.
- *Bio-regulation:* The presence of native and introduced pollinators is needed by many of the crops that were worth US$12 million to the economy in 2000. Vertebrates, such as bats, are essential pollinators of wild and domesticated species of cactus and agave, as well as *Bombacaceae* trees.

Source: Linares-Palomino 2009 in Mortimore *et al*. 2009.

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The Millennium Ecosystem Assessment (MA), The Economics of Ecosystems and Biodiversity study (TEEB), and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES)[4], provide a comprehensive and useful framework to understand the growing dependence on ecosystem services, and how best to protect them in perpetuity. In these three authoritative studies, Payment for Ecosystem (or Environmental) Services (PES) is listed as one of the mechanisms that allow farmers or other owners to be paid by society for the maintenance of these services. The working definition of PES is the one adopted in most UNEP publications on PES (for example, Payment for Ecosystem Services (PES) Primer) and has become fairly well accepted; it defines “a payment for environmental services scheme” as:

1. a **voluntary** transaction in which

2. a **well-defined** environmental service (ES), or a form of land use likely to secure that service

3. is bought by at least one ES **buyer**

[4] Relevant websites are, respectively, www.maweb.org, www.teebweb.org, and ipbes.net.

4. from a minimum of one ES **provider**

5. if and only if the provider continues to supply that service (**conditionality**) (Wunder 2007; STAP 2010).

1.4 Social dynamics in drylands

In the face of hardship, variability and risk, many dryland populations have developed resilience based on historic and current adaptive knowledge and skills. Local people often have a profound understanding of dryland ecosystems. They frequently use a wide range of wild species as part of their livelihoods, and their livestock and crops are the products of long periods of selective breeding for adaptation to local conditions. Local knowledge results from a continuing interaction between people and their environment. It has a value, measurable not in monetary (market) terms, but in the success or failure of household livelihood strategies over time. Successful strategies can be attributed to social mechanisms embedded within communities for the transfer of knowledge and responses to environmental cues. It is important that sustainable use strategies are informed by an understanding of these systems (Mortimore *et al.* 2009). An example of these principles is the management of risks by pastoralists (Box X).

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Box 5.The management of risk by pastoralists

Risk in African pastoral systems is handled in the following ways, enhancing the resilience of the system:

- *The range:* Livestock mobility, over space and time, optimises use of the range where rainfall is spatially and temporally very varied. Large and diverse ranges comprising wet-, dry- and drought-time grazing areas are managed as common property resources. Knowledge of when wild species yield food, particularly trees, helps to supplement reduced milk yields during dry times. Tree conservation is vital for conserving fodder, providing shade and for other benefits. Many (usually tree-based) products can be sold, such as gums, resins and medicinal plants.
- *Water:* Water management is tightly controlled, and rights are negotiated, along with range management. The availability of water often gives livestock access to valuable pastures.
- *Diversification:* A diversity of animals (grazers and browsers) reduces risk from disease, droughts and parasites. Risk is further controlled by redistributing assets through mutual support, including splitting herds between pastures. Mitigating risk from drought may involve diversification into distant labour or trading markets, as well as expanding trade in wild products. Opportunistic rain-fed agriculture is practised to spread risk (for example, the Turkana of Kenya have 23 sorghum varieties that only need 60–90 days to mature).
- *Institutions:* Risk management, through diverse traditional institutions such as *Qaaran* in Somali, *Iribu* in Afar, and *Buusa Gonofa* in Borana, includes ways to support those households that have lost livestock from drought, raids and disease. These social safety nets enhance labour sharing and security during periods of stress.

Source: Barrow in Mortimore et al. 2009

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Urbanisation, migration and population growth are in rapid transition in drylands. Many drylands have doubled their resident populations in 30–40 years. Moreover, demographic transition to lower fertility has been slow to occur in many dryland areas. Urbanisation is rapidly approaching 50% in some areas, tipping the balance between urban and rural populations in developing countries. According to the UN-Habitat more than 70% of people in some developed countries with drylands (e.g. Australia, Canada) are already living in cities.

Ever more complex patterns of migration (local, regional and international) are interlocking rural and urban economies, and many dryland households derive incomes from two or more places. Under rapid urbanisation, migrants take their human and financial capital with them to invest in housing, business and education. This raises the opportunity costs of investment in farmland or livestock. However, if emigrants prosper, finance can flow in the opposite direction and benefit those remaining in dryland areas.

Prices and markets play a major role in fashioning the strategies pursued by different dryland-dwelling people in the face of changing economic opportunities. The responses of Sahelian farmers and herders to better market conditions generated by the devaluation of the CFA franc in the francophone countries of West Africa bear witness to this creativity, as shown by increased livestock exports and rising cereal prices. Interviews with African farmers in high risk, drought-prone agro-ecosystems provides examples of strategies employed to manage livelihoods under conditions of uncertainty typical of drylands . In particular, the survival of Sahelian farming livelihoods through three decades of declining rainfall (from the mid-1960s to the mid-1990s) provides evidence of resilience (Holling 2001).

It should be noted that resilience is not achieved without cost. Assets are sold to avert hunger, alternative incomes are sought through migration, famine foods are searched out from trees and bushes, animals are lost, and infant and child mortality peak until the rain recovers and a harvest is secured. Food security in poorer households is transient and unreliable. But adaptive livelihoods are sustained from year to year.

Markets penetrated many drylands with the arrival of colonial cash crops for export. But an intensification of market penetration is occurring at present, based on cheap imports of East Asian goods and telephones rather than on agricultural exports (in the main). But nothing could be more fundamental than a final change from subsistence to market economies at the household level.

1.5 Understanding the complex relationship between livelihoods and the environment

Drought events (such as those of the 1970s and 1980s in the Sahel) are ‘fast’ variables, whereas the intensification of agriculture and the persistence of mobile pastoral systems are ‘slow’ variables (Reynolds *et al.* 2007a). Therefore, a painstaking analysis of system change in the medium to long-term is necessary to expose both variability and trends; such trends may have provide positive lessons and offer opportunities for enabling interventions. At the national scale, long-term data (1960 to 2000) do not support theories of agricultural collapse. Rather, the intricate interactions of policy with production and yield from year to year suggest that the role of demand factors has been underestimated (Djurfeldt *et al.* 2005; Mortimore 2003). These interactions between fast and slow variables are difficult to unravel because the proximate determinant of biomass yield in any year is the rainfall.

Sustainable land use in the drylands is also a matter of scale. It has been observed that scenarios of degradation and collapse in the human and ecological systems are often constructed at the global or continental scales (IPCC 2007), while 'success stories' have been recorded at the district or community scales. This is a consequence of the methodologies used. High level generic models are facilitated by global datasets including climate, demographic and economic data, and strong *a priori* hypotheses. Earth satellite imagery has, however, shown recent optimistic findings on 'greening' in the drylands.

District or micro-scale studies, on the other hand, tend to generate more nuanced and counter-intuitive findings which reflect the perceptions and knowledge of the people. Systems are, in fact, nested hierarchically. Increasingly, local land users are searching for opportunities outside their local human-ecological system. Thus, seasonal migration in search of non-agricultural incomes in West African coastal areas has become integral to the sustainable management of Sahelian dryland ecosystems—in bad rainfall years, household consumption is supported in this manner, and, when times are better, investment is made in animals or farming.

An example of the intricate interactions over time between human and ecological systems, fast and slow variables, scale, potential thresholds and local environmental knowledge is provided by the recent history of Mongolia (Chuluun 2008; Ojima and Chuluun 2008). Under socialism, fixed territories and shared ownership of livestock were imposed on a cultural landscape that included four discrete resources: seasonal pastures, reserve pastures, hayland and sacred lands. Because collective management of the range was practised before, pastoral groups achieved a measure of adaptation. But when private ownership was introduced in the 1990s, together with open access to profitable markets for cashmere wool, new entrants were attracted to livestock herding who avoided transhumance in favour of clustering around fixed water points and settlements. Rangeland degradation is now reported. Such examples as these suggest that neither imposed planning controls nor unfettered market forces can adequately substitute for indigenous knowledge and practice; moreover, the resilience of both an ecosystem and a long-practised mode of management may be put at risk by development interventions.

A further example of the intricate relations between ecology, management and institutions is provided by the re-greening of wooded farmland in Niger (Box 6).

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Box 6. A good idea sells itself—farmer-led tree regeneration in Niger

Niger's farmers are protecting and managing on-farm natural regeneration. A number of factors have triggered this:

- The evident environmental crisis of the 1970s and 1980s, and the consequent need to fight dust and sand storms, land degradation and declining crop yields, among other issues.
- A perceived shift in the 'rights to trees' from the state to private ownership.
- Demographic growth and the consequent need to increase production.

Some of the reported impacts of this farmer-managed re-greening are:

- High economic benefits for farmers who invest in the protection and management of on-farm natural regeneration (an internal rate of return of around 30%).

- Higher crop yields and improved household food security. Before the farmers had to sow two to four times before the crops succeeded as the strong winds covered the crops with sand or wind-blown sand razed the young plants. Now they only sow once, thus increasing the length of the growing season.
- A change in the local climate as wind and sun no longer scorch the soil. Rainfall studies have shown that large-scale re-greening also leads to locally higher rainfall (an increase of 30%).
- Farming systems become more complex, more productive, leading to increases in household food security. Trees produce fodder, which allows farmers to keep more livestock. More livestock means more manure, which is no longer used as a source of household energy, but is used to fertilise the fields and subsequently increase productivity.
- A reduction in the time women spend on the collection of firewood (for example, from 2.5 hours to half an hour per day.)
- Reduced vulnerability to drought. During the 2005 famine, child mortality in villages that had protected natural regeneration was much lower than in villages without.
- An increase in tree biodiversity in some regions.

Source: Reij 2008; Larwanou et al. 2006.

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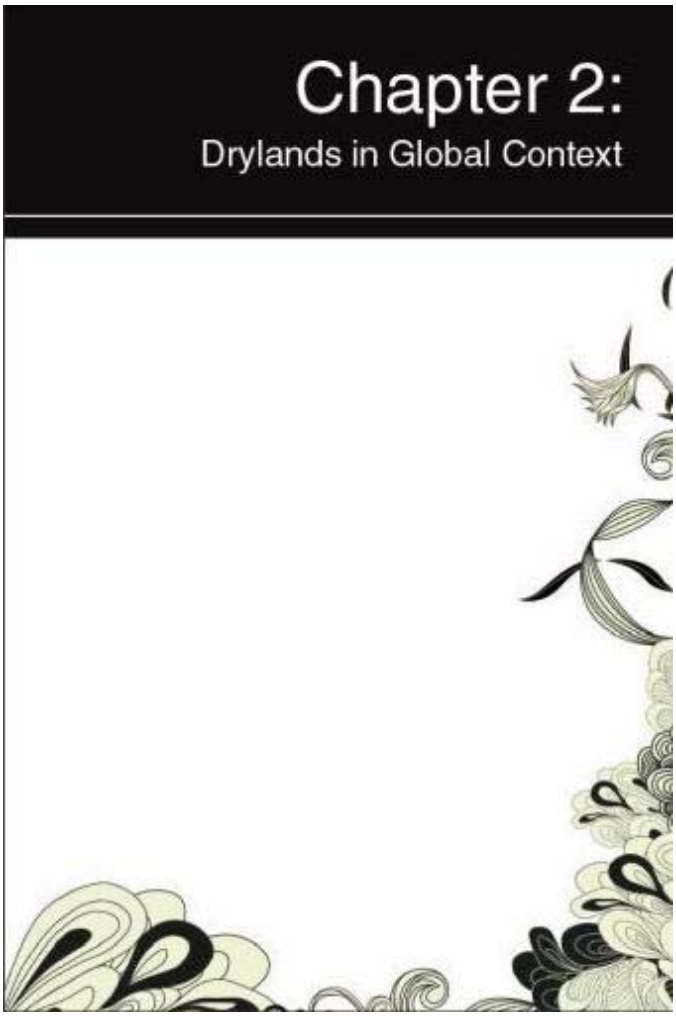
1.6 Conclusion

Drylands are large and significant; they span all continents, but are predominantly found in Africa and Asia. They have special ecological characteristics and their people are very adaptive and rapidly urbanising, although they are affected by global forces. Drylands demonstrate resilience and already provide many critical ecosystem services. Their global context is explored in Chapter 2.

Chapter 2: Drylands in a global context



The UN system is concerned about drylands on account of their interactions with global climatic, economic and geopolitical systems. This chapter introduces drylands in a global context, focusing on new opportunities for food production, water in the drylands, the economic contribution of dryland countries, the value of ecosystem services, and the changing global significance of drylands.

2.1 A changing world, changing drylands

The entire international community has a stake in the health of dryland systems. Dryland degradation, for example, costs developing countries an estimated 4–8% of their national gross domestic product (GDP) each year (Schaffer 2001). During drought periods, dryland populations emigrate to other areas looking for income, either in cities within their own country, camps where relief services are provided or less stricken areas in other countries. We increasingly understand that drylands are important, not only because of their physical extent, but on account of their interactions with global climatic, economic and geopolitical systems.

Traditionally neglected at the policy level, it is evident that drylands are becoming more important. This is the result of several converging trends: high population growth rates; demographic bulges of younger people entering job markets; increasing water scarcity, sometimes exacerbated by climate change; out-migrations; loss of cultural heritage; increasing food insecurity; and land and water grabbing by foreign investors. Globally, the most important emerging issues are: climate change, food security, biodiversity and human security including water scarcity. Such forces are highlighting the value of healthy drylands to the world, and their role in a secure global future.

2.1.1 Climate change

Some drylands are predicted to be heavily impacted by climate change, but they may also play an important role in mitigation, for example, through sequestering carbon in soils. Drylands have relatively low sequestration potential per unit area, but their large expanse makes them important. Their adaptation potential (for example, uniquely adapted biodiversity and social systems) is another important factor. Dryland people have a long and successful history of coping with environmental variability and scarce resources (particularly water) and may be well-placed to lead the way for others. There are also a great deal of lessons learned and good practices to be drawn from many years of experience in early warning systems, and the use of meteorological data in drylands.The global community should be looking to current drylands and the people who live in them for lessons about how to manage the transition to drier environments in other places.

As the planet warms, there may be more moisture in the atmosphere overall, but it will not necessarily fall in the drylands where it is needed. Furthermore, even in areas where the total amount of precipitation is not expected to change significantly, models predict that the timing of rains will change, with potentially significant impacts on the timing of planting, harvesting and other farming activities. The sustainable management of forests in drylands can play a major role in avoiding desertification and preserving scarce watersheds, as well as providing goods and services to rural populations. Drylands can be considered the ‘canary in the coal mine’ for how the world will cope with future change under scenarios that predict increasing dryness, temperatures and variability.

Some models predict that the impacts of climate change are very unevenly distributed geographically, and regional differences in crop production are likely to grow. Countries in the southern hemisphere are expected to suffer the greatest share of the damage in the form of declining yields and greater frequency of extreme weather events (IPCC 2007; FAO 2009). Climatic fluctuations may be most pronounced in sub-Saharan Africa and South Asia, resulting in the poorest regions with the highest levels of chronic undernourishment being exposed to the greatest degree of instability (ISDR 2008). Within these regions, the most severe impacts are likely to be on the lives and livelihoods of people living in extremely marginal conditions, and who are already highly vulnerable.

Africa alone hosts a total of more than 650 million people who are dependent on rain-fed agriculture in environments that are already affected by water scarcity and land degradation. If this trend is accelerated by

climate change, two-thirds of the region's arable land could be lost by 2025 (FAO 2010), and with it, the livelihoods of millions of smallholder farmers. By 2020, climate change could cause significant decreases in crop yields in some rain-fed African systems. It is expected that climate change will cause grassland productivity to decline by 40–90% in semi-arid and arid regions; it is also anticipated that high levels of desertification and soil salinisation, and increasing water stress, will occur in parts of Asia, sub-Saharan Africa and Latin America (IPCC 2007). By 2070, production in developing countries is projected to fall by 9–11% (Parry *et al.* 2009).

Perhaps the greatest threat posed by climate change is the accelerating and amplifying effect it has on existing risks and vulnerabilities. Climate change may expose more people to greater weather extremes more frequently, more erratically and for longer periods. Some countries are already confronted with immediate climate change impacts such as irregular, unpredictable rainfall patterns, increased incidence of storms, and prolonged droughts (IPCC 2007). By 2015, the number of people affected by climate-related disasters is estimated to reach 375 million per year (ISDR 2008). Climate change can also aggravate and accelerate water scarcity, biodiversity loss and land degradation—adding to other drivers of these risks, such as unsustainable farming practices. The year 2050 may see the loss of 11% of the natural habitat that was present in 2000 (Foley *et al.* 2005). Some models predict climate change to have complex and varied impacts on dryland biodiversity. In the Succulent Karoo region of South Africa, 2,800 plant species face potential extinction if temperatures increase from 1.5°C to 2.7°C. The Cape Fynbos biome is projected to lose 65% of its area if temperatures increase by more than 1.8°C, resulting in 23% of its species becoming extinct in the long-term (Fischlin *et al.* 2007).

However, not all dryland climates are expected to become drier (IPCC 2007), and, in some (if not all) drylands, variability in key climate parameters (including the amount and distribution of rainfall) has always challenged farming and pastoral livelihoods. For instance, in the Sahel of West Africa, between the 1960s and the 1990s, rapidly growing human populations adapted to a decline in average rainfall of more than 30%, with increased frequencies of drought-induced crop and fodder failures (Mortimore 2010). Such experience provides a foundation for enhancing and extending the capacity to adapt to climatic uncertainty in the future. Recent studies by Morgan *et al.* (2011) showed that in semi-arid grassland, elevated CO2 can completely reverse the desiccating effects of moderate warming that some models predict global warming to induce in many world regions through increases in evaporative demand. Their study condluded that in a warmer, CO2-enriched world, both soil water content and productivity in semi-arid grasslands may be higher than previously expected and that C4 grasses could prosper as carbon dioxide eliminate desiccation in warmed semi-arid grassland.

2.1.2 Agriculture and food security

Agriculture in the dryland regions faces both challenges and opportunities in the coming years. Many of the hunger affected countries are drylands (Fig 6) and conditions for crop growth in many of these countries are predicted to be become more challenging (Fig 7). These regions also show large gaps in potential crop yield, particularly in sub-Saharan Africa. Access to water, although often perceived as the limiting factor for crop growth may not be the most important factor. Recent work in Ethiopia has concluded that improved access to farming inputs, knowledge, markets and to use of improved techniques and seeds may play an important part in raising yields (Geogris 2010). Questions about the policy environment and the status of enabling framework for small-scale farmers have also been voiced in relation to the current famine in the Horn of Africa, with the Director of Oxfam calling for improved and consistent government support to build resilience in the agriculture sector to enable small-holder farmers to develop sustainable livelihoods (Stocking 2011). The FAO Committee on Agriculture has identified the need for secure land tenure, better access to markets and improved infrastructure

(FAO COAG 2010). Whilst the 2010 GCARD meeting has called for more research on crops that are locally important for small scale farmers to balance the previous focus on major staples such as wheat and rice.

The challenge of food security in the drylands is likely to increase without appropriate action at the policy level, due to the growing populations, particularly in sub-saharan Africa (see Godfray *et al*. 2010). Whilst there is a growing trend towards urbanisation at the global scale, the impacts on agriculture are expected to differ depending on the economic status of different countries. In the richer emerging economies, increasing urbanisation is expected to result in demands for largescale farming to supply supermarkets, in addition there is likely to be greater demand for high value goods that could be produced by urban and peri-urban smallholders (Satterthwaite *et al*. 2010). In East Africa, some 70% of people in major cities supplement their income through peri-urban farming. In poorer countries, small scale agriculture is likely to continue largely unaffacted by urbanisation, except perhaps for reductions in the labour force.

Drylands support a range of crops although, wheat and barley represent the main components of rainfed cropping systems in Mediterranean and middle Eastern areas whilst maize and sorghums are important in sub-Saharan Africa with cotton grown as an export crop in Egypt, Syria and sub-Saharan Africa (often under irrigation). Faba bean, chickpea and lentil are important food legumes and a major source of protein in the daily diet of low-income people in drylands. Other crops, such as oilseeds are also important. Dryland fruit and vegetable crops such as olive, almond, fig, pistachio, apple, apricot, peach, hazelnut, grape, quince, date palm, cucumber, melon are an integral part of the farming systems in different dryland regions.

Demand for major crops such as wheat and rice tend to increase as local wealth grows. However, these crops are rarely the best adapted to local conditions in drylands and some authors advocate a strategy of crop switching to those less affected by climate impacts (Lobell *et al*. 2008). Locally valued crops such as tef, and quinoa that grow under limited climatic conditions could be introduced elsewhere. Recently, demand for sesame, an oil producing seed that can be cultivated in dryland areas has soared as it produces a valuable oil crop. The world market has largely been supplied by Asia, although Africa as a major grower could also benefit if farmers are assisted to reach markets. This provides a great opportunity for small-holder farmers to generate a financial surplus as there is potential to increase the planting and sale of this high value product (Koska and Scarrer 2011). In Ethiopia, research indicates that small-scale farming is likely to be a more profitable means of producing sesame.

The yield gap experienced in dryland regions can be significant, but this provides an opportunity for improvement (Geogris 2010). Yield gaps may be due to sub-optimal farming techniques, poor access to inputs and lack of improved varieties, and so by addressing these issues, farmers can be assisted to improve their yields and produce a surplus in good years. However, given the existing variability in dryland weather patterns and increasing stochasticity expected under climate change, it will be important to recognise that over-intensification should be avoided. Traditionally small-holders in drylands have coped with “bad” years by using widespread community support networks and not over-intensifying (de Jode 2010).

Table 4. The impact of improved crop husbandry and agronomic practices on output and productivity in semi-arid areas

Agronomic Practice	**Impact on output in drylands of Africa**	**Remarks**

A. Optimum time of Planting	Up to 50% increase output in dry areas is possible.	Considerable research has already been done for dry areas of Africa.
B. Improved spatial arrangements and plant populations	Up to 20% increase in yields	Only a well-coordinated extension effort is required
C. Improved field preparation and tillage practices	Up to 30% in drier areas and areas with "difficult" soils in the humid zone.	A lot of as yet unfinished research is being undertaken.
D. Use of the best variety Available	Up to 30% in large areas.	Development is very fast.
E. Better fertilizer	Up to 50% in large areas.	In Asia, there is a good database on fertilizer response. In Africa less satisfactory
F. Better weed control	Up to 40% in many areas	Can very easily be improved
G. Better pests and disease control	Up to 30% almost everywhere	Much more research is required everywhere.

Source: Kidane et al. Ethiopian Institute of Agricultural Research, 2005 in Geogris 2010

Table 5. Food grain yield (t/ha), from research station, field trials and farmers' fields

Crop	Research Station 1979	Field Trials 1979	Farmer 1979	Farmer 95/96
Teff	2.4	1.8	0.8	0.8
Maize	9.0	5.0	1.2	1.7
Wheat	5.3	3.2	0.9	1.2

Sorghum	5.0	3.0	1.2	1.4
Barley	5.5	4.9	0.8	1.1
Haricot Beans	2.5	1.8	0.7	0.7
Horse Beans	2.9	1.5	0.6	1.1
Field beans	1.3	1.0	0.6	0.7
Groundnut	4.5	3.5	5.0	na
Sesame	2.0	1.1	0.3	na

Source: World Bank 1983; CSA 1996 in Geogris 2010

Pastoralism provides a prime example of flexibility and the ability to adapt to changing conditions and livestock provide a major source of livelihoods in dryland regions (de Jode 2010; Scoones *et al*. 2010; Thornton 2010). In Chad, pastoral animals make up over one third of exports and feed 40% of the population. The story is similar in Uganda where pastoralist and smallholder livestock producers contribute 8.5% of total GDP, and in Mauritania livestock contributes 70% of total agricultural GDP. Pastoralism and livestock production can also be major foreign exchange earner. In 2006, Ethiopia earned US$121 million from livestock and livestock products and Mali exported live animals worth US$44.6 million, whilst in Kenya, livestock raised by pastoralists is worth US$ 800 million a year.

Contrary to popular belief, Pastoralists tend to move in search of the best quality forage a, rather to avoid poor conditions. Consequently pastoralist cattle are often in better heath than sedentary of ranched cattle as shown by comparsions of productivity and value in Botswana, Zimbabwe, Kenya and Ethiopia (see de Jong).

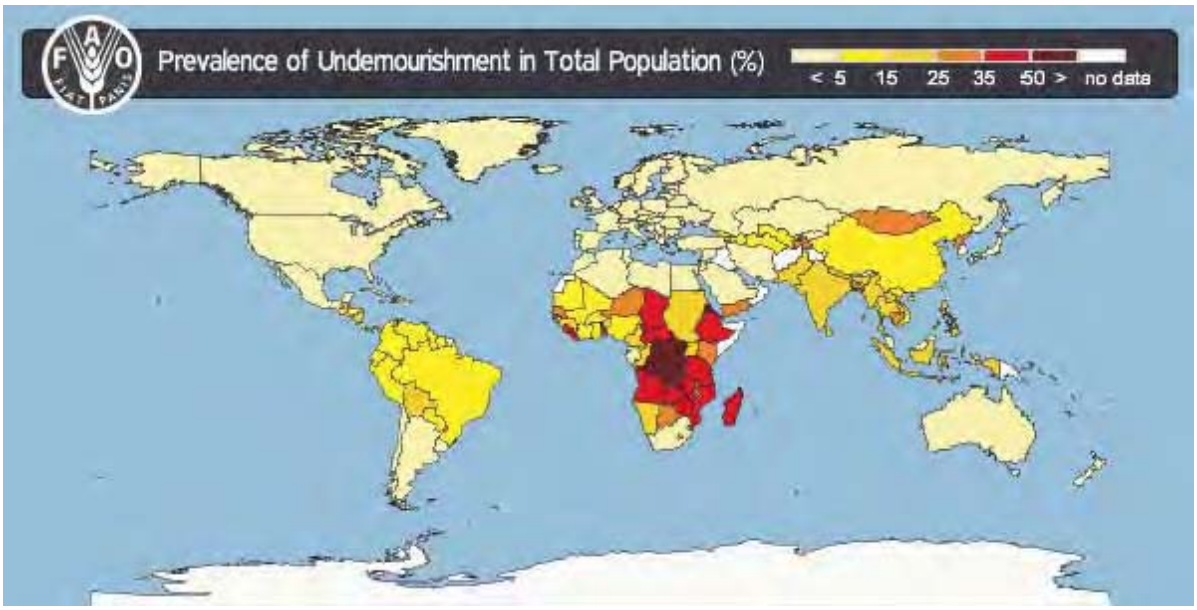
However, pastoralism is increasingly coming into conflict with modern governance systems. In many countries sedentarisation policies dominate and even though legislation in many areas of West Africa is now designed to accommodate the needs of pastoralists, it may not be fully implemented (McGahey 2011). Although the African Union is now encouraging dialogue on the issues. Discussions with Pastoralists in East Africa indicate that these communities feel they are not fully consulted either about policy that affect them or about aid packages that are designed to asssits them in times of hardship, but which may in fact exacerbate the situation through lack of consideration for local social networks and practices (Scoones and Adwara 2009).

The increasing use of veterinary fences and closure of borders can negatively impact herders, preventing access to traditional grazing grounds and also to regional markets. For example, the closure of the Sudan-Libya border during the Dafur crisis has severely impacted livestock trade and local livelihoods (in Scoones and Adwara 2010). However, there are some instances where fences may provide at least temporary benefits. A detailed study in Botswana has show that different socio-economic groups may perceive the impacts of fencing differently (McGahey 2011). To retain access to overseas meat markets, Southern Africa has a policy of fencing livestock areas to reduce the spread of cattle diseases. In 1995, in response to a disease outbreak, the Botswana government adopted a slaughter and compensation policy and also employed additional fencing. In turn, this resulted in a change in lifestyles with pastoralists moving and settling in villages. For the majority of the respondents in the study, this was seen as a positive move, village life was more rewarding than the hard work of pastoralism, and for those that restocked their cattle, the fences reduced cattle loss and herding workload.

However, there are downsides, the fences are associated with hotter burns when fires sweeps through the area as a result of the reduction in wildlife numbers that used to suppress vegetation growth, also a families have dug extra wells. So, it is still not clear how this will affect sustainability in the long run and how this may affect local perceptions of the fences and their impacts on grazing, water and livelihood provison.

Understanding and maintaining the provision of ecosystem services, and the capacity of the local environment to support livelihoods is key to the sustainability of dryland farming and pastoralism and further research will be important in this regard. Although, Drylands support some 200 million people and some 50% of the world's livestock, they are threatened by desertification. Globally, more that 12 million hectares of arable land are lost to desertification every year and the rate is likely to increase as a result of climate change. To address such losses improved farming techniques and greater understanding of the underlying ecosystem services provided by biodiversity will be needed. For example, recent research has shown the importance of ants and termites in tropical dry regions in increasing the yield of what in farm trials. Ants and termities were shown to have a similar function to earthworms in temperate areas, facilitating water infiltration and preventing runn-off. By understanding these dynamics, along with the impacts of interventions such as fences that lead to more intense wildfires, productivity and long-term sustainability can be improved in support of dryland populations.

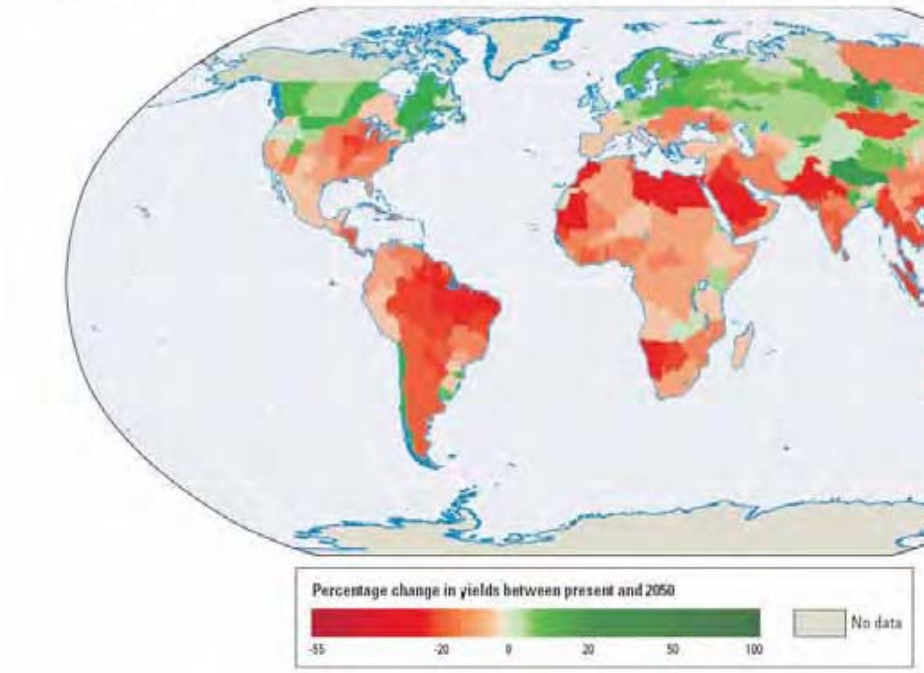
Figure 6. Hunger Map 2010, FAO



Source: FAO [http://www.fao.org/economic/ess/food-security-statistics/fao-hunger-map/en/]

Figure 7: Impact of climate change on potential agricultural yields by 2050

Map 3.3 Climate change will depress agricultural yields in most countries by 2050 given current agricultural practices and crop varieties



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Source: World Bank 2009b

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Box 7: Rain-fed agriculture in Africa and Asia: vital for future food security

In the context of continued population growth and predicted climate change, recent studies have envisaged a developing global crisis in the availability of abstracted water (Rosegrant *et al.* 2002a). They suggest that the projected trends in world population growth and dynamics will place substantially greater multi-sectoral demands on water, leading to exacerbated competition between sectors for an increasingly limited supply of abstracted water. This, in turn, will curtail the ability of irrigated agriculture to respond to the expanding food requirements of a global population, particularly those in the developing world. In contrast to the aspirations of theMillenium Development Goals (MDGs)(, this raises the spectre of a worsening food security crisis (Rosegrant *et al.* 2002A).

To reverse such a scenario, it has been concluded that much greater emphasis will have to be given to increasing the productivity of global rain-fed agriculture, which currently provides 60% of the world's food (Rosegrant *et al.* 2002b). In such an endeavour, the drylands of Africa and Asia pose special challenges, for it is here that some of the poorest and most vulnerable communities live. These communities manage, and largely rely upon, rain-fed agricultural and pastoral systems for their livelihoods and are the custodians of the natural resource base upon which such enterprises depend. Added to the constraints imposed by extreme poverty, health hazards and an often degrading resource base, is the inherent variability of rainfall amounts and distribution, and the risk this imposes on farm production.

Recognising the importance of rain-fed agriculture for both individual, as well as national, food security, agricultural research and development initiatives have, for decades, developed and promoted innovations that aim to increase the value and productivity of assets at hand, be they land, labor or capital. In many instances, such innovations not only attempt to increase productivity, but also mitigate the climatically induced uncertainty of production through specific soil, crop and rainfall management strategies (Cooper et al. 2009). Some examples include:

- Breeding new crop varieties that are better adapted to contrasting climatic conditions.
- Incorporating resistance to pests and diseases (many of which are triggered by specific climate sequences) within new crop varieties.
- Developing and promoting innovative seed supply systems to support the adoption of improved varieties.
- Identifying and promoting affordable input supply systems, such as the precision application of small doses of inorganic fertiliser.
- Low-cost land forming and residue management interventions at the farm and watershed scale that retain scarce rainfall where it can be most effectively used, such as *Zai* pits and planting basins.
- Developing and promoting more diversified production systems through the incorporation of high value legumes, such as groundnut, chickpea and pigeonpea, into crop rotations and agroforesty.
- Undertaking research on systems and value chains that link farmers to local, regional and global markets.

Such research has already shown great potential on research stations and in farmers' fields, with 'achievable' yields often several times greater than those obtained by traditional practices. However, in general, extensive adoption of these innovations has been low. While 'islands of success' continue to provide hope for the future, little scaling up of such successes has been reported and widespread impact is not yet evident. Indeed, in many situations, production and the quality of the natural resource base are declining.

Given this situation, and combined with the projected negative impact of water scarcity on the possible extent of expansion of irrigated agriculture, cereal deficits in most of Asia and Africa are expected to increase dramatically by 2025 if the current 'business as usual' rain-fed resource management and investment policies are maintained (Rosegrant *et al.* 2002c).

In such a scenario, either international food aid must be increasingly called for (an undesirable option), or policies must be put in place to greatly accelerate investment within the agricultural sector beyond the 'business as usual' scenario upon which such projections are based (Rosegrant *et al.* 2002c).

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2.2 Drylands are rising on the international community's agenda

The increasing significance and broader security concern in the drylands is coupled with the political recognition that the world cannot achieve the MDGs without addressing the needs of people living in the drylands. It is also becoming more apparent that drylands have unique resources of high economic value. This has led to an unprecedented level of political interest in drylands, overlain with a growing volume of both public and private resources that could be tapped in order to revitalise drylands areas.

Some countries, such as Tunisia and Namibia, are demonstrating benefits that show increased profiling of drylands in government thinking, if not direct investment. The other, more controversial, area is foreign investment in land/land use from countries that fear their own food security issues, even resulting in the displacement of local people for large-scale agricultural projects, termed 'land grabs'.

Among the potential investments for drylands development are:

- Food security commitments, of at least US$20 billion[5], some of which could optimally be directed at the rehabilitation of the drylands regions' resource base,
- Private investment, often transnational in nature, for purposes of enhancing food security,
- Climate change instruments, both mitigation (soil carbon, bioenergy) and adaptation (especially in vulnerable areas),
- Funds available for conflict prevention as well as post-conflict rehabilitation,
- Investments in conserving high value drylands biodiversity such as drought resistance and heat tolerant crop and livestock varieties,
- Unique biodiversity opportunities from cultural and eco-tourism, private sectors investments (natural products), and research into adaptation,
- Renewable energy opportunities, e.g., the European-Mediterranean thermal solar collectors plan.
- Support to woman farmers' access to productive assets,
- Payment for Ecosystem Services (PES) schemes are already being piloted, e.g., in tropical woodlands of Mexico.

This report explores some of these opportunities, with consequent caveats and limitations treated in a realistic manner. Dealing with these issues is not as obvious as may seem on first glance. The long history of development

[5] E.g. US$2 billion from the World Bank's Global Food Crisis Response Program (GFRP), US$3.5 billion within the United States' Feed the Future (FTF) pledge for agricultural development and food security over three years, US$18.5 billion estimated from other OECD countries.

interventions in drylands indicates that endogenous development, rather than external intervention, is more likely to succeed in making drylands prosperous. Landscape transformation is a long-term endeavour. Its sustained momentum is due to a positive social and economic evaluation of sustainable ecosystem management driving the development process. The UN system must, therefore, play a delicate 'enabling' role, taking into account all that has collectively been learned from, and in, the drylands.

2.3 A sustainable approach: drylands development

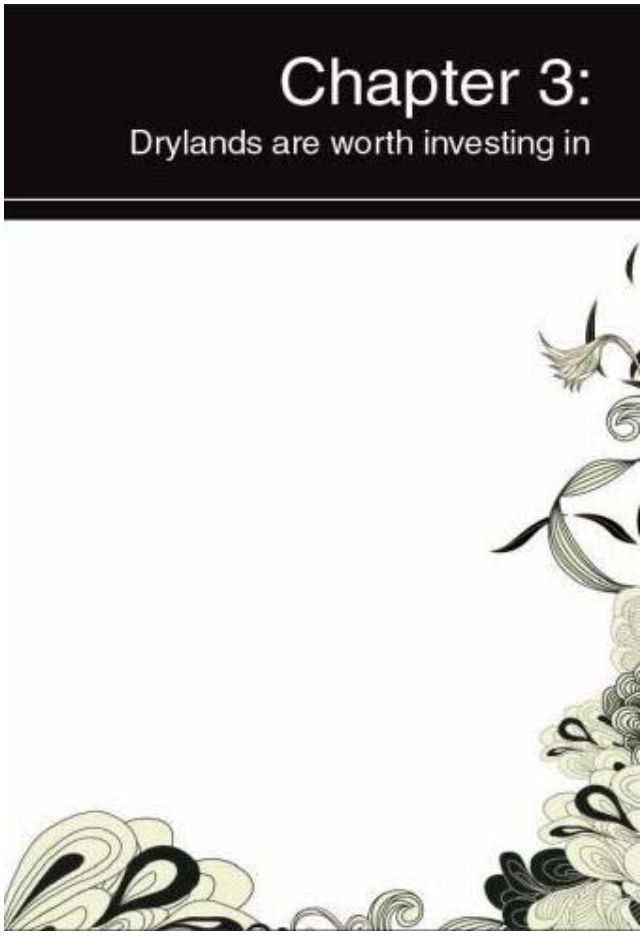
The UN system aims to promote sustained drylands development through long-term investments by public and private actors. Investment is a key strategy to enhance the well-being of drylands people, while maximising the benefits at an international level of sustainable drylands as carbons sinks, biodiversity stores and food baskets.

The main actors in any investment scenario are as follows:

- Government: the sectoral ministries of the state (e.g. Ministries of Agriculture, Transport, Environment), parastatals, and governance at all levels.
- Private: Commercial: large-scale farming enterprises, corporations, companies; Family: family farms, herders and livelihoods, small-scale enterprises, informal sector (including in cities).
- Public: non-governmental organizations (NGOs), Community Based Organization (CBOs): national and international organizations outside the state pursuing particular agendas; Donors: multi-lateral and bilateral funders of development projects and programmes.

The investment scenario applies to all interest groups and all activities in drylands: to urban as well as to natural resource- ('land') based systems, and to a range of activities or enterprises from production and service provision to conservation and protection. Any activity may feel the impact of constrained investment, and stands to gain directly or indirectly from re-capitalisation. Although the special needs and requirements for investments in the production base of often marginalised groups such as women, youth and indigenous peoples need to be carefully considered. The UN system is in a position to catalyse action.

Chapter 3: Drylands are worth investing in



This chapter addresses the opportunities for reversing the chronic under-investment that has constrained both productivity and livelihoods in drylands in poor countries. A framework is provided in terms of: Who invests? (identifying the four main groups of actors); Why invest? (seven good reasons for – drivers of - investment in drylands, whether in programmes, projects, policies or micro- and commercial scale opportunities); Which investments? (a summary analysis of 13 priority strategies); and What benefits? (desired outcomes for incomes, wellbeing, natural resource management and sustainability). The framework is developed in terms of 12 'investment areas' in which opportunities for public, commercial, community and household sectors are identified, and illustrated with reference to carbon and renewable energy.

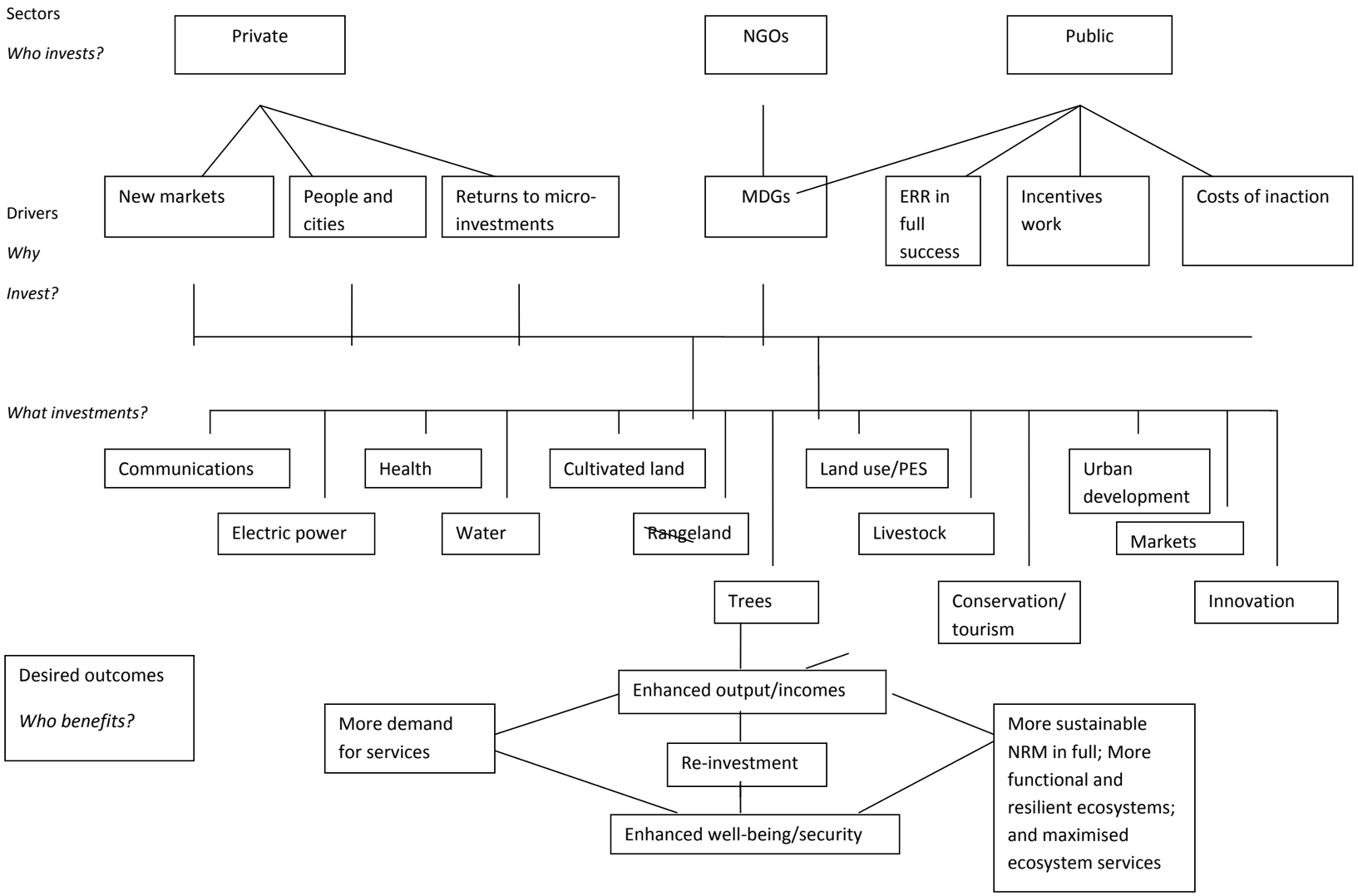
3.1 Analytical framework

Investment will be the key to economic growth in the drylands. However, it is not a uniform category, nor a simple one. Therefore, an analytical framework is first presented to clarify how processes of investment may work in a drylands context. Four major categories of actors are considered in Figure 8: communities, government, private household-scale and private large-scale. These actors are motivated by one or more of seven drivers, to invest in one or more of 13 priority areas, and from their investments certain interlocking benefits may be expected.

- Public sector investments create or sustain public goods such as infrastructure and knowledge. These are achieved through programmes, policies or project interventions. Public sector investments may create both benefits for project beneficiaries, or enabling environments for private investments. Public sector investments represent a compromise between national (political), international and donor priorities.
- In the private sector, small-scale investors aim to sustain their livelihoods through managing financial, human, social and natural capital (including land) at the micro-scale. Many investments made by poor people are created by labour either with very little or no financial capital—it is either family labour or co-operative labour sharing as practised in many small-scale farming or livestock production systems.
- Large-scale private sector investments (for example, in mechanised farming or processing factories) are very different from the labour-intensive and incremental micro-investments of private sector smallholders. Such investments can be evaluated by simple accounting procedures within the boundaries of the firm. For the other categories of investment, financial returns are but a part of their justification and performance.
- Community investments, which are intended to have social, as well as economic or environmental benefits. Many such investments implement the agendas of specific and diverse organizations or interests.

These categories cannot be rigorous or exclusive. But it is necessary to face the complexity of 'investment landscapes', especially in the drylands where intricate linkages exist between economic, social and environmental change. Another complicating factor is the mode and scale of impact of investment. Public sector investments through policy (for instance, creating incentives for specific forms of private investment) operate very differently from direct investments in infrastructure or projects. The activities of NGOs, often based on intensive social capital use, differ markedly from, say, a dam constructed by foreign contractors and partly paid for by donors. Thus, within a general aim of maximising productive investment in drylands, there are a range of modalities and scales which determine the nature, size and distribution of benefits.

Figure 8. A framework for investing in drylands



Source: name year.

3.2 Why invest

There are seven reasons why investment opportunities in drylands deserve a fresh assessment; these are:

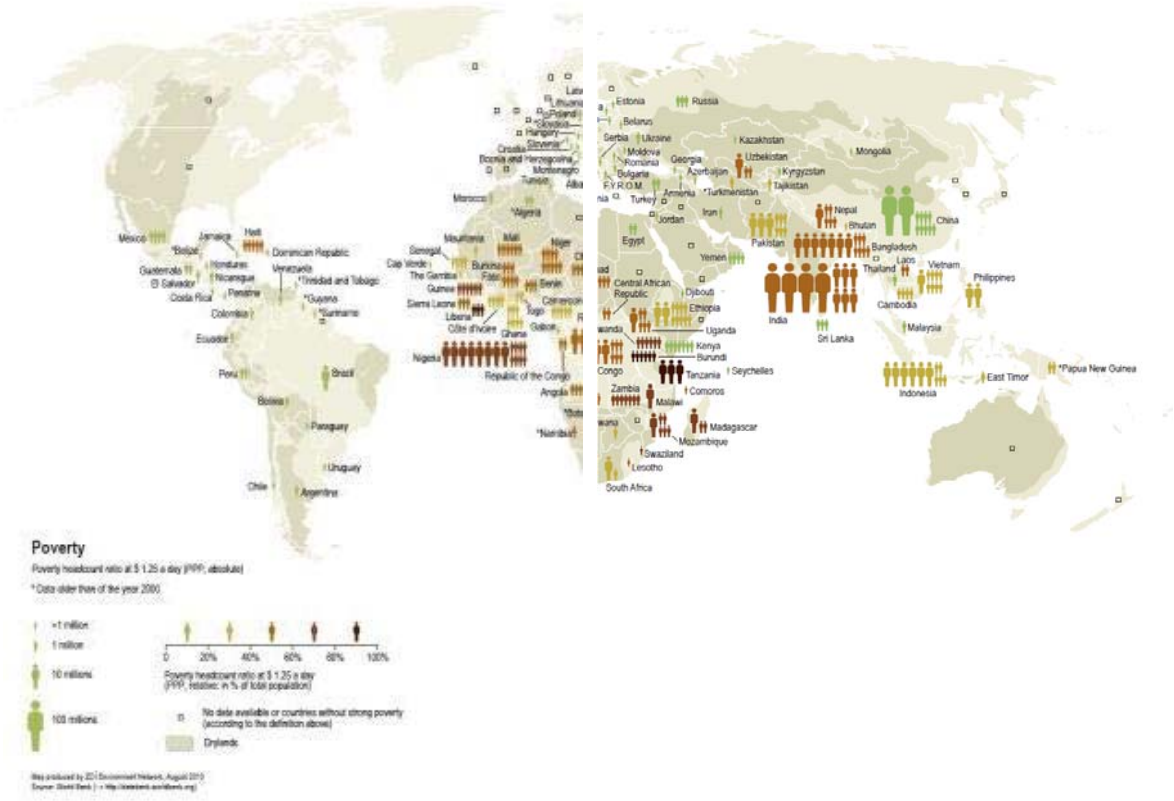
1) The Millenium Development Goals (MDGs), poverty reduction and agricultural development
2) New and expanding markets
3) Cities and people.
4) Micro-investments
5) Successful interventions.
6) Incentives do work
7) Commercial investments can pay through value chains

Each is reported in detail in this section.

3.2.1 The MDGs, poverty reduction and agricultural development

Dryland countries are committed to the MDGs and, in particular, to the reduction of poverty. According to the World Bank, agricultural investment has a strong record for reducing poverty (World Bank 2005; 2007). In China and India,—both of which have extensive drylands—rapid agricultural growth (including that of the 'green revolution') has accompanied by major declines in rural poverty. Recent studies suggest that the returns to public investment from the green revolution in dryland regions exceed those obtained in more humid areas (Hazell *et al.* 2002). Agriculture can be the lead sector for overall growth in agriculture-based countries, where an increase in the production of food staples can bring down prices and wage costs in other sectors, and can have multiplier effects, for example, in processing and service provision. A strong case can be made for smallholder production on grounds of labour quality, commitment and economy, impact on poverty reduction, and equity (Hazell *et al.* 2007). Raising smallholder productivity in drylands (whether in crop or livestock production) is, however, a greater challenge than in higher potential areas, but given the current large rural populations of sub-Saharan African dryland countries, aggregate benefits can be considerable.

Figure 9. Poverty map



Source. *ZOINET year*

The over-riding imperative for investing in drylands is, therefore, poverty reduction. In this respect, the community sector (including CBOs and NGOs) accepts a rights-based justification for action which converges with, and complements, the responsibilities of governments, donors and the UN.

3.2.2 New and expanding markets

It is a myth that deserts have always acted as barriers to economic, social or political intercourse, and that drylands have a history of remoteness and isolation. Drylands in North and tropical Africa and Asia have deep historical ties with markets, cities and different biomes. Traders and armies traversed them, bringing high value commodities, new knowledge and slaves to their respective home shores. Nomadic populations of the deserts and steppes played intermediary roles in these exchanges. When Europeans first made contact with drylands in South Asia and China, they were already urbanised, with investments in trade, technology and infrastructure.

The promotion of export agriculture (cotton, groundnuts, tobacco) in response to demand from the industrialised countries was based on land-surplus economies with a need to finance government and administration. Response was buoyant as rural people needed money for taxes and consumption. Governments installed infrastructure, financed research on new varieties, set up agricultural extension services and facilitated processing plants. But economic power became concentrated in urbanising coastal

regions. Colonial sea-borne trade promoted such coastal capitals and marginalised many African drylands, where investments were focused on their exports rather than on their social development. As a result, despite producing agricultural exports, many African drylands became politically marginalised.

After peaking in the 1960s (the Independence decade), these state-driven systems lost competitiveness owing to volatile world prices, crop disease, agricultural subsidies in western countries, the diversion of export earnings into urban and sometimes politicised investments, and over-extended public finances. Aspects of this basically African model also apply in Central Asia (where the drylands exchanged a pivotal role in east-west trade for a subsidiary status to the industrialising economies of China and the then Union of Soviet Socialist Republics (USSR) and other dryland regions.

From the 1980s, the colonial legacy of export agriculture was replaced with structural adjustment policies which included the devaluation of currencies, the withdrawal of the state from supporting the agricultural sector, and a decline in donor interest in agriculture. In time, there came a transformation of the market landscape, with a rapid diminution in freely accessible arable and grazing land, rapidly growing urban demand for food crops and meat, and the appearance of new product, service and niche markets. These included new urban commodity markets, export niche markets, expanding livestock markets, biofuel markets, supporting factor markets (land, labour, inputs, services, knowledge), and PES such as carbon sequestration. These markets are being driven both by internal forces, and by global changes that are offering new markets for dryland products and services in the sections which follow.

3.2.3 Cities and people

Continuing growth in the demand for food commodities is driven by population increases at rates of up to 3% a year in some dryland countries,.. In sub-Saharan Africa (including many drylands), agricultural growth was nearly 4% a year between 2001 and 2005, but only 1.5% on a per capita basis (World Bank 2007). Many producers are also purchasers of food staples, especially when droughts reduce agricultural yields in drylands, and short-term price fluctuations imperil their food security. But imports of staple food commodities—which run at about $20 billion in sub-Saharan Africa—reduce the competitiveness of local producers. If such demand were to shift to local suppliers, it could drive investment in domestic production even if there were no export markets. Since (in most countries) virtually all arable land is now appropriated, increased demand cannot be met in the long run by extending cultivation; it calls for sustainable intensification, and that requires investment.

3.2.4 Micro-investments

Too often neglected in reviews and analyses, private smallholder investments, while small in scale, have incremental benefits for assets and longer-term continuity as project interventions come and go. They are carried out within a livelihood framework, in which productive goals have to compete with health, education and many other priorities for resources. Thus, they are difficult to deal with in an economic analysis. Many are created by family labour and skills and are not priced in financial terms. Micro-investments are made across a range of natural resource-based activities, but the three considered below are: (1) landscapes of agricultural intensification; (2) tree management; and (3) pastoral specialisation.

a. Landscapes of agricultural intensification.

Recent studies show that the long-term investment strategies of small-scale farmers have gradually transformed some densely populated farming landscapes. Finance, where necessary, may be sourced from off-farm incomes, as well as from agricultural profits. It is highly significant that many of their strategies are designed to conserve the productive capacity of their land, rather than 'mining' it.

Landscape transformation is an indicator of agricultural intensification when it is based on increased inputs of labour, local knowledge, efficient nutrient cycling, and the use of organic inputs in combination with an affordable minimum of chemical fertilisers. Such landscapes are spreading rapidly outwards from their original nuclei (often in the vicinity of towns), driven by growing rural populations, new and growing urban markets, and increasing demand for, and values of, cultivable land and multi-purpose trees. In northern Nigeria and southern Niger, such market expansion has been found to have a beneficial impact on the ecosystems, pushing them towards more sustainable trajectories, in contrast to the wilderness of soil degradation predicted in some scenarios (Ariyo *et al.* 2001; Mustapha and Meager 2000). A recurring theme in analyses of intensifying systems is the diversity of livelihood circumstances and priorities, which cautions against generalisation.

b. Tree management

The major use of wood in drylands is for fuel, followed by construction and craft timber. Because natural woodland is often viewed as an open access resource, cutting wood for fuel has been blamed for deforestation. Yet this is only partly true. Contrary to claims of extensive treeless 'deserts' appearing in the vicinity of wood fuel markets, the value of multipurpose trees to their owners normally results in their protection and the displacement of commercial wood fuel demand to areas of easily accessible woodland (up to 200 km away in the hinterland of Kano, for example) (Cline-Cole *et al*. 1990).

Not often treated as capital assets by analysts, trees are a form of investment on farmers' fields and around houses as they can generate income from non-timber forest products (NTFPs) such as food (edible leaves or fruit), fodder, medicines, fibre or construction materials. The production of most NTFPs is poorly documented. Gum production (especially Gum Arabic, derived from *Acacia Senegal*) is better recorded than most as it enters international trade. In the Sudan (the world's major exporter), producers stand to gain most of its market value in profits because it is obtained from naturally regenerating trees on fallow fields; although transport to ports from inland locations reduces net returns. In another exporting country, Ethiopia, gum collection and sale are important to producers' livelihoods. While tree planting may be a sound investment, naturally regenerating trees also have asset value. However, planted or regenerating seedlings must be protected from free-ranging livestock, so they do have costs.

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Box 8. Estimated value of non-timber forest products in Senegal

In the Kolda and Tambacounda regions of Senegal, the sales of NTFPs like harvested fruit, leaves, seeds, gum, roots, bark and honey were worth US$2 million in 2000. The value added along the supply chain averaged 48%; the value added to game byproducts reached 63% (Ba *et al.* 2006). Extrapolated to national level, including value added to urban markets, a median estimate of the annual economic contribution of NTFPs was US$6.3 million. This is equivalent to an addition of 14% to conventional estimates of value added in the forest sector (timber, wood fuel and charcoal).

In addition, based on studies in two of the three major river basins, freshwater fisheries were estimated to be worth US$14.5–19.6 million in value added in the country as a whole. These values were 19–26% of the value of marine fisheries, the primary sector by value in the Senegalese economy. If recent movements in the value of the US dollar are taken into account, the national estimates increase to US$8.4 million for NTFPs and US$19–26 million for freshwater fisheries. In summary, between US$19 and US$35 million of value added from wild products is currently excluded from national accounts. At a minimum, this would represent 10% of the annual GDP recorded for Senegal.

Source: Mortimore *et al.* 2009.

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On the basis of observations in West Africa, it can be hypothesised that when timber and NTFPs acquire high value (following deforestation for farming), it will be worthwhile to protect naturally regenerating trees or to plant exotics (such as fruit trees) as a means of increasing the value of output per hectare on private land. This outcome has been recorded in regions with densely populated farmland (Cline-Cole *et al*. 1990). Recently, improvements in the security of tenure, together with market attractions and, perhaps, discouraging crop yields from farms, have sparked off a wave of tree protection projects claimed to extend to 5 million ha and 4.5 million people in southern Niger (Olsson *et al.* 2005).

(1) Pastoralism is fundamental to the well-being of millions of dryland people. Pastoral production systems are labour-intensive and involve the investment of human and social capital in institutions and local knowledge and on caring for each individual cow and her progeny. Grazing systems balance fodder and management. For example, the WoDaaBe cattle herders of Niger practise intensive breeding based on deep water availability with the capacity of animals to undertake often arduous daily journeys. It has been shown that such systems, despite the hardships imposed on their users, are more efficient in their use of natural resources than alternatives. Given the low cost of inputs in rangeland systems (compared to farming), this suggests that economic returns for some livestock investments can be high (Gabre-Madhin and Haggblade 2004). Another indicator is the value of market sales of livestock products and services, which include dairy products, meat, hides/skins and wool. In Kenya, a pilot project in Isiolo District implemented with a government investment of Kshs. 2.5 million resulted in earnings of Kshs. 18 million from livestock marketing (Reij and Steeds 2003).

Livestock products marketing and, therefore, the return to investment is linked not only with prices and access to markets (in a simple capitalist equation), but also with political and institutional changes affecting range management which may conflict with the interests of livestock keepers and the rationality of their mobile systems.). The difference from farm investments arises from a necessity of mobility in arid regions in order to take advantage of spatial and temporal variability in range quality. Investment for mobile pastoralists must, therefore, focus on stock, tools and breeding, rather than land *per se.*

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Box 9. Marketing livestock products on the Tibetan Plateau

Despite increasing needs for cash, and growing market integration, since the advent of an open market system in the 1990s, herders of the Tibetan Plateau still orientate their management to subsistence. The level of market participation depends on available surpluses and the accessibility of markets. There is a strongly seasonal pattern in marketing: in summer, they sell cashmere, hair and wool to buy domestic items and food if needed; in autumn, they sell animals or meat, dairy, skins and dung in order to buy imported food for the winter. Health needs, new taxes and technical innovations (such as solar panels) generate an increasing need for cash. But problems of access and seasonality tend to turn the terms of trade against the herders, and they are vulnerable to external forces such as price fluctuations, poor transport networks and inadequate information.

Source: Nori 2004

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Micro-investments for landscape transformation over a long period of time may not be sufficient to meet growing expectations of rising populations for income growth. However, rather than discarding this route, it would be wiser in the long run to aim to enable a largely endogenous investment stream to perform efficiently in achieving sustainable growth. Rangelands, in terms of technical potential, may be able to take advantage of carbon markets through micro-investments. These potentials are discussed on p. 61.

3.2.5 Successful interventions

Evidence from India and China indicates that economic rates of return to public investments may be higher in rain-fed dryland regions than in irrigated and more humid regions. In India, rural districts were classified into predominantly irrigated or rain-fed, and the rain-fed areas were subdivided into agro-ecological zones, including semi-arid. Five categories of public investment were analysed: high yield crops, rural roads, canal irrigation, electricity provision and education. There is considerable variability among the rain-fed zones, but in roads, electricity and education, the semi-arid zones performed better, on average, than the irrigated areas, and the investments had a greater impact in reducing the number of poor people. Comparable results were obtained in China (Fan *et al.* 2000). However, in remote places where population densities are low, services cost more to deliver per capita and returns may be expected to be lower.

Satisfactory economic rates of return (12–40%) have been cited for a number of projects, including soil and water conservation (Niger), farmer-managed irrigation (Mali), forest management (Tanzania), and farmer-to-farmer extension (Ethiopia) (Reij and Steeds 2003). Returns of over 40% are on record for small-scale, valley bottom irrigation in northern Nigeria and Niger. Where financial data are not available, the impact of project interventions can be evaluated from uptake, especially in the post-project period. Such evaluations are infrequent, however. These examples draw attention to a need for better *ex-post* monitoring of projects.

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Box 10. Investment in risk management as an approach to emergency response is producing posyive results

Investment in shifting from post-disaster relief to risk management as an approach to emergency response has shown success in Ethiopia. With the support of World Food Programme (WFP) and the World Bank, the Ethiopian government implemented the first index-based national disaster insurance. The mechanism targeted 5 million people who face food insecurity risk when drought strikes, but are usually able to sustain themselves under normal weather conditions. Those that are seasonally food-insecure risk becoming chronically food-insecure if they do not receive timely support during drought conditions as they are forced to resort to negative coping strategies, such as the sale of productive assets. Drought index insurance that releases adequate funds on time is, therefore, of great importance.

A Paris-based reinsurer, AXA Re-insurance, used a sophisticated index based on Ethiopia's historical rainfall data, agricultural output and a crop-water balance model, created by WFP and the company, to determine payouts. The Ethiopia Agricultural Drought Index had a correlation of about 80% with the number of food aid beneficiaries between 1994 and 2004. Analysis of the historical data revealed a 1:20 probability of catastrophic drought in Ethiopia, as occurred in 1965, 1984 and 2002. During the main crop season (the *Meher*), weather stations measured normal rainfalls, supported by remote sensing and field observations of rain and crop growth patterns. There was no payout in the pilot year, owing to favourable weather conditions.

The pilot revealed that:

- it is feasible to use market mechanisms to finance drought risk in Ethiopia;
- it is possible to develop transparent, timely and accurate indices for triggering drought-related emergency funding; and

- the time is right for facilitating predictable *ex-ante* resources that allow governments to put contingency plans in place, which, in turn, permit earlier and more productive response to shocks, i.e. managing risk rather than managing crisis.

Source: Hess, Wiseman and Robertson 2006.

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3.2.6 Incentives do work

The evidence on natural resource management accords a critical role to policy. Market incentives build on the fact that dryland people attach much importance to market participation. For most, the risks associated with isolation from markets (cash and food scarcity, unemployment, knowledge deprivation) now outweigh the risks of closer involvement (for example, dependence on highly priced food in times of scarcity). Closer involvement is seen to have many benefits: sales of produce; supplies of food and consumables, inputs and technologies; labour exchange; information; education-based careers; remittances; and investment funds.

Policies to promote dryland investment face a major challenge in the form of high perceived levels of risk. The biggest source of risk is a variable climate, which may directly cause losses of livestock or crops from droughts or floods, with ramifications throughout the local economy in marketing, whose profitability must ultimately justify private investments. In India, a private sector crop-buying company provides incentives through the e-Choupal system. Drylands in poor countries suffer from an absence of financial insurance mechanisms to build on the often inadequate provision for food storage, harvesting wild nature, and social claims inherited from past generations.

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Box 11. e-Choupal crop buying in India

One of India's leading private companies with interests in agribusiness and packaged foods (ITC), designed the e-Choupal system to address inefficiencies in grain purchasing in the government-mandated marketplaces—known as 'mandis'—in several states.

"Traders, who act as purchasing agents for buyers, control market information and are well-positioned to exploit both farmers and buyers…. Farmers have only an approximate idea of price trends and have to accept the price offered them at auctions on the day they bring their grain to market…. The approach of ITC has been to place computers with Internet access in farming villages, carefully selecting a respected local farmer as its host. Each e-Choupal ['gathering place'] is located so that it can serve about 600 farmers. . . Farmers can use the computer to access daily closing prices, as well as to track global price trends or find information about new farming techniques [or] to order seeds, fertilizer, and consumer goods from ITC or its partners, at prices lower than those available from village traders. At harvest time, ITC offers to buy crops directly from any farmer at the previous day's market closing price; if the farmer accepts, he transports his crop to an ITC processing center, where the crop is weighed electronically and assessed for quality. The farmer is then paid for the crop and given a transport fee.

Compared to the mandi system, farmers benefit from more accurate weighing, faster processing time, prompt payment, and access to a wide range of price and market information. Farmers selling directly to ITC. . . typically receive a price about US$6 per ton higher for their crops, as well as lower prices for inputs and other goods, and a sense of empowerment. [In 2004], e-Choupal services reached more than 3.5 million farmers in over 30,000 villages."

Source: Annamalai and Rao cited in WRI 2005:102-3

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Pricing policies can influence producers in dryland countries as they can in more humid areas, but dryland people have fewer alternatives if a mistake is made. West Africa provides examples. Open-door import policies in the 1970s'encouraged the dumping of grain and meat produced under subsidy in Europe or the USA. In Senegal, the French colonial government, followed by its independent successor, implemented a policy to subsidise imported rice which drove farmers away from cereal production for the domestic market and into groundnut production for export. Profits were invested in livestock and urban real estate, and this trend was accentuated after the collapse of this agrarian policy in the 1980s, with the withdrawal of input subsidies, credit and the devaluation of the over-valued currency in 1994 (Faye 2008; Faye *et al.* 2001). In Nigeria, following two decades of agricultural stagnation, the adoption of structural adjustment policies, together with the release of research-based maize varieties and subsidised fertilisers, led to a three-fold increase in maize production between 1984 and 1988, and upward trends in millet, sorghum and rice (Mortimore 2005).

Alternatively, policy can work through enabling incentives. These cost government very little: they are embedded in the policy framework which is configured by the political process and institutions. Among the critical institutions whose relevance is clear from experience are: land tenure, common pool resources, credit institutions, decentralised government services, and research and extension systems. The scope for influencing investment depends on the architecture of a particular country's institutions, for, as we have stressed, dryland countries are not all the same.

Poor dryland producers are not necessarily too poor to invest human and social capital (labour, skills, knowledge, local institutions) and savings in the long-term. Small-scale private investments were key to each of the landscape investment stories, even where public sector investment also played a role. The context of the decisions of small investors is critical. There are opportunities and constraints facing the individual investor that reflect the enabling incentives present in the economic environment, macroeconomic policies and the risk of external shocks such as drought. Resources are allocated to meet livelihood objectives (which include other elements besides agriculture), taking account of the costs and expected benefits (for example, to present or future income, leisure and inheritance). Many considerations, in addition to financial returns, have a bearing on these decisions. Among them are consumption requirements, social obligations and off-farm income opportunities. Many constraints, however, impede investment, including risk, lack of funds, soil infertility and ignorance of markets or off-farm alternatives. Thus, natural resources are embedded in a livelihood investment framework.

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Box 12. Smallholder investments in Kenya

Smallholder farmers make investments in their land which often go unrecognised. A study of landscape management in the Machakos/Makueni Districts of Kenya from 1930 to 1990 found the following investments were made by virtually all farmers:

- Clearance and enclosure of farmland.
- Improved management of enclosed pastures.
- Building of soil and water conservation structures.
- Adoption of new technologies.
- Integration of crop and livestock production.
- Planting and protecting economic trees on farms.

- Purchase of organic and inorganic fertilisers.
- Purchase of improved seeds.
- Erection of grain stores, poultry houses and livestock *bomas.*
- Acquisition and hire of farm transport vehicles.
- Building, improving and extending farmhouses.
- Purchase of animals, equipment, immunisation and salt cures.

These findings counter oft-repeated assumptions that smallholders do not invest in their land.

Source: Tiffen et al. 1994

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3.2.7 Commercial investments can pay through value chains

A benefit of globalisation is improved access to markets in industrial-urban economies for high value dryland products. Some of these niches have been opened up through innovative collaborations between governments, communities and NGOs, as well as commercial interests. Green, organic and fair trade products can exploit growing minority preferences in sophisticated markets where a premium is willingly paid by consumers who are committed to contributing two the twin goals of environmental sustainability and poverty reduction. 'Green economy' industries, such as solar power generation, and also service provision, such as in agriculture and animal production, provide additional new or potential investment opportunities. This growing sector is very place- and niche-specific.

For every marketed commodity there is a value chain linking producers with end-users through intermediaries. At each stage, value is added, so that the interests of producers are served by efficiency gains through competition or regulation. Conversely, market failures (such as monopolies, illegal rent-seeking, excessive taxation, or withholding fair prices from women) inflate end-user prices or deflate producer prices. Along these chains, therefore, are found the opportunities to regulate or intervene in support of poor producers of crops, livestock, natural products or other goods (WRI 2005). For example, emergency relief interventions can be designed in terms of a model of the value chain seen as embedded between environmental factors on the one hand (such as weather, taxation) and internal services on the other (such as transport, credit) (Jaspars 2009). The form such a model takes is specific to a particular time and place.

Fair trade and organic certification initiatives are intended to increase producers' gains on internationally traded products. Value chains are changing rapidly, especially at the international level, and are a key entry point for development (Vermeulen *et al.* 2008).

In summation, these seven reasons for investing in drylands have pointed to a multiplicity of actors, drivers and opportunities. We now take a closer look at these opportunities in responding to the question, 'What investments?'

3.3 Types of investments

In the preceding section, we have explored the questions 'who invests?' and 'why invest?' To provide an answer to the question 'what investments?', it is taken as given that investment will be the key to human and economic development, sustainable ecosystem management, and adaptive capacity. A summary typology of investment opportunities is needed, and this is provided in Table 6.

The typology covers four categories of investor: the public sector (governments, with donors), the large-scale commercial sector, the community and NGO sector, and individual small-scale investors. The last three are conceived as operationally separate, providing greater clarity than the common practice of grouping them together. The typology includes both existing and new opportunities, but they are not all of equal importance and the table is a preliminary assessment only—it is not possible in the confines of this report to provide details of every opportunity available. A critical mix of investment opportunities for a particular environment will be configured in a specific way. Without embarking on a discussion of every cell, some key opportunities are highlighted, and one of these, PES (which includes carbon markets), is currently being advocated as a 'win-win' strategy and is fully discussed in the next section of this chapter.

An analytical breakdown of 'investment' reveals considerable complexity. More is added when distinctions are made between financial, human, social, natural (including land) and physical (including improvements, or 'landesque' capital) investments (Berry *et al.* 2003). In the table, some key areas which are attracting investors' attention, or have major potential, are shown in bold italics. This is not a summary of development strategies as such, but a pointer towards dryland-specific investment opportunities for four groups of actors: the public sector, the private commercial (large-scale) sector, the community sector, and the household or small-scale private sector. The typology is expected to be incomplete. The investment areas identified are subjective and may overlap.

[position of Table]

Table6. Overview of investments in drylands

Investment areas in:	**Public sector (government, donors)**	**Commercial sector, large-scale**	**Community sector, NGOs**	**Household or small-scale sector**
1 Communications	***Transport infrastructure*** System regulation Telephones (landlines)	Transport companies ***Mobile phones***	Community-based contributions to accessibility	***Investment in carts, animals, phones***
2 Renewable energy	Electric power supply infrastructure Fuel-efficient cooking/heating technologies Solar and wind technologies	Public-private distribution systems Biofuels Hydroenergy	Cost-sharing power supply Biomass generation schemes	Uptake of fuel-efficient technologies, biomass, wind, solar
3 Education	***Schools infrastructure and management*** Vocational training provision Regulation of private provision	Private schools and pre-schools provision Business schools and other training schemes Private higher education	***Local schools and nurseries***	School fees and materials
4 Health	Hospitals infrastructure and management ***Preventive healthcare provision*** Regulation of private provision	Private health care provision	***Community-based health workers*** Health access costs	Medicines, medical advice

5 Water	***Water legislation to cover access*** Storage and distribution infrastructure Drainage and sewerage provision ***Forecasting, Early Warning Systems (EWS)***	Private distribution companies Dams, irrigation schemes	Local well/borehole/pump maintenance ***Community-based water sharing and infrastructure***	***Surface water management structures on private land***
6a Farmland	***Tenure law/reform*** **Access regulation for corporations, entrepreneurs, foreign interests for large scale farming e.g. biofuels** Market regulation Promotion of soil and water and biodiversity conservation	Large-scale farming, e.g biofuels, food commodities ***Agro-service provision***	Collaborative farm labour institutions ***Land use by-laws*** Advocacy groups	Labour hiring ***Soil fertilisation, sustainable land management(SLM),*** soil and water conservation Fencing, storage and other micro-investments (Box on Smallholder investments in Kenya)
6b Rangeland, livestock	***Tenure law/ reform*** ***Access regulation, reserves*** Conservation Animal health provision Water provision ***Market/movement*** regulation	Ranching ***Animal health provision*** Livestock marketing and transport	Livestock manuring and grazing contracts Enforcement of local grazing rights and cattle tracks ***Community-based livestock management***, water, health, grazing cooperation	Breeding and marketing animals Labour hiring Fencing, draining, improving private pastures

6c Woodland and trees	***Access regulation, reserves*** Protection, biodiversity, conservation	Sustainable plantations	Enforcement of local by-laws and rights to tree products Biodiversity conservation	Planting and protecting trees on-farm Managing useful biodiversity ***NTFP development***
7 Land use	***Strategy for PES, carbon etc.*** Regulation	***Execution of PES, carbon schemes***	***Local by-laws,*** land use plans, regulations, grazing control	***Provision of land for PES, Carbon, woodlots, new market crops, etc.***
8 Conservation and tourism	Gazetting of conservation areas and management, infrastructure Access provision Tourist services regulation	Licensed conservation in reserves? Management of tourist facilities	***Community-based wildlife management, harvesting and profit sharing***	Excluded
9 Urban development	Town planning and regulation Access legislation Market regulation ***Urban services***	Housing and commercial real estate	***Urban community*** management, services	Investment in built properties, vacant land, enlargements
10 Markets	Supervision of pricing, regulation, infrastructure	Commercially managed commodity markets	***Producer organizations***	Participation in selling in community, local, or distant markets
11 Innovation	Research ***Knowledge banking and communication*** Extension systems, service provision	***Participation/sponsorship of commercially attractive research*** ***Service provision (demand-led knowledge, inputs, marketing)***	***Community participation in research agenda-setting and field trials*** Community-based service provision	Protection, use and transmission of local knowledge ***Access to new***

	Public-private partnerships		(demand-led knowledge, inputs, marketing) Skill sharing	***knowledge***
12 Risk management	***Famine Early Warning System (FEWS)*** ***Seasonal weather forecasting*** ***Insurance*** ***Safety nets*** ***Hazard preparedness***	Insurance	Community-based credit and support through social capital institutions and capacities	

This is not a summary of development strategies as such, but a pointer towards dryland-specific investment opportunities for four groups of actors: the public sector, the private commercial (large-scale) sector, the community sector, and the household or small-scale private sector. The typology is expected to be incomplete. The investment areas identified are subjective and may overlap.Table 6 shows that:

- for almost every investment area there are multiple opportunities for different actors, although in a given situation, not all will apply;
- the resulting matrix offers collaborative possibilities between actors (for an example of this principle, see Box X);
- and drylands need not continue to be 'investment deserts'.

Some of these potential investments are already highly interesting to potential investors, and to the UN system in terms of their opportunities for sustainable development.

3.4 Renewable energy

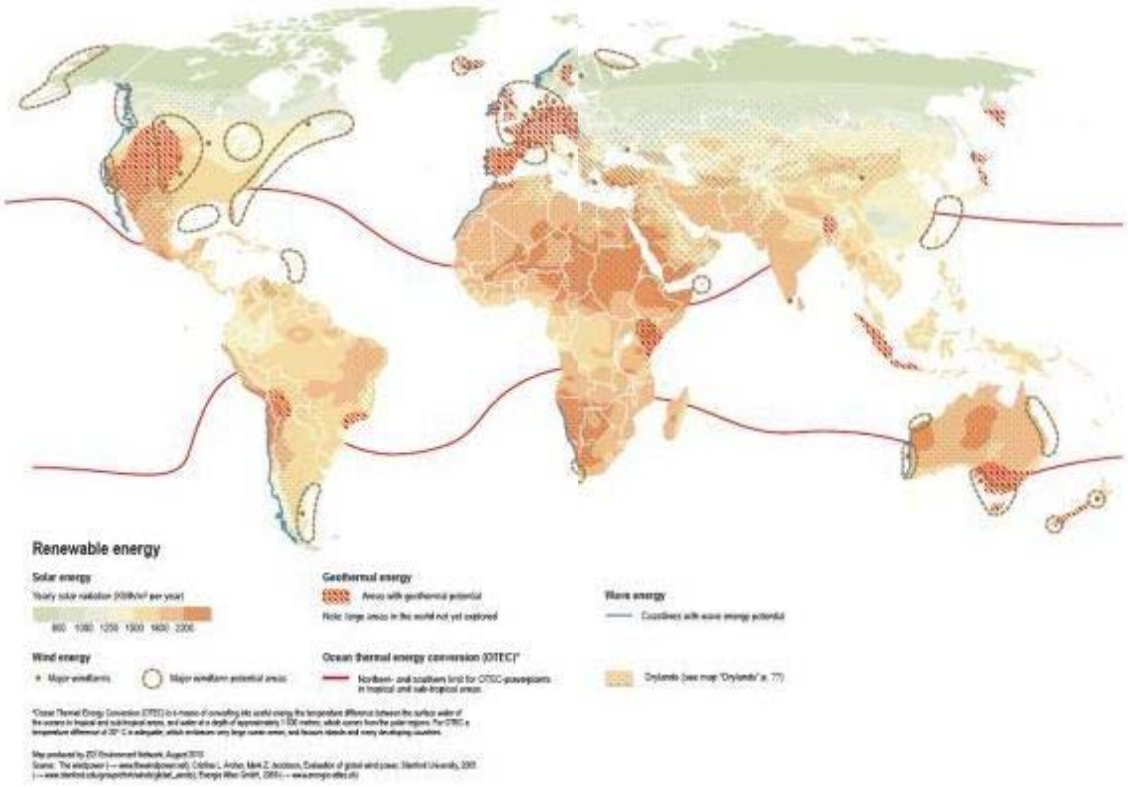
There is much interest in investing in renewable energy. Solar, wind and bioenergy projects have been undertaken in many dryland areas, and opportunities still exist. Jacobson and Delucchi (2009) recently argued that, with a correct set of policies and measures, it is possible for countries to set a goal of generating 25% of their energy supply with wind, water and sunlight sources within 10 to 15 years, and almost 100% of supply within 20 to 30 years. Bioenergy and wind turbines form the largest part of the current renewable energy technologies suitable for drylands. A recent wind turbine project in Kenya is to be, in part, financed by the Spanish Government, as well as promising to attract more investment, and will provide up to 30% of Kenya's current installed power. However, all renewable energy projects require land, which may lead to land use conflicts, as well as environmental (such as bird collisions on wind turbines) and social consequences.

Current unsustainable energy use and climate change concerns from resulting greenhouse gas (GHG) emissions have revitalised the move towards 'green or low carbon' development which has been on the horizon since the 1970s.Although still a minority element of energy consumption, renewable energies are increasing (UNEP 2009).

Alongside this, there is a push towards using ecosystems in adaptation and mitigation of climate change as it is being recognised that ecosystem services are irreplaceable and their protection often provides win-win solutions (Campbell *et al.* 2009; CBD 2009; Trumper *et al.* 2009). For instance, the role of forests in removing carbon dioxide from the atmosphere and, hence, in mitigating climate change, has been recognised within the UN Framework Convention on Climate Change (UNFCCC). These two aspects of the current trend towards greener development are raising new opportunities in terms of sustainable development, environmental protection and poverty alleviation.

Opportunities for the drylands arise from the creation of renewable energy and subsequent investments, as well as the revenue and environmental and social benefits generated by the carbon market and emerging PES.

Figure 9. Renewable energy



Source: ?

Support for renewable energy and shifting investment patterns (from donor sources to private investment) are creating opportunities in the renewable energy market in a number of nations, including developing countries

(Martinot *et al.* 2002). There are examples of such markets involving an array of investors from private dealers and rural entrepreneurs to small and large companies.

The key markets for renewable energy are: localised individual and private use; large-scale and private use; industrial, agricultural and transportation use. The renewable energies that offer the most potential in the drylands are biomass (which may not be the most easily accessed or sustainable option), solar and wind energy.

3.4.1 Solar energy

There exist different types of solar energy (Tsoutos *et al.* 2005); of most interest to the drylands are photovoltaic (PV) power generation and solar thermal electricity. Power generation through PV can be attractive to households and businesses alike, and has been shown to be a successful market in many countries such as India, China, Kenya, Mexico and South Africa (Martinot *et al.* 2002). Furthermore, the use of PV can provide economic growth, stable livelihoods and even better health, through for example, reduced local air pollution which comes from kerosene lamps, and also the fire risk from lamps being knocked over, for those involved (IEA 2008).

There are examples of successful businesses employing solar power, although experience has been mixed, especially in the use of PV for powering water pumping, either for agriculture or for drinking water. Indeed, experience shows that PV power is often abandoned due to poor maintenance and lack of technical expertise (Martinot *et al.* 2002; IEA 2008). Currently, grid-based solar power is not widely undertaken. Reasons for this vary, but may include the limits of the technology and environmental risks. The potential negative impacts of solar technologies are the need for land, degradation of fragile ecosystems, strain on water resources, and pollution sources (Tsoutsos *et al.* 2005).

3.4.2 Wind energy

Windfarms need to be on open, exposed areas with high average wind speeds (at least 20 km/h). However, they do have a greater capacity to provide energy on a large-scale than current solar power technologies; as a result, the use of wind power is growing rapidly (DeCarolis and Keith 2006). There is great potential for the application of large-scale wind power in the drylands, with some countries, such as Kenya, planning large-scale construction. The International Institute for Sustainable Development (IISD) recently conducted an assessment of the potential to invest in wind energy in Egypt—a fossil fuel-producing country (Elsobki *et al.* 2009). They found that the principle barrier to large-scale implementation of wind power was the low price paid for wind–generated energy. Future investment, therefore, depends on the market for renewable energy, which is currently most promising in countries that do not contain major fossil fuel reservoirs; in the future, the market for renewable energy in fossil fuel-producing countries may also pick up as resources become depleted.

Moreover, there are concerns surrounding the intermittency of power generation and the spatial distribution of applicable sites relative to areas where provision is needed—these factors are likely to increase the cost of electricity provided by large-scale enterprises (DeCarolis and Keith 2006). Environmental impacts of concern include the possibility of bird collisions, especially along migratory routes. However, the debate on the environmental impacts of wind energy is ongoing as European countries, such as Germany and The Netherlands, have not suffered on a scale to warrant major concern.

Provision of electricity, especially to areas where there is not a steady supply, can be a lucrative investment, and the use of renewable energy makes the provision sustainable and attractive to carbon-conscious investors. The economic benefits of increasing renewable energy depend on it being provided to areas where economic development is strong, or is developing, although welfare and quality of life benefits are felt wherever it is used

(Martinoz *et al.* 2002). High transaction costs and technical capacity for the technology can be a problem, limiting the investments. But with careful assessment of the relative options, along with the context, green energy can be an investment potential for the drylands.

3.5 Carbon market opportunities and constraints for drylands

The Clean Development Mechanism (CDM) is a market-based flexibility mechanism of the Kyoto Protocol which allows project participants to implement emission reduction projects in non-Annex I (developing) countries. The CDM has stringent rules and regulations. All projects must utilise specific baselines and monitoring methodologies approved by the CDM executive board. The majority of projects are renewable energy projects (60%); in contrast, afforestation/reforestation projects currently form only 1% of CDM projects (Seeberg-Elverfeldt 2010), mainly due to the restrictions imposed, for example, on the eligibility of land. While bureaucracy might be may be unavoidablein any regulation-based mechanism, an important cause for slow moving projects and processes is the complexity involved in the measurement and monitoring of carbon stock changes in the various pools (above-ground biomass, below-ground biomass, dead wood, litter and soil organic carbon). These measurements are the very basis of CDM projects and, hence, methodologies regulating these measurements cannot be anything but rigorous (Tipper 2009).

In the drylands, the number of CDM projects is limited, but include methane capture and waste management, and renewable energy. Some projects also engender social and other environmental benefits in the country where the project is underway, especially when linked with the voluntary carbon market. One CDM A/R project in Albania (Albania 2005) aims to revitalise degraded pasture by assisted natural regeneration, resulting in increased soil stability, improved wildlife habitat, greater employment and increased natural resources.

Projects eligible under the CDM or Joint Implementation (JI) relevant to the context of dryland management are, *inter alia*, renewable energy projects, such as windfarms, waste management and biofuel production; and afforestation and reforestation projects. There are 15 sectoral scopes for projects. The actual number of projects registered is large, and their diversity is considerable, with details available from the UNEP Riso website: www.cdmpipeline.org.

These markets are built on the fact that, on the one hand, there is a need to reduce atmospheric carbon, but on the other, there is still a need to undertake activities that emit carbon (the **concept of carbon offsetting**). The need to reduce emissions on a national level for signatories to the Kyoto Protocol created the **regulatory compliance market** which is used by companies and governments that, by law, have to account for, and contain, their emissions within given limits known as 'emission allowances' (Seeberg-Elverfeldt 2010). The compliance market is governed by strict rules and regulations and, as such, only a limited number of projects can be conducted. The project-based approach is a requirement under the CDM/JI, not a characteristic of the compliance market as a whole; for example, AAUs can be freely transferred/sold by one country/entity to another without any reference to a project.

Parallel to this, a **voluntary market** has also emerged. The voluntary carbon market offers a wider range of activities, but is driven by expectations of future regulatory requirements. Voluntary carbon credits are purchased by the private sector interested in increasing their corporate social responsibility and public relations. This market has increased, though land-based projects are still low compared with other projects (Hamilton *et al.* 2009). An important requirement of all carbon projects is that they be additional, permanent and avoid leakage.

These concepts stem from Clean Development Mechanism rules:

Additionality: (i) A non A/R CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity; (ii) An A/R CDM project activity is additional if the actual net greenhouse gas removals by sinks are increased above the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the registered A/R CDM project activity.

Non-permanence: For an A/R CDM project activity, the non-permanence of storage of carbon is addressed by: (a) issuance of temporary certified emission reductions (TCERs) for the net anthropogenic greenhouse gas removals by sinks achieved by the project activity since the project start; (b) issuance of long-term certified emission reductions (lCERs) for the net anthropogenic greenhouse gas removals by sinks achieved by the project activity during each verification period.

Leakage: For a non-A/R CDM project activity, leakage is the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary and which is attributable to the CDM project activity.

For an A/R CDM project activity, leakage is the increase in greenhouse gas emissions by sources which occurs outside the boundary of the A/R CDM project activity and which is attributable to the A/R CDM project activity.

Projects have to be monitored, reported and verified according to stringent rules. Costs of project: upfront costs, transaction costs (which are usually fixed) and monitoring costs are substantial and increase in relative terms for small projects due to large fixed transaction costs.

Carbon markets were created from the UNFCCC process and provide investment in projects that either reduce GHG emissions or remove carbon dioxide from the atmosphere.

Dryland carbon storage accounts for more than one third of the global stock, mainly due to the large surface area of drylands and long-term storage of the soil carbon (when not degraded), rather than due to vegetation cover. Drylands have the potential to sequester more carbon than currently stored as they are far from saturated (FAO/LEAD 2006). For example, a desert rehabilitation project in Israel (which included the establishment of dry forests, dune stabilisation, savannisation projects and rain-fed dryland agroforestry) increased the carbon stocks of the dryland .However, the capacity to store carbon will be dependent on myriad factors including climate, history, past land use, status and opportunity for management change (FAO 2009).

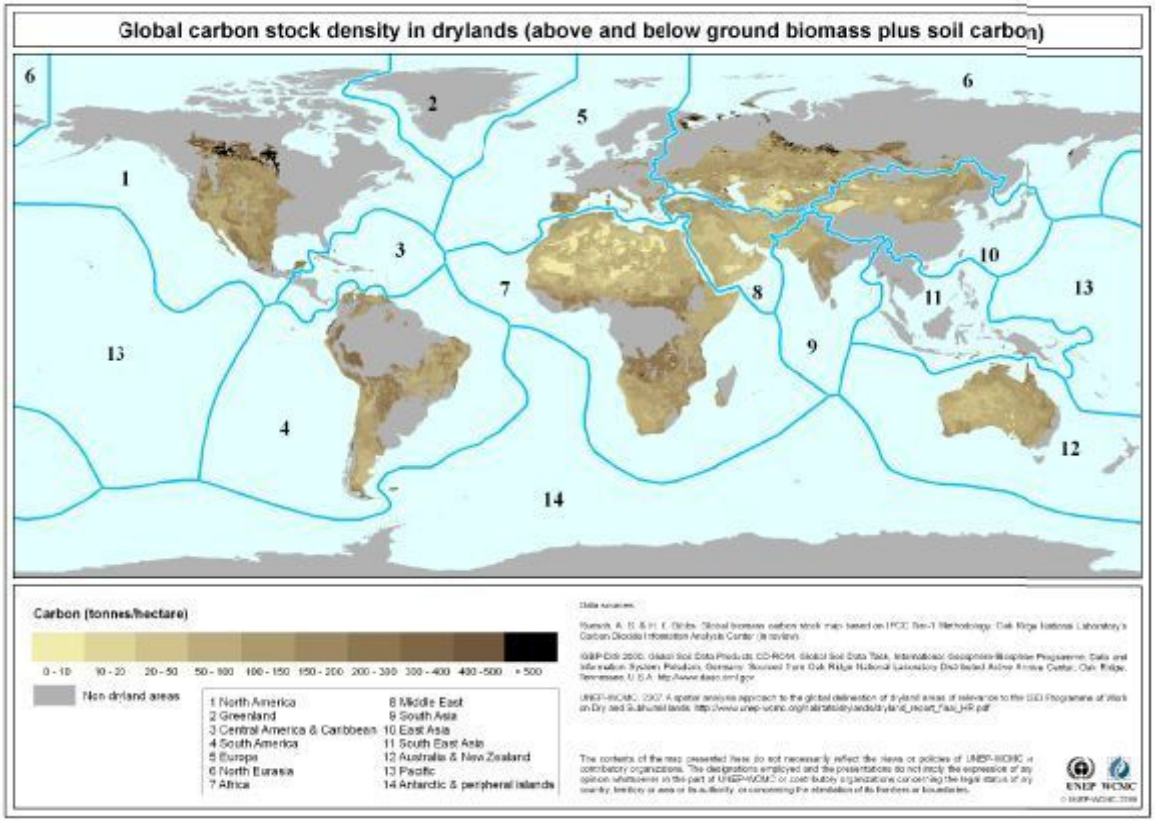
Table 7. Comparison of total and drylands carbon stocks in some regions of the world

Map number	Region	Total carbon stock per region (Gt)	Carbon stock in drylands (Gt)	Share of regional carbon stock held in drylands (%)
1	North America	388	121	31
2x	Greenland	5	0	0
3x	Central America and the Caribbean	16	1	7

4	South America	341	115	34
5x	Europe	100	18	18
6	North Eurasia	404	96	24
7	Africa	356	211	59
8	Middle East	44	41	94
9	South Asia	54	26	49
10	East Asia	124	41	33
11x	South East Asia	132	3	2
12	Australia/New Zealand	85	68	80
13x	Pacific	3	0	0
Total		**2053**	**743**	**36**

Source: Trumper *et al*. 2008

Figure 10. Map of carbon mass per hectare throughout the drylands



Source: Trumper *et al.* 2008

In the drylands, rainfall is low and evapotranspiration is high; the soils of drylands are characterised by frequent water stress, low organic matter content and low nutrient content (FAO 2004). The physical environment and certain management practices easily result in degradation. Carbon storage in drylands is affected by these bioclimatic elements and is slow. In areas of low rainfall, sequestration rates are low and, depending on the carbon price, growing trees for carbon may not be viable; in fact, this may be the case in other areas, not just where rainfall is low (Flugge and Abadi 2006).

3.5.1 Extending carbon markets to agriculture

The first Emission Reductions Purchase Agreement (ERPA) was recently signed, not only marking the first project that sells soil carbon credits in Africa, but also paving the way for a new approach to carbon accounting methodologies, which do not exist yet for this nascent area. This project illustrates concretely how carbon finance can support both the environment and generate revenues for local communities. Although the value of the ERPA

exceeds this, the direct benefit to communities is over US$350,000, with an initial payment of US$80,000 to be made in the first year (2011) based on project performance and payments for the sequestered carbon.

The Kenya Agricultural Carbon Project, implemented by the Swedish non-governmental organization Vi Agroforestry, is located on 45,000 ha in the Nyanza Province and Western Province of Kenya. There, smallholder farmers and small-scale business entrepreneurs are trained in diverse cropland management techniques such as covering crops, crop rotation, compost management and agroforestry. These practices increase the yield of the land and generate additional sources of income for the farmers through payment for environmental services in the form of carbon credits. The project, developed with the support of the Africa Region of the World Bank, generates carbon credits which are sold to the BioCarbon Fund. It allows smallholder farmers in Kenya to access the carbon market and receive carbon revenues through the adoption of productivity-enhancing practices and technologies.

The project is an example of a triple-win strategy: implementing policies and programmes that will, first, increase farm productivity and incomes; second, make agriculture more resilient to variations in climate, and thus promote stability and security; and, third, help make the agriculture sector part of the solution to the climate change problem, rather than part of the problem.

The approval of this first soil carbon project in Africa is an important step in extending carbon finance to include agriculture. The potential for carbon sequestration in the soil is estimated at 5.5 gigatons (Gt) annually with good land management practices, which is the equivalent to 13% of current emissions from all sectors. So soil carbon has a huge contribution to make in addressing the climate change challenge (Andrew Steer pers.comm.)).

The BioCarbon Fund is an initiative with public and private contributions, administered by the World Bank. It purchases emission reductions from afforestation and reforestation projects under the CDM, as well as from land use sector projects outside the CDM, such as initiatives that reduce emissions from deforestation and forest degradation, and increase carbon sequestration in soils through improved agricultural practices. In addition, the BioCarbon Fund, which was created to help open the carbon market, develops methodologies and tools that are in the public domain.

3.5.2 Markets and value chains in drylands

Fair trade and organic certification initiatives are intended to increase producers' gains on internationally traded products. Value chains are changing rapidly, especially at the international level, and are a key entry point for development (Vermeulen et al 2008).

[images of the Body Shop-type community projects, natural products, European consumers, etc]

3.6 Recapitalising the drylands: who benefits?

The desired outcomes specified in our Framework for Investing in Drylands are unsurprising, but are the necessary architecture of a future for drylands. At the centre is enhanced income for dryland populations (an economic benefit), leading to the following outcomes: (1) reinvestment, growth and more sustainable natural resource management (an economic-ecological pathway); and (2) enhanced well-being and security, and more demand for

services (an economic-social pathway). It is easy to specify these, but difficult to quantify and manipulate the linkages. That must be the aim of policy in the drylands.

Questions of distribution are intrinsic to any discussion of the benefits of investment. Not all dryland people are poor, marginalised or under-privileged. 'Trickle-down' effects have been adduced to ameliorate inequalities in benefits, particularly from public sector investments. On the other hand, policy incentives for small-scale private investments must be seen to work in terms of equitable benefits if their full potential is to be realised. Differentiation and social mobility within dryland societies are specific to time and place. Thus, in dryland India, for example, long-term improvements in average poverty indicators have accompanied persistent poverty.

Within any beneficiary population there are differentials between social groups based on gender, age, ethnicity or income. This is particularly relevant in view of the importance of using dryland investment to advance the MDGs. The case of women is instructive because the differential is not only in terms of the distribution of benefits from investment, but also in the nature of their participation in investment. Many small farmers in sub-Saharan Africa and South Asia are women, but a lot of agricultural interventions do not take that into account. Some field programmes aim to increase the productivity of crops without understanding that higher production can mean that women have to work longer and harder in the field, leaving them less time to care for their households; this can undermine the welfare of the household in general. But when a woman is paid cash for her work, she may be more likely than her husband to spend it on food and school fees for her children—both of which are consumption and investment in human capital. Many women manage their local natural resources and keep knowledge and expertise of indigenous production methods, plant species and their various uses, such as medicinal uses. However, women rarely own the land that they manage and, without assets, cannot access agricultural credit or extension services. Moreover, they may not participate fully in local decision-making processes, which limits their possibilities for improving their agricultural livelihoods, or adapting to change. While they may hold the key to environmental sustainability, food security and poverty reduction, their lack of capital restricts the materialisation of such potential. On the other hand, in many dryland societies, the participation of women in trade (often profitably) and in keeping livestock counters their marginalisation in agriculture.

3.7 The cost of inaction

The neglect of dryland people takes its costly toll through frequent relief efforts, for example, as the current Horn of Africa crisis shows. Leaving dryland people out of the development process is costly in economic terms, but even more so in terms of human suffering. An example from the drylands of north-eastern Brazil points to a way out of the neglect of drylands as a development priority. Here, the focus has been on developing high value produce for a very select market. This has turned out to be a commercial success and generated substantial income for farmers in these drylands. The investment period has been long and required considerable inputs, not least connecting the dryland areas and their farmers with credit institutions and market representatives. The advantage of this approach is that it offers an integrated framework in which the many dimensions of the dryland development problem can be logically related. Agency responses should thus be linked rather than fragmented. It is likely that different agencies see differing perspectives of the problem, reflecting their standpoints. A 'One UN' approach needs an integrated theoretical framework that accommodates diversity.

A final and compelling argument for promoting investments in drylands is the losses that will accrue to national economies from inaction on dryland degradation. Estimating these costs is not easy, but studies have been undertaken of three countries with extensive drylands: China, Ethiopia and Mexico (Berry *et al.* 2003).

3.7.1 China

According to the Government of China, over 40% of the land area is adversely affected by grassland degradation, the loss of soil fertility and the depletion of natural forest. This area increased from a rate of an additional 1,800 km^2 per year being degraded in the 1980s, to 3,436 km^2 per year being lost in the late 1990s. The most intensively affected areas are the Loess Plateau and the vast Western Region.

Official estimates of the costs of degradation for the country as a whole are US$7.7 billion in direct costs (such as loss of soil; nutrients, reservoir siltation, loss of labour through migration), which is about 4% of GDP, and US$31 billion in indirect costs. An alternative set of estimates divides the costs between on-site and off-site costs. The on-site costs (desertification, soil erosion, salinisation and pollution) are reported to be US$11 billion, with an additional US$6 billion for the replacement of lost nutrients (costs that are difficult to estimate); and the off-site costs (mainly the loss of reservoir functions) are estimated at US$12 billion. These approximations reflect both the uncertainties and the huge size of the territories and populations involved.

Investment in sustainable land management is around 0.08% of GDP. While the returns to farmer investment are high in the regions with greatest potential, drylands still need external investment. Total public sector investment increased in the 1990s from US$2.2 billion to US$6.5 billion, and investment in soil and water conservation has grown at a rate of 10% per year.

3.7.2 Ethiopia

Estimates of the losses due to land degradation are mostly confined to direct costs and are highly variable, reflecting the inadequacies of the data. A World Bank study in 1994 estimated yearly losses of US$106 million per year from nutrient removal through the erosion of cultivated land, US$23 million from forest losses, and US$10 million from the loss of livestock capacity; in total, this amounted to US$139 million or almost 4% of agricultural GDP. At the farm level, another study estimates the losses of nutrients under wheat to cost from US$46/ha to US$544/ha in grain output foregone, and those of maize, US$31–379. Applied to all cropland in the highlands, the total losses would be approximately US$1.7 billion. Indirect costs, such as the loss of environmental services, the silting of dams and rivers, increased irregularity in stream flow, reduced groundwater capacity, and the loss of labour and skills due to malnutrition, poverty or migration, are even more difficult to estimate.

By the mid-1980s, 50% of the highland areas of Ethiopia were estimated to be significantly eroded. Despite intensive activity by donors and government at this time, their investments had only impacted 1% of the highlands, and conservation structures imposed on local people were not well maintained. A strong association between land degradation and periodic food emergencies was apparently inescapable. However, recent studies of conservation landscapes in northern Ethiopia have demonstrated that, in some areas, small-scale private investment has been maintained over several decades, with the counter-intuitive implication that returns to micro-investments on farms are acceptable.The agricultural sector has achieved a measure of recovery thanks to changes in policies.

3.7.3 Mexico

A large part of Mexico, including some densely populated regions, is dryland. Nationally, land degradation impacts about 65% of this resource. It is estimated that losses of nutrients and productivity from farm and grazing land cost over US$2 billion per year, losses due to salinisation cost US$1 billion per year, and those of deforestation cost US$0.5 billion per year. These are direct costs. Environmental degradation, including pollution, soil erosion and deforestation, amounted to 13% of Ntaional Domestic Product (NDP) in 1992. Because laws governing access to

land favour large-scale commercial operators and smallholders lack the financial resources to invest in conservation (and if they do, investments do not produce economic returns owing to unfavourable pricing), , 0.7–0.9 million people migrate across the border to the USA every year. This and other indirect costs are difficult to evaluate.

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Drought and food crisis in the Horn of Africa

The failure of the past two rainy seasons in the Horn of Africa has seen harvests fail and livestock mortality soar, with the result that food prices have increased out of the reach of millions, by up to 240% in Eastern Kenya, Eastern Ethiopia and Southern Somalia. Malnutrition rates have risen to over 30% across the drought affected area and a famine has been declared in southern Somalia (European Commission, 2011). This crisis, affecting over 12 million people[6], is considered the worst drought to hit the region in the past 60 years and highlights the importance of continued investment in drylands.

While the region has always been subject to recurring droughts, these have increased in frequency in recent years, occurring in 2005, 2006, 2008 and 2011 (IFAD, 2011) and, although there remains debate within the scientific literature, there is evidence to suggest that climate change will cause a continuation of this trend (e.g. Williams and Funk, 2011). The impact of such droughts depends more than any external intervention on the strength of the farmers' and pastoralists' livelihood systems (FAO, 2011), and as such efforts to increase the resilience of local livelihood systems have great potential to reduce the scale of emergency response needed.

The link between short term relief and long term sustainability was highlighted by the UN Secretary General at an Emergency Ministerial Meeting on the Horn of Africa held in Rome on 25th July 2011: "responses – to the drought, and now the famine – must not only ensure that people are fed, but also encourage sustainable livelihoods and food and nutrition security, especially among pastoral people."[7] This echoes the twin-track approach proposed by the UN Comprehensive Framework for Action (UN, 2008), which aims to build longer term resilience, as well as meeting immediate basic needs, while addressing the issue of food security.

The good news is that decades of investments in the Horn of Africa, in the form of risk reduction strategies, formal and informal safety nets and humanitarian interventions, as well as a general move from disaster response towards a broader risk management strategy, have begun to reduce vulnerability and enhance capacity for disaster management. Assuming an adequate level of support, human deaths from starvation and disease are less likely now than 20 or 30 years ago (FAO, 2011). Initiatives which have increased resilience include IFAD's Pastoral Community Development Project, co-financed with the International Development Association, which has entered its second 5 year phase following the success of its first. This aims to improve the livelihoods of 600,000 pastoral and agro-pastoral households in Ethiopia, around 25 per cent of the total, by delivering basic social services, strengthening pastoralists' ability to withstand external shocks, reducing rural poverty and enhancing economic growth, and boosting the institutional capacity of pastoral community organizations and local governments.
The current crisis in the Horn of Africa serves to emphasise the need for continuing and increased support for initiatives promoting resilience in the region. Long-term investments offer the opportunity to support the population of the Horn of Africa to respond to drought: not only this time, but for the many droughts to come.

[6] as of 4th August 2011

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3.7.4 Implications of costs estimates

Notwithstanding the difficulties of estimation, it is clear that direct costs of land degradation are high both at the national and the farm levels, and that the inclusion of indirect costs may at least double the total costs to the economy. But "the responses appear to be an order of magnitude less than the economic impact of the problem" (Berry *et al.* 2003). A recent study approximated that the loss of agricultural productivity in the arid regions of Cameroon costs US$1–2 billion per year, and the cost of degrading watersheds is US$50–150 million per year. (Fomete in press). Scenarios of future losses vary according to their baseline and operational assumptions. The accuracy of these scenarios is less important than the stimulus provided by such estimates to formulate coherent strategies at national level to deal with land degradation.

In addition to the long-term costs of land degradation, governments of dryland countries and donors absorb the short-term costs of crisis management when food scarcities threaten large populations after drought or conflict. For example, humanitarian requirements for HoA for 2011 are estimated at $2.5 bn. There are no aggregate estimates of the total costs of the Sahel drought of the 1970s or the Ethiopian famine of the 1980s; emergencies absorb resources which could have been invested in longer-term development. If the costs of neglect are huge, so are the potential benefits of sustainable investments.

3.8 Conclusion

Drylands have special characteristics resulting from their ecology, their geopolitical situation with respect to the rest of the globe, and their cultural and economic inheritance. They also have special opportunities for investment, which are coming to the fore as globalisation continues. To make the most of these assets, and to rectify the neglect which has led to widespread poverty, a correct balance must be struck between public and private sector investment, with scope for strategies that are tailored for the diversity of conditions found.

Why has this potential for local, national, regional and global benefits not been realised before? Much of the answer to this question lies in myths, market failures, a lack of public goods (security, infrastructure, banking services, administrative services, educated workforce), weak incentives (or disincentives) and high costs transferred to the donor and/or investor (so that only highly lucrative investments in mineral extraction can be justified). Types of risks and costs faced in the drylands include tenure insecurity, conflict, variable weather, scarcity of human capital, and high transaction costs.

This chapter has argued that there are now good reasons for bringing investment to the drylands and realising the full potential of local investors. Above all, the revitalisation of drylands should benefit the poorest, and contribute to the achievement of the MDGs.

Chapter 4: Responding to the challenge—acting together

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The UNCCD's 10-year strategic plan is an important platform for galvanising common action to highlight drylands as indispensable, yet exhaustable, capital. Cooperation in the UN system regarding mainstreaming drylands and related issues of desertification, land degradation and drought can benefit from a structured approach along key institutional functions, with a clear understanding of the contributions and expectations from individual institutions. The process for strengthening international environmental governance has identified several key functions, four of which are of particular relevance for cooperation and acting together on drylands: strengthening the science-policy interface; advancing interlinkages and synergies in the implementation of the drylands agenda; identifying opportunities for integrating drylands targets into national development cooperation; and reviewing the effectiveness of achieving these targets. The UN community has devised a strategy around this approach.

As the previous chapters have illustrated, the challenges drylands face are complex. This calls for a coherent and holistic UN-wide response. First and foremost, the benefits of revitalised drylands should be equitable and targeted to support the poorest in society. A central element of the response to decreasing productivity and land degradation is sustainable land management. Another aspect is addressing the underlying causes of land degradation and the creation of conditions which enable sustainable land management to be effectively applied and therefore contribute to the sustainable development of drylands.

4.1 Strengthening the science-policy interface

Understanding the interactions between society and drylands, including desertification, land degradation and drought, requires data, expertise and knowledge from a wide range of disciplines. With its broad technical expertise, and tradition of collaboration with a wide range of partners, the UN system is well-placed to contribute to such an understanding. Efforts to keep the drylands agenda under review are, however, not confined to the technical level alone. The science and policy communities need to be well informed and this dialogue can be helped through a structured science-policy interface.

It should be stressed that policy-setting and implementation related to drylands and associated issues of desertification and land degradation should be based on the best available knowledge. Therefore, there should be an intimate connection between the scientific and policy-making communities. Such a connection will help to make research and scientific information on drylands more policy-relevant, and policy development and implementation more science-based. Efforts to improve the institutional framework for sustainable drylands development at all levels must include strengthening of science-policy links as existing and new environmental governance institutions require access to the best scientific knowledge available. This includes expertise in the social and economic sciences, as well as interaction with research communities worldwide.

Two of the three Rio Conventions have science support bodies. The UNFCCC is supported by the Global Climate Observing System (GCOS), which has been in existence for 15 years. Recently, the Group on Earth Observations Biodiversity Observation Network has been established to help coordinate the many biodiversity observation systems. In addition, the UNFCCC also benefited from the scientific advice and support of the Intergovernmental Panel on Climate Change (IPCC), which has been regularly issuing assessment reports on the state and evolution of the climate system, and the CBD now has a similar body, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

In contrast, the UNCCD—the main convention dedicated to drylands and related issues of desertification, land degradation and drought—does not currently have a dedicated observing system or a stable, long-term, scientific advising body to provide relevant, reliable, accurate and timely information to the various decision-makers, managers and stakeholders committed to the sustainable development of drylands (Akhtar-Schuster *et al.* 2011). Science could be more effective in the policy arena if an independent, interdisciplinary panel, similar to the IPCC or IPBES, could be established to inform the UNCCD , or if the drylands agenda could be systematically addressed by these existing panels. Any mechanism would need to be scientifically credible and politically legitimate, with an agenda also being informed by all interested parties including practitioners and civil society organizations.

The process of establishing a new international body for the UNCCD could start by linking to either the IPCC or IBPES (or both) via *ad hoc* technical working groups that could tackle a very specific aspect of land degradation and deliver sound outputs quickly (Akhtar-Schuster *et al.* 2011). If successful, this incremental approach could gradually lead to the establishment of a more permanent arrangement. The recent initiative of Federal Ministry for Economic Cooperation and Development (BMZ) and the UNCCD on the economics of land degradation (Measuring

the Value of Land, UNCCD/GIZ/BMZ) offers a positive example of how broad-based partnerships can be created to deliver concrete outputs that are time-bound (Akhtar-Schuster *et al.* 2011).

Some of the key elements necessary to strengthen the science-policy interface with respect to drylands and their ecosystem services are addressed in the next section, along with information on the role the UN system is playing in facilitating these processes. To this must be added the essential role that the UN also plays in building the capacity of others to carry out these tasks.

4.1.1 Acquisition of drylands information: research, modelling, monitoring and observations

Environmental knowledge and information acquisition is principally achieved through research, monitoring and observation. In addition, modelling of environmental change, especially climate change, and the development of scenarios have become increasingly important tools both in developing understanding and in supporting decision-making processes.

With regards to drylands and related issues of desertification, land degradation and drought, a wide diversity of observing systems (such as ground-based weather radar, space-based sensors and manual land monitoring) are already in place to monitor specific aspects of climate change and environmental degradation, both of which have caused great concern in recent decades (Verstraete *et al.* 2011). For instance, most countries have developed and implemented facilities to monitor the weather (such as meteorological services); the state of natural resources (such as hydrological networks and rangeland monitoring sites); and the distribution of human and livestock populations (through periodic censuses). A few large-scale networks have also been implemented—such as the Collaborative Rangeland Information System (ACRIS) in Australia, La Surveillance environnementale à long terme en réseau circum-saharien (ROSELT) in Africa, DESURVEY in Europe and The Land Degradation Assessment in Drylands (LADA) project at the FAO —although these efforts are often targeted at a subset of the issues at hand, and remain limited in scope and capacity, as well as in institutional stability and financial longevity. In addition, national systems and networks tend to operate in isolation, both between agencies within a country and between countries (Verstraete *et al.* 2011).

Space-based remote sensing techniques have made great progress in repeatedly delivering quantitative information on a global scale, but at spatial or temporal resolutions that may not be sufficient for all applications and users. These techniques also most often provide biophysical observables, rather than information on social or economic variables. At the other end of the spectrum of scales, field studies, surveys and other methods to collect information locally provide a rich characterisation of particular situations, but for very limited regions and time periods, and with little standardisation. None of these activities have historically been coordinated, either thematically, or in space and time. Even less effort has been expended to develop and recommend common strategies, measurement protocols, archiving standards, quality control procedures and information sharing processes (Verstraete *et al*. 2011).

There is an urgent need for coordination and integration of these various sources of information into a hierarchical, nested, multi-scale system if we are to address an issue as broad as the sustainable development of drylands (MA 2005; Verstraete *et al*. 2009; *Vogt et al*. 2011). In particular, this effort needs to identify critical variables that have, to date, rarely been measured to facilitate access to appropriate information at the most relevant level of detail, and to foster the adoption of data quality and communication standards. To these ends, any approach must encompass a strong engagement with affected countries to ensure a sense of ownership and willingness to contribute data from local systems. The resulting system needs to be useful for national and sub-national, as well as supranational, decision-making. It should aim to gradually converge on a set of commonly agreed standards. Additionally, coordinated effort to integrate and improve existing observation networks is likely to have a very positive influence on scientific research and our ability to understand and predict the complex

processes at work in drylands (Reynolds *et al.* 2011). It may also help us to estimate the impacts of specific decisions and actions.

In view of these gaps in existing arrangements for the observation of key variables in drylands, and the great need for coordination in this area, there have been calls for the establishment of a Global Drylands Observing System, which would capitalise on the achievements of systems already established to support the other Rio Earth Summit (1992) Conventions (Verstraete *et al.* 2011). This new Global Drylands Observing System would provide an integrated, coherent entry point and user interface for a range of underlying information systems. It would help to: identify and generate missing information; propose a set of standards for the acquisition, archiving and distribution of data where these are lacking; evaluate the quality and reliability of these data; and promote scientific research in these fields by improving access to data. The UN could play an important role in helping to make the proposed Global Drylands Observing System a reality.

4.1.2. Drylands assessments

Assessments analyse data and information stemming from research, modelling, monitoring and observations. There have been several ongoing and proposed future assessments in drylands. Key recent global assessments that cover desertification, land degradation and drought issues have been the Millennium Ecosystem Assessment (MA 2005), the Fourth Global Environment Outlook (UNEP 2007), the IPCC's Fourth Assessment Report (IPCC 2007), the International Assessment of Agricultural Science and Technology for Development (IAASTD 2009), the Comprehensive Assessment of Water Management in Agriculture (Molden 2007), the Third Global Biodiversity Outlook (CBD 2010), and the 2010 Forest Resources Assessment (FAO 2010).

The Global Environmental Facility (GEF) has funded the LADA project, to be implemented by the UN Environmental Programme (UNEP) and executed by the FAO. This project started in May 2006 and has benefited from the support of the UNCCD, the International Soil Reference and Information Centre (ISRIC), the UN University (UNU), the Global Land Cover Network (GLCN) and other regional and national partners.

The Global Assessment of Human-Induced Soil Degradation (GLASOD) has produced a global map of soil degradation at a scale of 1:10 000 000. The Long-Term Ecological Surveillance Observatories Network of the Sahara and Sahel Observatory (ROSELT/OSS) is an institutional arrangement that aims to address desertification and apprehend its mechanisms in the circum-Sahara zone. The ARCIS is not a monitoring system as such, but rather a partnership between federal and state governments, with responsibility for managing natural resources in Australia's rangelands.

In addition to this proliferation of global assessments, there have also been an increasing number of regional and national assessments, often tied to national state-of-the-environment reporting. However, each of these assessments has used a different conceptual framework for assessment design and implementation, which has contributed to the challenges in bringing coherence to the assessment processes. Recently, there has been an increasing convergence on variations of the MA framework, which may improve this process, as well as land management on the ground, in the future (UNEP 2009).

4.1.3. Information exchange and knowledge management

In recent decades, the world has witnessed developments in information and communication technologies that have revolutionised the exchange of information. These developments have facilitated the growth of national and regional environmental information networks and systems. Within the UN system, numerous organizations and specialised agencies work on different aspects of desertification, land degradation and drought, including the FAO, UNEP, UNDP, the World Meteorological Organization, the World Food Programme and the UN Educational,

Scientific and Cultural Organization. Other relevant bodies that address desertification either annually or periodically include the Commission on Sustainable Development, the UN Forum on Forests and the UN General Assembly. This list does not include the agencies that provide funding for projects and programmes to combat desertification or improve land management, such as the International Fund for Agricultural Development (IFAD), the World Bank, GEF and the regional development banks.

Outside the UN system, other intergovernmental organizations also address desertification and related issues, including the Organization for Economic Cooperation and Development (OECD) Club du Sahel, the Agence de la Francophonie/Institut de l'Energie et de l'Environnement de la Francophonie (IEPF), the Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD), Arab Organization for Agricultural Development (AOAD), the Centre for Environment and Development for the Arab Region and Europe (CEDARE), the International Centre for Agricultural Research in the Dry Areas (ICARDA), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Observatoire du Sahara et du Sahel (OSS) and the International Union for Conservation of Nature (IUCN). While all of these organizations have reported to the UNCCD on their activities, there has been to date little coordination in terms of collectively managing the knowledge and information that they have. The UNCCD's recent reporting cycle in 2010 aimed to collect best practices, but further work on knowledge management and coordination is still required.

These numerous international NGOs and academic consortia are involved in relevant activities and are significant knowledge depositories. For example, TerrAfrica has developed a comprehensive knowledge base through an internet-based tool to compile and share SLM materials and to support an SLM network of practitioners. They have also recently initiated collaboration with the World Overview of Conservation Approaches and Technologies (WOCAT) (Schwilch *et al*. 2011; Reed *et al*. 2011). The knowledge base has tools to support online interaction between users, allowing SLM stakeholders to form virtual communities, exchange information, and organise regional workshops, study tours and training. Despite potential for independent scientific expertise to inform efforts to monitor and assess desertification and land degradation, efforts are still required to channel practical and scientific expertise in formats which can appeal to political decision-makers.

Collaboration between the UNCCD and other UN agencies, intergovernmental organizations and NGOs for information exchange and knowledge management could be strengthened.

4.1.4 Scientific and technical advice

Many of the environmental scientific and technical advisory bodies in the UN system are intergovernmental. Several multilateral environmental agreements, including the three Rio Earth Summit (1992) Conventions and a number of other related conventions, have prominent intergovernmental scientific and technical advisory bodies or processes. These bodies consider assessment findings, commission studies, operate networks and advise their parent bodies. The UN system can contribute to their work, but they are ultimately answerable to the Member States of the agreement in question.

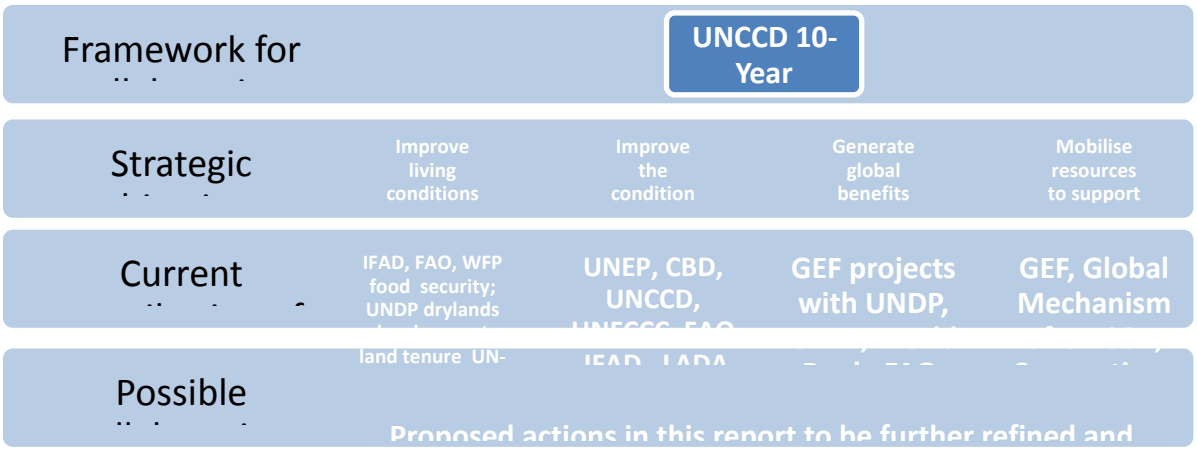
4.2 Supporting the UNCCD

During the process of developing this report with more than 25 UN agencies, non-UN experts and partners, three important objectives were agreed upon by the UN system for joint action:

1. Enhancing the economic and social well-being of dryland communities in a sustainable manner.
2. Enabling dryland communities to sustain their ecosystem services and make a contribution to global public goods.
3. Strengthening the adaptive capacity of global drylands to manage environmental change, including climate change.

This effort falls within the framework of the UNCCD's 10YSP, which aims to forge a global partnership to reverse and prevent desertification and land degradation, and to mitigate the effects of drought in affected areas in order to support poverty reduction and environmental sustainability. At its 63rd session (2008 to 2009), the UN General Assembly (UNGA), in support of the decision 4/COP8, adopted the resolution A/RES/63/218 in which it reasserts its commitments to combat and reverse desertification and land degradation, and mitigate the effects of drought in accordance with the UNCCD the 10YSP and framework to enhance the implementation of the Convention (2008 to 2018). The UNGA in this resolution "recognises the cross-sectoral nature of desertification, land degradation and drought mitigation, and in this regard invites all relevant United Nations organizations to cooperate with the Convention secretariat in supporting an effective response to desertification and drought" (A/RES/63/218).

Figure 11. UN collaboration on drylands in the context of the 10-Year Strategic Plan of UNCCD



4.2.1 UNCCD: An important instrument

In the context of continued UN-wide cooperation on land, the key land-related Convention naturally plays a leading role. Reversing and preventing desertification, alongside mitigating the effects of drought, are key inputs to any attempts to reduce poverty and improve environmental sustainability in drylands. Hence, UNCCD, developed as a result of the Rio Earth Summit (1992), has a pivotal role to play as the only global treaty focused on developing countries and on improving living conditions. Its dual emphasis on environment and development gives it a unique position in facilitating progress towards MDG achievement since numerous tools and policies proven in the dryland context can be translated elsewhere, while many others will be independent of natural environmental conditions.

Partnership lies at the heart of the UNCCD, casting resource users and their communities as central to the solution, rather than part of the problem. This approach recognises the interdependence of drylands and other world systems, but debate has been ongoing (Adeel *et al.* 2009) on the scope of the UNCCD. Although drylands deserve continued focus and attention, discussion has focused on whether the Convention should expand its scope to Sustainable Land Management (SLM) and poverty alleviation worldwide. Land is not inexhaustible, and there are ever-growing, competing claims on it, in particular, in Africa as Asian and Middle Eastern countries grow their interest in investing there due to water and food shortages at home. Some postulate that much of Africa's mineral wealth remains unexplored–so that may also have a bearing on land claims. In addition, privatisation of land is occurring in some communal areas (for instance, in Kenya), which is leading to agricultural impacts on the migrations; and sedentarisation policies in some areas, such as West Africa, discourage nomadic lifestyles.

For developing countries,- agricultural development is the first step on the development ladder, and necessary to meet MDGs regarding food security. Thus, the Food and Agriculture Organization (FAO) and World Bank have identified areas of suitable land for agricultural development (FAO and 2009). Many developing countries are experiencing changes in development interventions, investments in biofuel production, and in land policy and land use. Resource shortages, particularly water and food shortages in Asia and the Middle East, have led to land grabbing and infrastructure development.

4.2.2 Mechanism for collaboration

The 'Delivering as One' initiative has tested a number of different ways for UN agencies to work together at the national level. At the global level, there are examples of the UN system working together across agencies. One particularly relevant example is the EMG cooperation on biodiversity resulted in the report *Advancing the Biodiversity Agenda—A UN system-wide contribution*, which was presented to the tenth Conference of the Parties of the Convention on Biological Diversity in Nagoya, Japan, in November 2010. In addition to a joint framework and individual contributions from EMG members, this report also identified four areas for further collaboration. They were: 1) strengthening the science-policy interface; 2) advancing interlinkages and synergies in the implementation of the biodiversity-related conventions; 3) identifying opportunities for integrating biodiversity targets into national development cooperation; and 4) reviewing the effectiveness of the achievement of targets. These principle functions could also be considered in the framework for UN cooperation on dryland matters.

United Nations University - International Network on Water, Environment and Health (UNU-INWEH) is an interagency mechanism established in 2003 by the UN Chief Executives Board for Coordination and the High Level Committee on Programmes of the UN. It aims to promote coherence and coordination in UN system actions aimed at implementing the water agenda, which includes issues associated with water supply and sanitation, as well as water resources management. The UN-Water initiative continues to focus on developing its role as a support mechanism for members, partners and other key stakeholders in their efforts to provide leadership and solutions to water challenges in Member States. The participating UN organizations have agreed that they should adopt a coordinated approach to collaboration within the UN system, with partners and donors who wish to support the implementation of the work of UN-Water. The participating UN organizations established a UN-Water Inter Agency Trust Fund, as well as a forum to steer the operational management of UN-Water, called the Joint Steering Group. Members of UN-Water and United Nations Office for Project Services (UNOPS), signed a Memorandum of Understanding to set up the administrative structure for UNOPS, which includes all aspects of the United Nations - Water Inter-Agency Trust Fund (UNW-IATF) such as remittances, disbursements and transfer of funds; and monitoring and reporting to the UN-Water Members through the Joint Steering Group and donors.

Such an incentive structure, it would seem, may help to support interagency collaboration on a practical level. In contrast, agenda, policy and norms-setting mechanisms are fairly well-established, for example, through the Commission on Sustainable Development. The question is: what mechanisms would best suit the drylands agenda, while considering links to wider land-related issues on the global agenda? Proposed priorities that need to be addressed include land shortage; land grabbing and insecure tenure; land use trade-offs; loss of land and water productivity; land restoration; and specific issues within the drylands agenda. Consideration of these topics will be at the forefront of the IMG on Land's work in 2011.

4.3 Interlinkages and synergies in the implementation of the drylands agenda

The UNCCD is the main convention dedicated to dryland-related matters. The Convention was adopted in 1994 in Paris as the third of the 'Rio Conventions' and the first treaty negotiated in response to the UN Conference on Sustainable Development. The Convention introduced an innovative approach to combating desertification that focused on both natural and socioeconomic processes, and popular participation. Without the UNCCD, the international recognition of the significant, deleterious relationship between poverty and drought and/or desertification (particularly in Africa) would be considerably weakened, as would the international support for grassroots actions to combat desertification and achieve sustainable development in affected areas.

Other conventions, such as the CBD, UNFCCC and Ramsar Convention on Wetlands, also address dryland issues. With the proliferation of multilateral environmental agreements (MEAs) at global and regional levels, there has been a growing call for increasing the collaboration between MEAs, particularly between the three Rio Conventions. For example, it is important to note that the Parties to the UNCCD and CBD have adopted a joint work programme on the biodiversity of dry and sub-humid lands. The World Summit on Sustainable Development (WSSD) in 2002 underlined the need to strengthen collaboration within and between the UN system and other relevant international organizations in order to encourage effective synergies among MEAs and to increase scientific and technical cooperation between relevant international organizations (UNEP-WCMC 2004).

UNEP also identified a number of cross-sectoral themes that would benefit from greater synergies, including: scientific and technical assessments; implementation, compliance and enforcement; advocacy and outreach; mainstreaming environment protection in sustainable development; financial and administrative arrangements; capacity-building and technical assistance, monitoring and reporting; joint meetings, joint programming and information management.

Many of these themes would benefit from greater shared knowledge management between the various MEAs. While the UNCCD Secretariat has identified a number of activities aimed at promoting greater synergies with other MEAs, there have been limited efforts to complement these initiatives with better long-term institutional knowledge management (Chasek *et al.* 2011). Despite the fact that there have been joint workshops and other initiatives, many have primarily involved representatives from the Secretariats of the three Rio Conventions. This kind of approach is useful in terms of initiating the horizontal dialogue at the international level, but it is the vertical transfer of such synergy to regional, national and local levels (particularly to the operational level) that remains constrained.

The scientific bodies of the different MEAs could also benefit from greater collaboration to advance a sense of shared scientific knowledge (Chasek *et al.* 2011). While representatives of the major Conventions often attend meetings of the CBD's Committee on Scientific, Technical and Technological Advice (SBSTTA), the UNFCCC's Committee on Scientific and Technological Advice (SBSTA), and the UNCCD's Committee on Science and Technology (CST) (not to mention the scientific bodies for other MEAs, including the Convention on Migratory Species, Convention on International Trade in Endangered Species and the Ramsar Convention, as well as the IPCC), there is no central depository for reports that may be relevant for other MEAs (Wagner 2006). As a result, it is difficult and time-consuming to obtain information about other monitoring and assessment activities and determine if they may be useful for other Conventions. Duplication of work often results, which could be alleviated if there was some type of central clearinghouse or depository for such information.

It is also worth mentioning that the Aichi Targets adopted by the CBD COP 10 contain a number of specific targets of particular relevance to drylands and associated investments including:

- Target 2 which agrees to ensure that, by 2020, biodiversity values will have been integrated into development and poverty reduction strategies and planning processes.
- Target 4 which agrees that, by 2020, Governments, business and stakeholders at all levels will have taken steps to achieve sustainable production and consumption and will have kept the impacts of use of natural resources well within safe ecological limits

- Target 13, which ensures that by 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, is maintained

4.3.1 Current global level synergies

Together with various UN bodies and specialised agencies, the secretariats of all the MEAs are members of the Environment Management Group, which serves as the coordination body on environmental issues for the UN system and is chaired by the Executive Director of UNEP. On a number of occasions, UNEP has used its convening power to bring together representatives of MEA secretariats to discuss common administrative and substantive issues. Several meetings have been organised on the subject of harmonised reporting and information or knowledge management, as well as cooperation with the World Trade Organization. In 2007 the Executive Director of UNEP established an MEA Management Team, comprising the executive heads of all UNEP-administered MEAs.

The rationale for collaboration among the Conventions stems from the interlinkages between the issues that they address. For example, climate change can be an important driver of desertification and biodiversity loss; and ecosystem dynamics can impact the earth's carbon, energy and water cycles and, therefore, affect climate. Furthermore, measures undertaken under one Convention to address climate change (including mitigation and adaptation activities), to combat desertification and land degradation, or to conserve and sustainably use biodiversity, might have consequences for the objectives of the other Conventions.

A number of elements of the texts of the three Rio Conventions imply interlinkages with the objectives of the other Conventions such as the the Ramsar Convention and Convention on Migratory Species (as well as other MEAs – Multilateral Environmental Agreements). In the case of the UNCCD, encouragement to coordinate activities among the three Rio Conventions is built into the text of the Convention itself (Article 8.1). For example, the Ramsar Convention and UNCCD provide specific direction to protect and restore wetlands and drylands, recognising their ecological value, as well as their direct use benefits. In addition, the three Rio Conventions share a number of cross-sectoral themes, such as those relating to research and monitoring, information exchange, technology transfer, capacity building, financial resources, and public awareness (Table 6).

Table 8. Building Synergies between the UNCCD and other MEAs

Cooperating MEAs	Initiative Purpose	Purpose
UNCCD and CBD	Joint Work Programme (JWP) on the biological diversity of dry and sub-humid drylands	The JWP contains three main elements: assessments, targeted actions for conservation and sustainable use of biological diversity, and enabling activities and joint reporting. Each details joint or shared activities of the two Secretariats to facilitate national and local action (UNCCD 2007).

UNCCD and UNFCCC	Coordination of Reporting	Identifies how the development of national adaptation programmes of action under the UNFCCC could take place in close collaboration with UNCCD National Action Programmes (NAPs).
UNCCD and Convention on Migratory Species	Memorandum of Understanding	Agrees to cooperate further to achieve better coherence in the development of specific targeted actions to address issues relating to migratory species in areas affected by drought and desertification.
UNCCD, UNFCCC and CBD	Workshop on Forests and Forest Ecosystems	Encourages the implementation of specific actions at the local level relating to forests and forest ecosystems and their use and conservation as derived from the mandates and commitments under each convention, and to further develop synergistic processes in this sector that would contribute to more effective implementation of the Rio Conventions.
UNCCD and International Tropical Timber Organization (ITTO)	Joint Initiative	The focal points of both organizations in Peru jointly requested and received assessment and project formulation assistance from the ITTO in 2005 in the evaluation of Peru's forest fire impacts on ecosystem changes and in the identification of strategies and actions to prevent, mitigate and revert desertification along the Piura River basin through a Contingency Plan.
UNCCD, CBD and UNFCCC	Joint Liaison Group	Improves the exchange of information, explores opportunities for synergistic activities, and increases coordination among the three Rio Conventions and their Secretariats for the benefit of their respective parties (UNFCCC 2004).
UNCCD and United Nations Forum on Forests (UNFF)	Memorandum of Understanding	Calls for cooperation on a wide range of common issues between sustainable forest and land management, particularly in arid land forests, tropical dry forests and low forest cover countries; underscores the link with

		climate change, and promotes synergies between the Secretariats, including a common programme on forest landscape restoration.

Source: adapted from Chasek *et al.* (2011).

Regarding the existing scientific advisory bodies of the MEAs, one of their strengths is that they are mandated to support particular agreements, processes and organizations, and have the potential to call on and involve scientists in their work (UNEP 2009). Unfortunately, many of these scientific advisory bodies are not particularly scientific and have evolved into political bodies; indeed, according to the UN Joint Inspection Unit's report, the UNCCD "does not always get the scientists it needs" (Ortiz and Tang 2005). Despite this inherent weakness, there are many overlapping issues addressed by each body that could benefit other MEAs. So far, there has only been limited collaboration among these scientific bodies. According to UNEP (2009), in only two cases are there direct and mandated links between an MEA and a scientific assessment process: the UNFCCC and the IPCC, and the International Treaty for Plant Genetic Resources for Food and Agriculture and the State of the World's Plant Genetic Resources for Food and Agriculture. As a result, there are many complementary and potentially overlapping scientific initiatives that could support policy development. It is possible that their impact would be more significant and less duplicative if they cooperated more, or were more closely coordinated (UNEP 2009).

4.3.3 National level synergies—lessons learned and opportunities

Perhaps the best means for strengthening coherence among the Conventions, however, is national level coordination, cooperation and coherence. Many MEAs and UN agencies like UNEP recognise the importance of national level synergies. For example, through various decisions, UNEP has called for studies, pilot projects and initiatives to improve the implementation of MEAs by paying particular attention to synergies and interlinkages. As a result, UNEP and some COPs of MEAs (as well as UNDP and UNU, among other UN bodies) have undertaken a number of innovative initiatives to promote synergies. For instance, the National Capacity Self-Assessment (NCSA) process explicitly encourages States to consider synergies among MEAs, particularly the UNFCCC, CBD and UNCCD. In responding to Parties' requests to improve coordination and cooperation among the MEA Secretariats, there are a number of practical measures that have been undertaken. These measures generally take advantage of the synergies among the MEAs on specific issues. Many of these measures address specific obligations that States have under the agreements; for example, to develop implementing legislation, to establish or designate responsible institutions, to collect information and report, and so forth. The UNCCD also recognises the importance of promoting greater synergies with other MEAs (UNCCD 2007).

At the national level (and, to some extent, at regional and international levels, too), activities may include:

1) Developing national technical committees to identify synergies, interlinkages and ways to implement related MEAs simultaneously at the national level. These technical committees could also suggest timeframes and targets for implementation; for example, Kenya has developed such a committee with assistance from UNEP's Partnership for Development of Environmental Laws and Institutions in Africa (PADELIA).
2) Developing joint projects and work plans where there is common concern.
3) Integrating the collection, analysis and dissemination of scientific information and other data.
4) Providing public education and disseminating information.
5) Suggesting legislative, regulatory, policy and institutional measures to implement the MEAs. Such legislation may not fully implement all of the provisions of the various MEAs, but it could identify and incorporate the relevant provisions from the relevant MEAs.; Uganda's forest legislation is one such example.
6) Capacity building, as exemplified by the Green Customs Initiative.
7) Clustering MEAs for the purposes of public awareness raising activities.

4.4 New impetus for change—a UN commitment

Desertification, land degradation and drought are serious environmental issues that have hindered the development of dryland regions for the past 60 years at least (Verstraete *et al.* 2011). On the other hand, drylands have an immense scientific, economic and social value. The past decade has seen a renewed interest among donors, researchers and practitioners in dryland development. With more lands around the world facing increasing deterioration and degradation, the UN General Assembly declared the period from January 2010 to December 2020 as the Decade for Deserts and the Fight Against Desertification to promote action that will protect drylands. The Decade is an opportunity to make critical changes to secure the long-term ability of drylands to provide value for humanity's well-being.

The goals and objectives of the Decade flow directly from the General Assembly's resolution A/RES/64/201. The motivation for this resolution was the Parties' concern about the deteriorating situation of desertification in all regions, which has far-reaching implications for the attainment of the MDGs, particularly the eradication of poverty and ensuring environmental sustainability.

In this regard, the resolution mandates the pursuit of three objectives, which are:

- organising activities to observe the Decade in order to raise awareness of (a) the causes of, and (b) solutions to, ongoing land degradation and desertification in the framework of the 10YSP and framework to enhance the implementation of the Convention (20082018);
- mobilising financial and technical support for the Convention secretariat to support special initiatives in observance of the Decade, as well as other observance events and activities worldwide; and
- monitoring and reporting on progress in preparation of the Secretary General's Report to the General Assembly at its 69th Session on the status of implementation of the resolution.

The UN could also play an important role in the establishment of a Global Soil Partnership (GSP) for Food Security, and Climate Change Adaptation and Mitigation presents an opportunity to raise the profile of desertification and land degradation issues. The renewed recognition of the central role of soil resources for assuring food security, and the increased awareness that soils play a fundamental role in climate change adaptation and mitigation, have triggered numerous projects, initiatives and actions that need an increased effort of coordination and partnership in order to avoid unnecessary duplication of efforts and waste of resources, especially in times of substantial budget restrictions. The added value of the GSP in developing synergies and cost savings among the various existing networks and programmes will assure that the partnership receives the necessary support and endorsement by all major players and stakeholders.

The GSP will aim towards collaboration and sharing of responsibilities in order to provide a coherent framework for joint strategies and actions. Soils can be considered as non-renewable in the timeframe of human activities. There is increasing degradation of soil resources due to population pressures, inappropriate practices and inadequate governance over this valuable resource. The GSP should aim to facilitate the dialogue and interaction among the various users and stakeholders currently competing for the use of soil resources at the global scale. This will complement similar initiatives for water (the Global Water Partnership) and land (Voluntary Guidelines on the Responsible Governance of Tenure of Land and Other Natural Resources (VG)).

4.4.1 UN system-wide collaboration

The 'one UN' approach is well-positioned to play an important part in this. A UN system-wide collaboration on drylands could address the following priorities:

1) **Support governments to improve the enabling environment for drylands development** including improving governance, infrastructure and education; harmonising natural resource policies; providing assessments of the full value of drylands and associated ecosystem services; and supporting appropriate investment policies. For example, UNEP conducts integrated assessments of land and dryland issues through Global Environmental Outlooks which utilise the Drivers-Pressures-State-Impacts-Responses framework. The concepts of human well-being and ecosystem services are core in the analysis, but the assessments extend to include environment-society interactions more generally. UNEP has also co-developed methods for land health surveillance, which combines systematic ground sampling with remote sensing analysis, and environmental accounting of dryland systems to assess sustainability and policy options from an integrated viewpoint. UNEP's integrated environmental assessments are conducted through broad-based participation involving intergovernmental and multi-stakeholder processes and capacity building. Global and thematic integrated environmental assessments by UNEP involve participation from governments and the scientific community.
2) **Promote the concept of value chains**, working with the private sector to promote tools which encourage sustainable production and consumption, such as eco-labelling.
3) **Promote the diversification of income and livelihoods in drylands** to remove pressure from the resource base, while supporting traditional knowledge and associated livelihoods.
4) **Encourage water-efficient intensification of agriculture** through approaches such as SLM and taking into consideration important cross-cutting issues such as gender. For example, UNEP are developing a publication on the Ecosystems Services Approach to Food and Water Security. The theme Water Use Efficiency in Agriculture may offer potential collaboration with different UN agencies, such as FAO, and other partner organizations in the future.

5) **Work towards reducing the transaction costs (including risk management) for investments into drylands**, in particular, through climate-aware technologies and by supporting the identification and engagement of relevant investment partners, including indigenous peoples and local communities.
6) **Support public and private investment in drylands** by, for example, preparing a typology of drylands investments in order to promote those which are more sustainable (in particular, focusing on carbon markets and energy).
7) **Support social protection**; for example, through the use of scenario modelling as a tool for considering the winners and losers, or virtuous and vicious outcomes, of various investment proposals, including gender and age considerations.

The EMG's Issue Management Group (IMG) was tasked with proposing options for follow-up actions. A number of initiatives are proposed in Table 7. The IMG will consider the options in order to prepare a joint agenda for action on drylands—and possibly on wider land-related issues—that would present opportunities for cooperation and joint action.

Table 9. Initiatives proposed by the EMG's Issue Management Group (IMG)

Priority	Possible collaborative initiative	Bodies who could be involved	Added value of agencies' collaboration
Support governments to improve the **enabling environment**	• Support for infrastructure, support for harmonisation of natual resource policies, appropriate investment policies and improved governance. • Strengthening the relevant policy, institutional and regulatory frameworks for dryland investment and sustainable development through support to country-led interventions such as the Country Pilot Partnerships for SLM. • Provide a safety net against unavoidable transitional costs, and create a more conducive environment for responsible private investment by working with governments.	UNDP, UNEP, FAO, World Bank, GEF	• Reduce transaction costs for governments. • Increase coherence of technical support.
Promote the concept of **value chains**	• Work with the public and private sector to promote tools such as eco-labelling, certification and codes of conduct, which encourage sustainable production and consumption within drylands and for dryland resources.	UNCTAD, UNEP, UNDESA, UNDP, ILO, WTO (trade), WIPO	• Harmonise technical advice. • Reduce cost of delivery.
Promote the **diversification** of income and livelihoods	• Enable greater access to credit and insurance at all levels. Facilitate access to commercial finance for SLM initiatives. • Normative work on income and livelihoods in drylands to remove pressure from the resource base, and roll-out through,	IFAD, Global Mechanism, World Bank, UNDP, FAO, CBD, UNFCCC, UNCCD	• Consolidation of on-the-ground experiences and lessons learned with established norms, field presences

	for example, PEI/UNDP DDC.		and other assets.
Encourage **intensification** of agriculture in a water-efficient manner,	• Promotion of drylands agriculture in a water-efficient manner through approaches such as SLM, and incorporating biodiversity considerations.	FAO, UNDP, GEF, World Bank, IFAD, UN-Water [coordination body], WFP, CBD	• Make best use of scarce resources for investment into agriculture. • Ensure lessons learned are taken on board. • Reduce cost of delivery.
Work towards **reducing transaction costs**	• Support innovative market-based mechanisms including cap-and trade schemes and PES. • Enhance available tools for risk management for investments in drylands, including through climate-aware technologies.	UNEP, UNFCCC, CBD	• 'One UN' approach for drylands programmes.
Support **public and private investment in drylands**	• Prepare typology of drylands investments to generate awareness of the characteristics of certain types of investment opportunities in order to promote those which are more sustainable (focusing on carbon markets and energy, in particular). • Work with the private sector to prepare a 'good practice' guide for working in drylands. • Produce a guide to community-based products and services in drylands (such as the recent Small Grants Programme (SGP) guide to biodiversity products from Latin American and Caribbean (LAC).	UNDP, IFAD, World Bank, UNEP-WCMC	• 'One UN' approach for programmes. • Reduce costs. • Make good use of institutional infrastructure and established relationships with governments.
Support **social protection**	• Extend 'twin-track' approach to food and nutrition security that focuses on immediate, as well as longer-term, structural needs. • Establish use of scenario modelling as a tool for considering the winners and losers, or virtuous and vicious outcomes, of various investment proposals, including gender and age considerations.	WFP, WTO (trade), FAO, UNHCR	• Coherent approach, building from differing perspectives and experiences of agencies.
Promote rural urban linkages and sustainable	• Work with national governmenst to achieve balanced territorial development and	UN-HABITAT, UNDP, UN-Water, World	• Reduce cost of 'correcting' unplanned settelments;

urbanisation	equitable access to ressources and development gains; promote adequate housing; • Faciliate the flow of information, knowledge and expertises between urban centers and rural areas • Promote sustainable city development and land use planning to avoid proliferation, protect vulnerable landsacpes	Bank	• Enablying environment for job creation and economy of scale; city development

4.5 Opportunities for integrating drylands targets into national development cooperation

4.5.1 Newly developing agendas and priorities

As set out in previous chapters, it is clear that there are new emerging issues pertaining to drylands, as well as old issues that are in need of new approaches. This means that new knowledge needs to be incorporated into action on the ground, while research and learning continue. The world needs to embrace new approaches to old and emerging challenges, new economic accounting, new questions and perspectives, new scales, and new partners and partnership arrangements.

4.5.2 The development cooperation context: how will drylands become a priority on the agenda?

Desertification, land degradation and drought are important barriers to sustainable development that cut across multiple sectors, disciplines, actors and interest groups. Given the continuing trends in increasing land degradation and its pronounced links with climate change, biodiversity loss, poverty, health, food, water and energy insecurity, and human displacement, there is an urgent need to mainstream land issues into national cross-sectoral policies and international negotiations.

It is also important to achieve synergetic outcomes offering multiple benefits for several MEAs, including the UNFCCC, CBD and the UNCCD. The setting of shared goals across sectors and MEAs can contribute to the alleviation of the multiple impacts of climate change, biodiversity loss and land degradation on the environment, livelihoods and human well-being, as well as providing efficiency savings and reducing trade-offs between MEAs.

Following recent trends in international development assistance (such as the Monterrey Consensus on Financing for Development (2002) and the Paris Declaration on Aid Effectiveness (2005)), there is increasing emphasis on a country-driven approach towards environmental and development goals. Hence, the need to mainstream land degradation and SLM issues into national policies and frameworks becomes increasingly important, and is encouraged by international mechanisms such as the UNCCD and the MDGs adopted in 2000. In particular, MDG7

on environmental sustainability is particularly explicit on mainstreaming, requiring countries to "integrate the principles of sustainable development into country policies and programmes and to reverse the loss of environmental resources".

The focus of the political and public awareness aspects of the UNCCD should shift from a negative perspective, which is usually based on desertification, erosion, biodiversity loss, famine and migration, towards creating a positive image by scientifically supporting dialogue and knowledge on the links between land, food and water security and the improvement of human livelihoods in drylands. Moreover, TEEB- style studies (i.e. The Economics of Desertification, Land Degradation and Drought) could also help in making the case to donors to invest in drylands. Given the current global attention on land degradation, and the growing interest in investing in land, there is great potential for mobilising partnerships around a global economic assessment and for implementing its recommendations later on. This would require champions of the cause to coordinate and facilitate action in both the policy, scientific and donor spheres.

There are also several emerging innovative financing mechanisms that can be tapped into to support sustainable development in drylands. Innovative financing mechanisms are ways of generating funding for development and biodiversity conservation that are non-traditional in nature (i.e. beyond Official Development Assistance and government budget), and can be from internal, external, private or public sources (World Bank 2009). These have already been highlighted in the Chapter 3. They include incentives and market-based mechanisms such as public payment schemes (e.g. permanent conservation easements, contract farmland set-asides, co-finance investments, payments for proven investments in land conservation and environmental or green taxes); open trading under regulation (e.g. conservation banks, tradable development rights, trading of emission reductions or removals such as the Kyoto Clean Development Mechanism); and self-organised private deals (e.g. direct payment for environmental services, conservation concessions).

Market-based approaches to environmental management, such as payments for environmental services (PES), have been recognised as some of the most innovative means of financing ecosystem conservation programmes. A significant amount of resources can be generated locally from these services to finance programmes aimed at combating desertification, land degradation and drought. More than 400 PES schemes are currently under operation in many countries with public-private partnerships (not only in drylands). As a rule, PES schemes are tools to maintain the environment, but are not designed to enhance development or to alleviate poverty (Pagiola *et al.* 2005). However, regarding land degradation issues, and especially within drylands, such environmental tools need to foster social and economic development. In partnership with private sector organizations, PES schemes in drylands can generate considerable resources locally to combat land degradation and aid natural resource management.

4.5.3 Supporting national agendas

The UNCCD draws global attention to the worldwide seriousness of desertification, land degradation and drought, and the development needs of countries with extensive drylands. One of the first actions of countries affected by desertification is to prepare NAPs; such programmes are one of the key instruments in the implementation of the UNCCD at a national level. They are strengthened by Action Programmes on Sub-regional (SRAP) and Regional

(RAP) level. Developed in the framework of a participative approach involving the local communities, NAPs spell out the practical steps and measures that need to be taken to combat desertification in specific ecosystems.

Much has changed since work first started on NAPs for the implementation of the Convention. New global studies like the MA and the reports of the IPCC have deepened understanding of the causes of land degradation. The shifts in the UNCCD's operating environment also led COP8 in September 2007 to approve the UNCCD 10YSP and framework (2008–2018). This specifically "recognises the need for Parties to realign their NAPs."

Guidelines for NAP realignment stipulates that NAP implementation, monitoring and evaluation, and access to funding be supported by planning that provides baseline information, sets targets and a timeframe, specifies the range of activities envisaged to reach the targets, and identifies indicators to measure progress. Furthermore, aligned NAPs should embrace grassroots governance (whether territorial or local) and seek grassroots ownership, as well as being integrated, or 'mainstreamed', into the national development process. Poverty and environmental degradation are inextricably linked and, under most circumstances, cannot be analysed or addressed separately. The UN is better positioned to coordinate and support countries to integrate poverty eradication strategies and environmental frameworks, the lack of which poses a major constraint to the management of natural resources.

4.5.4 Key areas of collaboration

a. Capacity support and institutional strengthening for national action

The UN has a pivotal role to play in building the capacity of developing countries to address desertification, land degradation and drought issues, particularly in developing countries (such as Africa). Policy and institutional reforms for creating an enabling environment have been recognised as a necessity for promoting poverty reduction in drylands. The UN should continue to give this issue special attention, with a focus on empowering the poor to participate in decisions that affect their lives and to expand their opportunities and build their strengths and capabilities to overcome adversities and natural calamities such as drought.

Partnerships and collaborations between governments, UN agencies, multilateral and bilateral agencies, and NGOs are key to this process of capacity support and institutional strengthening for national action. These include, for example, UNEP, who could provide awareness raising, advocacy work and applied research; FAO, who could offer technical assistance to field implementation; theWorld Bank and regional development banks, who could provide catalytic technical assistance for preparation of investment programmes; Global Mechanism who would support resource mobilisation; GEF Secretariat, who would offer support to programmes related to international water, biodiversity and climate change in the drylands; international NGOs, such as the World Conservation Monitoring Centre (WCMC), the International Institute for Environment and Development (IIED) and the OSS, who could advise on specific technical support matters, such as maps and methodological approaches for pastoral development in the drylands..

b. Tools for monitoring and evaluation, research and assessments

The UN could support the establishment of a dedicated observing system and a stable, long-term scientific advisory body to provide relevant, reliable, accurate and timely information to the various decision-makers, managers and stakeholders committed to the sustainable development of drylands. The recent initiative of BMZ and the UNCCD on the economics of land degradation could be promoted and supported.

c. Tools for calculating the value of drylands and identifying trade-offs at the national level

Economic factors are an important direct and indirect driver of desertification and land degradation, and are associated with market failures and the lack of appropriate economic policies to address these failures. Hence, economic and political instruments and mechanisms are required to modify the market in such a way that it encourages landowners to invest in SLM options, thereby helping to combat land degradation.

Valuation of the economic costs of land degradation and desertification would increase awareness of the extent of this phenomenon and its impacts on rural development and agriculture in dryland countries. This could also be a useful tool for decision-making on sectoral orientations for development assistance targeted at desertification, land degradation and drought. The proposed Economics of Desertification, Land Degradation and Drought study will respond to this need by calculating and communicating the cost of these issues, assessing the cost and benefit of action versus the inaction, and providing practical guidance for effective decision-making. Furthermore, the tenth meeting of the Conference of the Parties to the CBD requested that the CBD and UNCCD collaborate to develop a further assessment of the value of drylands biodiversity.

4.4.5 Financial resources

New financial resources will be needed in drylands to address desertification, land degradation and drought. A key priority for many countries is to obtain adequate environmental finance in order to meet their needs in regard to these issues. Investment in dryland development and the conservation of dryland natural resources can yield long-term poverty reduction benefits, and, as such, should become part of national development planning and budgeting processes.

Recently, GEF became a financial mechanism of the UNCCD, along with the Global Mechanism. The GEF Assembly has allocated US$400 million to the land degradation focal area for the next GEF financing cycle, the fifth replenishment (GEF-5), which began 1 July 2010. The funds would play a catalytic role towards the implementation of the UNCCD 10YSP, mobilise additional investments for SLM from other sources, scale-up SLM innovations, and mobilise baseline knowledge and tracking tools for the long-term monitoring and assessment of the impact and trends of land degradation. With this amount, the GEF expects to mobilise an additional US$2 billion; and benefits from the implemented activities are expected to reach up to one billion smallholder farmers and pastoralists, and to impact positively on up to 500 million hectares of land.

But these resources are catalytic and insufficient to meet the scope of the need. The UN system must think creatively about how to harness other funds available from, for example: food security commitments, private investment, climate change instruments, conflict prevention and post-conflict rehabilitation, the conservation of high value drylands biodiversity, unique biodiversity, and renewable energy opportunities. The UN can contribute to investments in drylands through the interventions described in Table 4.

4.6 Review of effectiveness in the achievement of drylands targets

The international community has long recognised that desertification, land degradation and drought are major economic, social and environmental problems of concern to many countries in all regions of the world. These issues are likely to be substantially exacerbated by climate change and population growth, among other drivers. The UNCCD 10YSP (2008–2018) provides a global framework to support the development and implementation of national and regional policies, programmes and measures that would prevent, control and reverse desertification and land degradation, and mitigate the effects of drought, through scientific and technological excellence, raising public awareness, standard-setting, and advocacy and resource mobilisation, thereby contributing to poverty reduction.

During its eighth session in Madrid, in September 2007, the UNCCD COP adopted a ten-year strategic plan. Through decision 3/COP 8, the CST was requested to advise COP 9 on how best to measure progress on the achievement of strategic objectives 1, 2, and 3 of The Strategy:

- Strategic Objective 1: To improve living conditions of affected populations
- Strategic Objective 2: To improve the conditions of the ecosystems
- Strategic Objective 3: To generate global benefits through effective implementation of the Convention

The 10YSP and framework to enhance the implementation of the Convention has paved the way for the evolution of a new monitoring and assessment process/paradigm within the UNCCD. The review and monitoring system is based primarily on the derivation of performance indicators to measure progress against the operational objectives of the Strategy, and impact indicators to measure progress against the strategic objectives contained in national, sub-regional and regional profiles. Special attention will be placed on measuring investment flows for UNCCD implementation and on the establishment of a knowledge management system, including the dissemination of good practices emanating from the reports that will complement and reinforce the review process undertaken by the Committee for the Review of Implementation of the Convention (CRIC).

The Strategy contains seven core indicators that are examples of the types of indicators that need to be established to provide information on the trends in affected areas. In UNCCD Decision 17/COP.9, a subset of two impact indicators (i.e. III Proportion of the population in affected areas living above the poverty line; IX Land cover status) was identified as the minimum required for reporting by affected countries, beginning in 2012. The remaining nine impact indicators, while recommended, were considered optional for inclusion in reports by affected countries.

Development of explicit targets and indicators for achievement of those targets can provide a sound basis for reviewing the effectiveness of measures; UN entities can play a role in the review process through structured

reporting, self-evaluations and indicators. In addition, evaluations allow institutions to incrementally improve their performance both individually and collectively through results-based cooperation.

Conclusion

"The true measure of the success for the United Nations is not how much we promise, but how much we deliver for those who need us most".

United Nations Secretary-General-elect, Ban Ki-moon
Acceptance Speech to the General Assembly upon election

The UN system has come together to highlight the importance of drylands to key emerging issues on the global agenda, including climate change, food security and human settlements. The current report is the fruit of nearly two years of interagency cooperation in response to a challenge presented to the Environment Management Group (EMG).

Three objectives have been established and seven approaches agreed, together with proposed initiatives to be considered in more detail in 2011. But the modality for collaborative action must take into account the high transaction cost. What form and priorities will be set for collaboration on the UN land agenda will be the important questions going forward.

The Environment Management Groups' Issue Management Group on Land was requested to prepare this UN system-wide rapid response report on drylands, highlighting the importance of drylands, together with options for follow-up action. The report takes the standpoint that the UN should approach the topic in a positive and proactive way.

Benefits of a common approach are many, and the foundation for a new and multi-sectoral paradigm of cooperation is sketched out in this report.

The report is not the end of the process. Rather, it signifies a milestone in a unique effort by the UN system to join hands in supporting the implementation of UNCCD's 10-year strategic plan by 'delivering as one'—a multi-sectoral approach.

Appendices

Appendix 1: Acronyms and abbreviations

A/R	Afforestation/Reforestation
ACRIS	Collaborative Rangeland Information System
ACSAD	Arab Centre for the Studies of Arid Zones and Dry Lands
AOAD	Arab Organization for Agricultural Development
BRIC	Brazil, Russia, India, China
CBD	Convention on Biological Diversity
CBNRM	Community-based Natural Resource Management
CBO	Community Based Organization
CDM	Clean Development Mechanism
CEDARE	Centre for Environment and Development for the Arab Region and Europe
COP	Conference of the Parties
DDC	Drylands Development Centre (UNDP)
DDP	Drylands Development Paradigm
DFID	Department for International Development
ECA	Economic Commission for Africa
ECOWAS	Economic Community of West African States
EMG	Environment Management Group
ERPA	Emission Reductions Purchase Agreement
EWS	Early Warning System
FAO	Food and Agriculture Organization of the United Nations
FEWS	Famine Early Warning System
GDI	Global Drylands Imperative
GDP	Gross Domestic Product
GEF	Global Environment Facility
GLASOD	Global Assessment of Human-Induced Soil Degradation
GLCN	Global Land Cover Network
IAASTD	International Assessment of Agricultural Science and Technology for Development

ICARDA	International Centre for Agricultural Research in the Dry Areas
ICIMOD	International Centre for Integrated Mountain Development
ICRAF	International Council for Research on Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and communication technologies
IEA	International Energy Agency
IEPF	Institut de l'Energie et de l'Environnement de la Francophonie
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
IISD	International Institute for Sustainable Development
ILO	International Labour Organization
ILRI	International Livestock Research Institute
IMG	Issue Management Group
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISDR	Strategy for Disaster Reduction
ISRIC	International Soil Reference and Information Centre
ITU	International Telecommunications Union
IUCN	International Union for the Conservation of Nature
LADA	Land Degradation Assessment in Drylands
LDC	Least Developed Country
LGP	Length of the growing period
MA	Millennium Ecosystem Assessment
MDG	Millennium Development Goal
MERET	Managing Environmental Resources to Enable Transition to Sustainable Livelihoods (Ethiopia)
NAP	National Action Programme
NAPA	National Adaptation Programme of Action on Climate Change
NASA	National Aeronautics and Space Administration
NDVI	Normalised Difference Vegetation Index
NDP	National Domestic Product
NGO	Non-governmental organization
NICT	New Information and Communication Technologies
NPP	Net primary productivity

NTFP	Non-timber forest product
OECD	Organization for Economic Co-operation and Development
OSS	Observatoire du Sahara et du Sahel
PACD	Plan of Action to Combat Desertification
PCPR	Projeto de Combate a Pobreza Rural (Brazil)
PES	Payment for Environmental Services
PSNP	Productive Safety Net Programme (Ethiopia)
ROSELT	La Surveillance environnementale à long terme en réseau circum-saharien
SLM	Sustainable land management
STAP	Scientific and Technical Advisory Panel (of the Global Environment Facility)
TEEB	The Economics of Ecosystems and Biodiversity study
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNDP DDC	United National Development Drylands Development Centre
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNHCR	United Nations High Commissioner for Refugees
UNOPS	United Nations Office for Project Services
UNU	UN University
UNW-IATF	United Nations-Water Inter-Agency Trust Fund
USD	United States Dollar
WCMC	World Conservation Monitoring Centre
WIPO	World Intellectual Property Organization
WISP	World Initiative for Sustainable Pastoralism
WOCAT	World Overview of Conservation Approaches and Technologies
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization

Appendix 2: References

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Appendix 3: List of Tables

Appendix 4: List of Figures

Appendix 5: Contributors

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<Back cover>

Drylands – an important ecosystem for human well-being and sustainability, locally and for the world.

This publication, produced under the auspices of the Environment Management Group of the United Nations, argues that drylands in developing countries should be 're-capitalised'. This will require a cross-sectoral approach, something that the United Nations, with its global reach and wide range of activities and expertise, is uniquely positioned to catalyse.

The Environment Management Group (EMG) is a United Nations System-wide coordination body. It furthers inter-agency cooperation in support of the implementation of the international environmental and human settlement agenda. Its membership consists of the specialized agencies, programmes and organs of the United Nations including the secretariats of the Multilateral Environmental Agreements. It is chaired by the Executive Director of United Nations Environment Programme (UNEP) and supported by a secretariat provided by UNEP.

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