



# Scientific Facts on Desertification

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## Level 2 - Details on Desertification

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This Digest is a faithful summary of the leading scientific consensus report produced in 2005 by the Millennium Ecosystem Assessment (MA):  
*"Desertification Synthesis Report"*

The full Digest is available at: <https://www.greenfacts.org/en/desertification/>



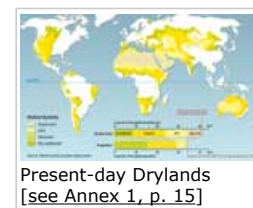
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- Each question is answered in Level 1 with a short summary.
- These answers are developed in more detail in Level 2.
- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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## 1. What is desertification?

Desertification refers to the persistent degradation of dryland ecosystems by climatic variations and human activities. It occurs on all continents (except Antarctica) and affects the livelihoods of millions of people, including a large proportion of the poor in drylands.



The U.N. Convention to Combat Desertification (UNCCD) defines it as "land degradation in arid, semiarid and dry subhumid areas resulting from various factors, including climatic variations and human activities." Land degradation is in turn defined as the reduction or loss of the biological or economic productivity of drylands.

In 2000, drylands, which occupy 41% of Earth's land area, were home to a third of the human population, or 2 billion people.

Ecosystem services are the benefits obtained by people from ecosystems, for instance crops, forage and wood. In drylands, water scarcity limits the production of such services provided by ecosystems. Persistent, substantial reduction in the provision of ecosystem services as a result of water scarcity, intensive use of services, and climate change is a much greater threat in drylands than in non-dryland systems. Areas most vulnerable to desertification are the sub-Saharan and Central Asian drylands.

Desertification occurs as a result of a long-term failure to balance human demand for ecosystem services and the amount the ecosystem can supply. The pressure is increasing on dryland ecosystems for providing services such as food, forage, fuel, building materials, and water which is needed for humans, livestock, irrigation, and sanitation. This increase is attributed to a combination of human factors (such as population pressure and land use patterns) and climatic factors (such as droughts). While the global and regional interplay of these factors is complex, it is possible to understand it at the local scale.

Some 10 to 20% of drylands are already degraded, and, if no countermeasures are taken, desertification will threaten future improvements in human well-being and possibly even reverse gains in some regions. Therefore, desertification is one of the greatest environmental challenges today and a major barrier to meeting basic human needs in drylands.

## 2. How are desertification and human well-being linked?

**"Desertification is potentially the most threatening ecosystem change impacting livelihoods of the poor. Persistent reduction of ecosystem services as a result of desertification links land degradation in drylands to loss of human well-being."**

### 2.1 Is a downward spiral of desertification inevitable?

More people in drylands than in any other ecosystem depend on ecosystem services for their basic needs. Many of the basic resources, such as crops, livestock, fuelwood and construction materials, depend on the growth of plants, which in turn depends on the climate that determines water availability.

Fluctuations in the supply of ecosystem services are normal, especially in drylands, but a persistent reduction in the levels of all



Women often play a key role in water management in drylands (Mauritania)  
Source: MA

services over an extended period constitutes desertification. Dryland people have found ways of coping with periods of scarcity lasting up to several years, but if scarcity lasts too long, at some point their resources and adaptation strategies can be overwhelmed with irreversible consequences. Their capacity to cope with a shortage of services for extended periods can be increased by demographic, economic, and policy factors (such as the ability to migrate to unaffected areas). The amount of time that has passed since the last stress period also influences this capacity to cope.

When a dryland ecosystem is no longer capable to recover from a stress period, a downward spiral of desertification may take place (Figure 1.1 [see Annex 3, p. 17] ). It involves mechanisms such as excessive loss of soil, changes in vegetation, losses in terms of water quality and quantity, and changes in the regional climate system. The intensity and impact of such desertification mechanisms vary from place to place and change over time; depending on the level of aridity and the varying pressure exerted by people on the ecosystem's resources. Even deserts can degrade further and provide even less ecosystem services, though such hyperarid areas are not covered by the U.N. Convention to Combat Desertification (UNCCD) definition of drylands susceptible to desertification.

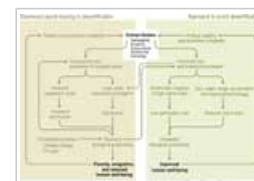


Fig 1.1 How developments in drylands can contribute to or prevent desertification? [see Annex 3, p. 17]

Table 1.1. Key Dryland Ecosystem Services [see Annex 8, p. 21]

Drylands include many different elements, such as inland waters, human settlements, and cultivated systems, that are all critically linked to desertification processes. Freshwater ecosystems are particularly important for maintaining ecosystem services in dryland areas. Nearly half of the world's cultivated systems are located in drylands, and thus have a large impact on their landscape. Although cities only account for a small portion of dryland area, they host a large portion of its population.

Understanding how different socioeconomic and biophysical processes interact at a given location over time is critical to understanding desertification. A downward spiral of desertification may occur but is not inevitable (Figure 1.1 [see Annex 3, p. 17] ). While assessment methods to evaluate the extent of desertification using different geographic scales may be sound by themselves, their findings cannot simply be scaled up or down in order to draw conclusions at other levels.

## 2.2 What are the consequences of desertification?

Desertification affects all categories of ecosystem services:

- Provisioning services such as food, forage, fiber, and fresh water,
- Regulating services such as water purification and climate regulation,
- Cultural services such as recreation and cultural identity, and
- Supporting services such as soil conservation.

These effects can be quantified directly or indirectly and management approaches are available to prevent, reduce, or reverse these manifestations of desertification.

When faced with desertification, people have responded by either increasingly using other low productivity land for cultivation or by converting more rangeland into cultivated land. Since policies to promote alternative livelihoods are usually not in place, people often migrate to other areas, towards cities or even to other countries. These migrations sometimes exacerbate urban sprawl and can bring about socio-political problems.

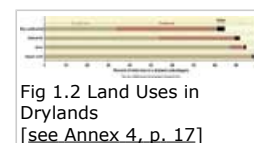


Fig 1.2 Land Uses in Drylands [see Annex 4, p. 17]

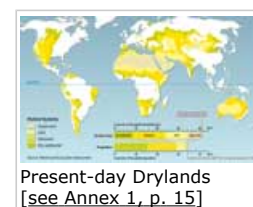
Conversion of remaining rangelands and forested drylands into croplands and the use of unsustainable cultivation practices increase the pressure on the ecosystem (causing erosion and soil fertility decline) and thus the risk of desertification. Because of overgrazing, in many semiarid areas, there is a progressive shift from grassland (land fully covered by grasses) to shrubland (land covered by scattered bushes) that promotes soil erosion by leaving the topsoil exposed to the wind, which can lead to desertification.

### 3. Who is affected by desertification?

**"Desertification occurs on all continents except Antarctica and affects the livelihoods of millions of people, including a large proportion of the poor in drylands. Assessments of the extent of desertification vary, but even by conservative estimates it ranks among today's greatest environmental challenges with serious local and global impacts."**

#### 3.1 What is the geographical extent of desertification?

Desertification takes place in drylands all over the world. Some 10 to 20% of drylands may already be degraded; this represents 6 to 12 million square kilometers. The exact proportion of drylands currently undergoing desertification is difficult to estimate mainly because the few assessments made so far take into account different data which leads to a very wide range of estimates.

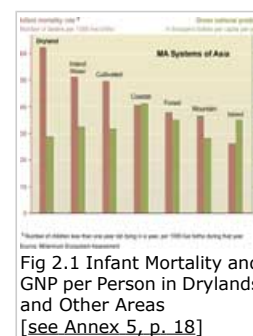


Since all drylands are potentially threatened by desertification, and that it could affect a very large number of people, desertification clearly ranks among the greatest environmental problems of today.

#### 3.2 How vulnerable are affected populations?

On average, compared to the rest of the world, dryland populations lag far behind in terms of human well-being and development indicators, and 90% of them live in developing countries.

The per capita income (GNP) of OECD countries is almost ten times greater than that of developing dryland countries. Similarly, the average infant mortality rate for all dryland developing countries reaches about 54 per 1000, which is ten times higher than the average infant mortality rate in industrial countries. (Figure 2.1 [see Annex 5, p. 18] )



The level of poverty of dryland populations varies with the level of aridity and from region to region. The low level of human well-being is worsened by the high population growth rates in drylands and by a number of policy factors such as the slow growth of health and education infrastructure, facilities, and services. The situation is worst in various parts of the drylands of Asia and Africa which lag well behind drylands in the rest of the world.

Dryland populations are often marginalized both socially and politically due to their impoverishment and remoteness from decision-making centres. They are thus unable to play an effective role in the decision making processes that affect them and are more vulnerable to factors of change like drought.

### 3.3 Do impacts of desertification extend beyond drylands?

Desertification has environmental impacts outside of the areas in which it is occurring. For instance, desertification processes and reduction of vegetation can lead to the formation of airborne particles affecting cloud formation and rainfall patterns etc. Large dust clouds can have impacts not only locally but also thousands of kilometres away from their point of origin, affecting air quality and causing health problems in more densely populated areas. Finally, reduction of vegetation cover in drylands leads to destructive floods downstream and excessive clay and silt loads in water reservoirs, wells, river deltas, river mouths, and coastal areas often located outside the drylands.



A couple walks home during a dust storm in Xinlinhot, China  
Source: MA

The social and political impacts of desertification also reach non-dryland areas. For instance, the movement of people from drylands to other areas can exacerbate urban sprawl and bring about internal and cross-border social, ethnic, and political frictions. Desertification-induced movement of people may harm local, regional, and even global political and economic stability and encourage foreign intervention.

## 4. What are the major causes of desertification?

**"Desertification is caused by a combination of factors that change over time and vary by location. These include indirect factors such as population pressure, socioeconomic and policy factors, and international trade as well as direct factors such as land use patterns and practices and climate-related processes."**

These factors lead to decreased land productivity and a downward spiral of degradation and poverty (Figure 1.1 [see Annex 3, p. 17]). Where conditions permit, dryland populations can avoid degradation by improving their agricultural and grazing practices in a sustainable way

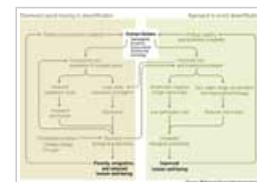


Fig 1.1 How developments in drylands can contribute to or prevent desertification [see Annex 3, p. 17]

To counter the problems effectively, it is important — but difficult — to distinguish between effects resulting from natural conditions and those caused by management decisions as well as economic and policy factors.

### 4.1 What social, economic, and policy factors can contribute to desertification?

Policies leading to an unsustainable use of resources and the lack of adequate infrastructures are major contributors to land degradation. Agriculture can play either a positive or a negative role, depending on how it is managed. Local institutions can contribute to preventing desertification by allowing land users to manage and use ecosystem services more effectively through enhanced access to productive land, capital, labor, and technology.

Policies favoring sedentary farming over nomadic herding can contribute to desertification. The majority of dryland areas (65%) are rangelands that are more suited to sustainable grazing than crop production. Sedentarizing nomads and limiting their movements leads to desertification because it reduces their ability to adjust their economic activities in the face of stresses such as droughts.

When farmers and herders lose control or long-term security over the land they use, the incentives for maintaining environmentally sustainable practices are lost, and this can greatly contribute to desertification. Control and security does not necessarily require private property rights; and collective and community-based management practices have proven quite effective. Unappropriate decision making can cause problems of water scarcity, groundwater depletion, soil erosion, and salinization.

## 4.2 Does globalization play a role in desertification?

The process of globalization can either contribute to desertification or help prevent it. Globalization creates stronger links between local, national, sub-regional, regional, and global factors related to desertification. Studies have shown that, in dryland areas, trade liberalization, macroeconomic reforms, and a focus on raising agricultural and livestock production for exports can sometimes lead to desertification. In other cases, enlarged markets can also contribute to successful agricultural improvements.

Global trade regimes and linked government policies can influence food production and consumption patterns significantly and affect directly or indirectly the capacity of dryland ecosystems to recover from stresses. Selective production and export subsidies, such as those in the European Union and the U.S., stimulate overproduction of many food crops in those countries. This can drive down prices on the international market, and have often undermined the livelihoods of many food producers in poorer countries. However, removing international trade barriers without regulation at national level may also encourage unsustainable agricultural practices.

## 4.3 How can land use affect desertification?

Historically, dryland livelihoods have been based on a mixture of hunting, gathering, farming, and herding. This mixture varied with time, place, and culture, since the harsh conditions forced people to be flexible in their use of the land. Population pressure, however, has led to the extension of cultivated lands in dryland areas. In some cases this has caused desertification and conflicts between herders and farmers who claimed access to the same land. In other cases, when policy and market conditions were favorable, it led to positive interactions between the two groups.



Water erosion and reduced soil conservation in semi-arid Burkina Faso negatively affects ecosystem services  
Source: MA

In some areas, the increase in cultivation has been driven by increased irrigation which has often been unsustainable. Irrigation can cause environmental problems such as waterlogging, salinization, water pollution, eutrophication, and excessive groundwater use. On the whole, irrigation has had a strong impact on inland waters, causing a decline in biodiversity and further desertification.

Frequent and intensive fires can contribute to desertification when they affect natural vegetation. However, limited controlled fires can play an important role in the management of dryland herding and farming systems, promoting nutrient cycling and forage quality.



## 5. How will different future development paths influence desertification?

**"Population growth and increase in food demand will drive expansion and intensification of cultivated lands. If unchecked, desertification and degradation of ecosystem services in drylands will threaten future improvements in human well-being and possibly reverse gains in some regions."**





### 5.1 Which scenarios have been explored in this assessment?

In order to better understand the consequences of different development and management options, the Millennium Ecosystem Assessment developed four scenarios that explore the future of desertification and human well-being in drylands until 2050 and beyond.

The four plausible scenarios explored in this assessment consider **two possible paths of world development**: increasing globalization or increasing regionalization. The scenarios also consider **two different approaches** to environmental issues: in one approach, actions are reactive and address problems only after they become obvious, in the other approach, ecosystem management is proactive and deliberately aims for long-term maintenance of ecosystem services.

The four scenarios are:

- Global Orchestration - This scenario depicts a globalized world with reactive ecosystem management; with an emphasis on equity, economic growth, and public goods such as infrastructure and education
- Order from Strength - This scenario represents a Regionalized world with reactive ecosystem management; with an emphasis on security and economic growth
- Adapting Mosaic - This scenario considers a regionalized world with proactive ecosystem management, with an emphasis on local adaptations and learning
- TechnoGarden - This scenario depicts a globalized world with proactive ecosystem management, and an emphasis on green technologies

		World Development	
		globalization	regionalization
Ecosystem Management	reactive	 <p>Global Orchestration</p>	 <p>Order from Strength</p>
	proactive	 <p>TechnoGarden</p>	 <p>Adapting Mosaic</p>



## 5.2 Are pressures on drylands expected to increase?

In all four scenarios, the desertified area is expected to increase, though not at the same pace. Poverty and unsustainable land use practices will continue to be the main factors driving desertification in the near future. The relief of pressures on drylands is strongly linked to poverty reduction. Under all four scenarios, population growth and increase in food demand will drive an expansion of cultivated land, often at the expense of woodlands and rangelands. This is likely to increase the extent of desertified land. None of these scenarios foresees a reversal in the threat of desertification.

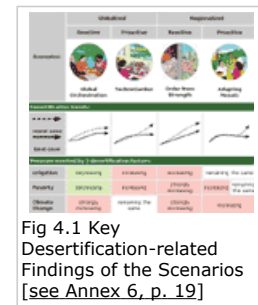


Fig 4.1 Key Desertification-related Findings of the Scenarios [see Annex 6, p. 19]

In all these scenarios, climate change is linked to desertification, but its impacts vary depending on the region and the management approach adopted. Climate change is expected to affect the global water cycle and local precipitation trends. It is likely that extreme weather events in drylands will further intensify, bringing more floods and more droughts.

### The two management approaches:

**Proactive management approaches** are likely to be more effective in coping with desertification and related economic conditions in drylands. In a proactive approach, ecosystem management is aiming to adapt to projected changes and to reduce the vulnerability of ecosystems and society to the disturbances caused by desertification. Measures that aim to adapt to climate change and to avoid the extension of irrigation can jointly slow down the desertification process in the longer term.

In contrast, under **reactive management approaches**, ongoing pressures on ecosystem services, due to climate change, overgrazing, and large-scale irrigation, are likely to remain or get worse, leading to further desertification. The regionalized-reactive scenario (Order from Strength) leads to the most unsustainable dryland developments.

### The two world development paths:

**Globalization** will not necessarily lead to increased desertification. Prospects for cooperation and resource transfers to support ecosystem management are better in this case due to institutional reforms and rapid technological development. In the globally proactive management scenario (TechnoGarden), policy reforms that strengthen property rights and the integration of environmental issues are expected to lead to relatively less pressure in drylands. However, market and policy failures can still increase the risks of desertification.

In contrast, in a **fragmented regionalized world**, the role of global agreements will be more limited because of the diminished interest in resource transfers or in issues that go beyond the national or regional boundaries.

### 5.3 What are the key challenges for the future?

Dryland ecosystems are at a greater risk than other land ecosystems to suffer from persistent reductions in their capacity to provide benefits to humans as a result of water scarcity, intensive use of services, and climate change. Local adaptation and conservation practices can mitigate some losses of dryland services, but it will be difficult to reverse losses in terms of food and water provision as well as in the biodiversity that support those services.



A farmer in semi-arid Burkina Faso works as a blacksmith during the dry season  
Source: MA

Freshwater scarcity, which already affects 1-2 billion people, is expected to increase, causing even greater stresses in drylands. If nothing is done to reduce this scarcity, it will result in a worsening of desertification.

The prospects for implementing the U.N. Convention to Combat Desertification (UNCCD) vary between scenarios. Implementation would be particularly difficult in a regionalized-reactive world (Order from strength scenario), while prospects would improve in a more globalized world with proactive ecosystem management (TechnoGarden scenario).

## 6. How can we prevent or reverse desertification?

**"Effective prevention of desertification requires both local management and macro policy approaches that promote sustainability of ecosystem services. It is advisable to focus on prevention, because attempts to rehabilitate desertified areas are costly and tend to deliver limited results."**

### 6.1 Why are actions needed?

In order to prevent and reverse desertification, major policy interventions and changes in management approaches are needed. Such interventions should be implemented at local to global scales, with the active engagement of stakeholders and local communities.



Truck with wood  
Source: MA

Societal and policy actions need to adjust to the degree of desertification that a society faces or is likely to face. In areas where desertification processes are at the early stages or are relatively minor, it is possible to stop the process and restore key services in the degraded areas. Prevention is a lot more cost-effective than rehabilitation, and this should be taken into account in policy decisions.

Addressing desertification is critical and essential to meeting the Millennium Development Goals which aim to eradicate extreme poverty and ensuring environmental sustainability amongst other objectives.

On average, human populations in drylands have a lower quality of life than people in other areas. Worldwide, approximately half of the people living below the poverty line live in drylands and their societies are particularly vulnerable as a result of dryland ecosystem conditions and poverty. Addressing desertification would therefore contribute to the eradication of extreme poverty and hunger.

## 6.2 What actions can be taken to prevent desertification?

The creation of a "culture of prevention" can go a long way toward protecting drylands when desertification is just beginning and even when it is ongoing. It requires a change in governments' and peoples' attitudes. It has been shown that dryland populations, building on long-term experience and active innovation, can stay ahead of desertification by improving agricultural and grazing practices in a sustainable way.



Terracing prevents further gully erosion and stores surface runoff for olive production (Tunisia)  
Source: MA

Preventive actions include:

- Integrating land and water management to protect soils from erosion, salinization, and other forms of degradation.
- Protecting the vegetative cover, which can be a major instrument for soil conservation against wind and water erosion.
- Integrating the use of land for grazing and farming where conditions are favorable, allowing for a more efficient cycling of nutrients within the agricultural systems.
- Applying a combination of traditional practices with locally acceptable and locally adapted land use technologies.
- Giving local communities the capacity to prevent desertification and to manage dryland resources effectively.
- Turning to alternative livelihoods that do not depend on traditional land uses, such as dryland aquaculture, greenhouse agriculture and tourism-related activities, is less demanding on local land and natural resources, and yet provides sustainable income.
- Creating economic opportunities in dryland urban centers and in areas outside of drylands.

## 6.3 What actions can reverse land degradation?

Rehabilitation and restoration approaches can help restore ecosystem services that have been lost due to desertification. Restoration aims to reestablish a previous ecosystem state and all its functions and services, while rehabilitation seeks to repair specific parts of the systems, in order to regain ecosystem productivity.

Effective restoration and rehabilitation of desertified drylands require a combination of policies and technologies and the close involvement of local communities.

Examples of actions to restore and rehabilitate ecosystems include:

- establishing seed banks,
- reintroducing selected species,
- countering erosion through terracing and other measures,
- enriching the soil with nutrients, and
- planting trees.

Policies that create incentives for rehabilitation include capacity building, capital investment, and supportive institutions.

The success of rehabilitation practices depends on the availability of human resources, sufficient funds and infrastructures, as well as on the degree of dependence on external technologies and cultural perceptions. Adequate access to these resources can lead to successful rehabilitation of some ecosystem services and also help reduce poverty. When

these conditions are not met, efforts to rehabilitate fail. Restoring degraded dryland services may thus be difficult even with major policy and technology interventions.

## 7. Is there a link between desertification, global climate change, and biodiversity loss?

Biological diversity, which contributes to many of the services provided to humans by dryland ecosystems, is diminished by desertification. Vegetation and its diversity are instrumental in soil conservation and in the regulation of surface water and local climate. The disruption of the interlinked services that are provided by dryland plant biodiversity is a key trigger for desertification and its various consequences, including the loss of habitats for other species.

Desertification affects global climate change through soil and vegetation losses. Indeed, dryland soils contain a lot of carbon which could be released into the atmosphere as a result of desertification, with significant consequences for the global climate system. It is estimated that each year 300 million tons of carbon are lost to the atmosphere from drylands as a result of desertification. This represents about 4% of global emissions from all sources combined.

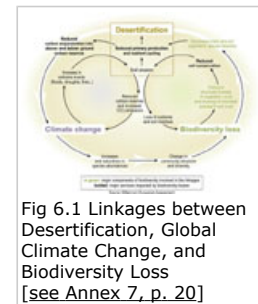


Fig 6.1 Linkages between Desertification, Global Climate Change, and Biodiversity Loss [see Annex 7, p. 20]

The effect of global climate change on desertification is complex and not yet sufficiently understood. On the one hand, higher temperatures can have a negative impact through increased loss of water from soil and reduced rainfall in drylands. On the other hand, an increase in carbon dioxide in the atmosphere can boost plant growth for certain species. Although climate change may increase aridity and desertification risk in many areas, the consequent effects of biodiversity loss on desertification are difficult to predict.

Environmental management approaches for combating desertification, conserving biodiversity, and mitigating climate change are linked in many ways, thus a joint implementation of the U.N. Conventions that target Desertification, Biological Diversity, and Climate Change can yield multiple benefits.

## 8. How can we better understand desertification?

### 8.1 How can the extent of land degradation be monitored?

**Scientifically robust and consistent baseline information about the extent of land degradation is important when it comes to identifying priorities and monitoring the consequences of actions.**

Previous assessments of the global extent of land degradation provided different figures and, in general, suffered from shortcomings linked to the information sources used. There is a need for a systematic global assessment and monitoring program, leading to the development of a scientifically credible, consistent baseline of the state of desertification.



Erroneous plowing techniques can often cause serious erosion  
Source: MA

Drylands lend themselves readily to remote sensing because they are mostly cloud-free. Continuity of observations is required to account for the high year-to-year variability of

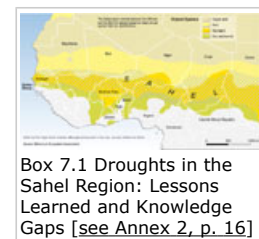
dryland ecosystem conditions. Combining the use of satellite-based remote sensing or aerial photographs with ground-based observations can provide consistent, repeatable, cost-effective data on vegetation cover. Access to affordable satellite imagery is thus critical, particularly in developing countries.

Both human actions and climate variability influence vegetation and its growth. Long-term monitoring is needed to distinguish between these two influences. Quantifying such impacts requires an established baseline against which changes can be assessed. But this comparison is complicated by year-to-year and even decade-to-decade fluctuations.

In order to better understand the impacts of desertification on human well-being we need to improve our knowledge of the interactions between socioeconomic factors and ecosystem conditions. These interactions are most easily analyzed at a local scale, where linkages can be most clearly identified. Therefore, information about socioeconomic factors related to desertification needs to be gathered at sub-national levels.

## 8.2 How can uncertainties about abrupt or irreversible changes be reduced?

Changes in ecosystems can be gradual until a certain threshold is reached, at which point abrupt or irreversible changes can occur. Uncertainties about the way biological, physical, social, and economic factors interact limit our ability to detect such thresholds in drylands and to assess the actual effect of policies on desertification.



Box 7.1 Droughts in the Sahel Region: Lessons Learned and Knowledge Gaps [see Annex 2, p. 16]

The impact of poverty reduction strategies on ecosystem services and desertification has not yet been fully explored by governments and the international community. To be successful in combating desertification, policies should include broader notions of poverty and should take into account the role of ecosystem services in poverty reduction programs.

The contribution of cities located in drylands to desertification is not clear. It is not known to which degree they may contribute to desertification (through the overexploitation of dryland ecosystem services) or relieve some of the pressures on desertified areas (through economic opportunities).

## 9. Conclusion: Main findings

Desertification is the persistent degradation of dryland ecosystems. It affects the livelihoods of millions of people. In 2000, drylands, which occupy 41% of Earth's land area, were home to a third of the human population. A significant portion of drylands are already degraded, and the ongoing desertification threatens the world's poorest populations and hinders the prospects of reducing poverty. Therefore, desertification is one of the greatest environmental challenges today. It is a major barrier to meeting basic human needs in drylands and leads to losses in terms of human well-being.



Children from Serdah village at the Khanasser valley in Syria  
Source: MA

The causes of desertification include social, political, economic, and climatic factors that contribute to an unsustainable use of scarce natural resources. The magnitude and impacts of desertification vary greatly from place to place and change over time. Furthermore, wide gaps remain in our understanding and monitoring of desertification processes, gaps which sometimes prevent cost-effective actions in affected areas.

Outside of drylands, desertification also has strong adverse impacts, for example by increasing the occurrence of dust storms which affect areas thousands of kilometers away from the desertified areas and can cause political and social problems because of human migrations.

Depending on the degree of dryness of a region, desertification can be prevented and dryland ecosystems restored through specific interventions and adaptations. On the whole, prevention is a much more effective way to cope with desertification, because later attempts to rehabilitate desertified areas are costly and tend to deliver limited results.

The four scenarios developed by the Millennium Ecosystem Assessment to explore the future of desertification and human well-being in drylands show that total desertified area is likely to increase, and that the relief of pressures on drylands is strongly linked to poverty reduction. The scenarios also show that proactive management approaches will probably be the most effective in coping with desertification. On the whole, combating desertification yields multiple local and global benefits and helps mitigate biodiversity loss and human-induced global climate change. Environmental management approaches aiming to combat desertification, mitigate climate change, and conserve biodiversity are interlinked in many ways. Therefore, joint implementation of major environmental conventions can lead to increased synergy and effectiveness, benefiting dryland populations.

Effectively dealing with desertification will help reduce global poverty, and is essential for meeting the Millennium Development Goals. Dryland populations must have access to viable alternatives in order to be able to maintain their livelihoods without causing desertification. These alternatives should be embedded in national strategies to reduce poverty and combat desertification.

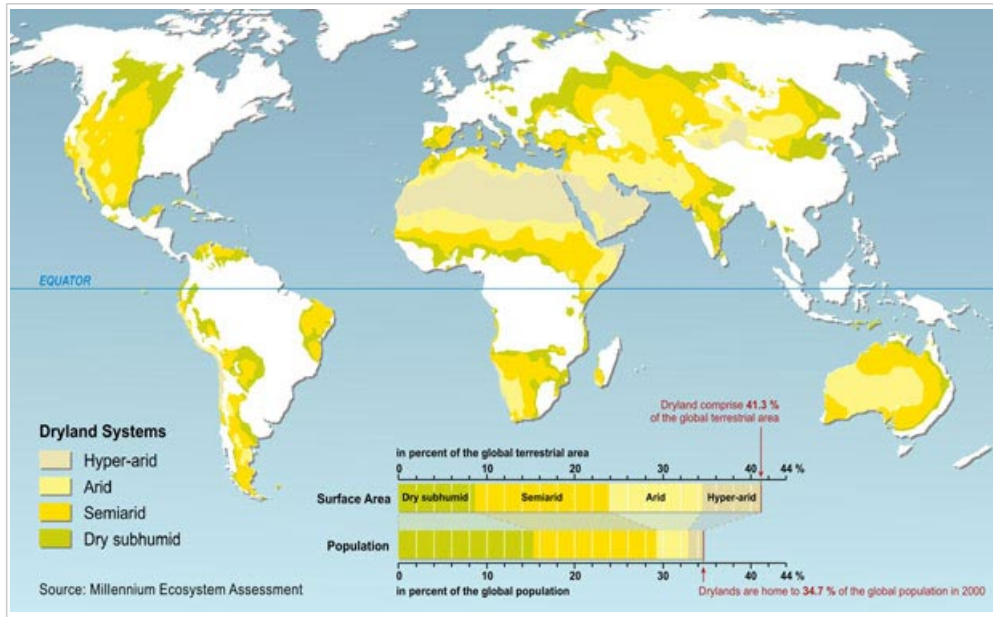


# Annex

## Annex 1:

### Appendix A: Present-day Drylands and Their Categories

Drylands include all terrestrial regions where the production of crops, forage, wood and other ecosystem services are limited by water. Formally, the definition encompasses all lands where the climate is classified as dry subhumid, semiarid, arid or hyper-arid. This classification is based on Aridity Index values<sup>†</sup>.



<sup>†</sup>The long-term mean of the ratio of an area's mean annual precipitation to its mean annual potential evapotranspiration is the Aridity Index (AI).

**Notes:** The map is based on data from UNEP Geo Data Portal (<http://geodata.grid.unep.ch/> [see <http://geodata.grid.unep.ch/>]). Global area based on Digital Chart of the World data (147,573,196.6 square km); Data presented in the graph are from the MA core database for the year 2000.

Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.23



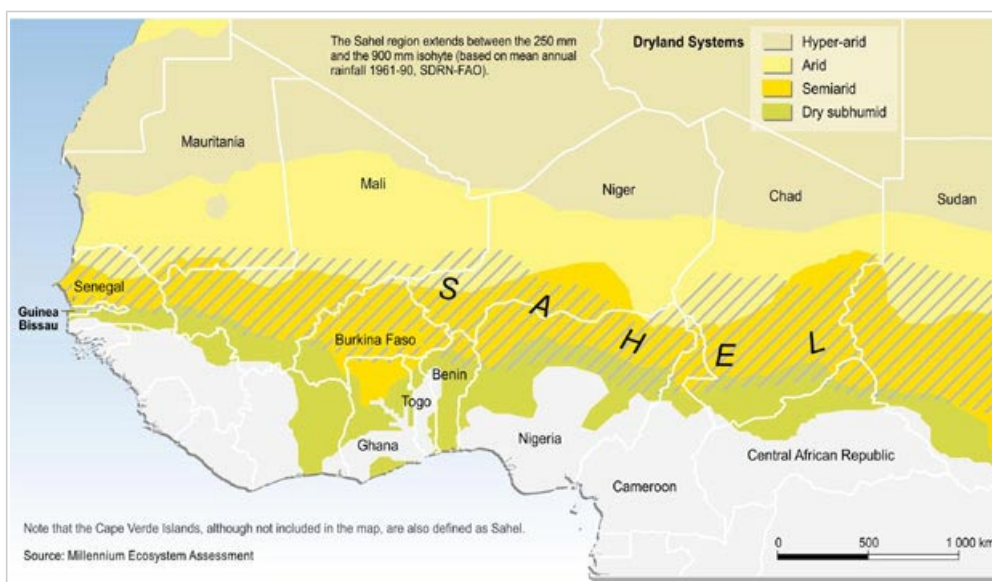
## Annex 2:

### Box 7.1 Droughts in the Sahel Region: Lessons Learned and Knowledge Gaps

The Sahel region in Africa has been hit by a series of droughts and subsequent famines in the 1970s and 1980s (C5 Box 5.1, C22.6.4). These droughts are natural phenomena in the Sahel, and the consequent land degradation in the Sahel has further reduced regional rainfall (C13.6.1). More recently, the warming of the Indian Ocean is also thought to have contributed to these droughts.

Droughts in the Sahel reduced productivity, leading to low vegetation cover that increased albedo, reduced water recycling and monsoon circulation, thus decreasing precipitation. Reduced vegetation cover also led to soil erosion and further reduction of productivity. This vicious cycle further suppressed vegetation cover (C13 Box 13.1). Reduced vegetation cover could also be attributed to human activities such as unsustainable land use practices, including overstocking, overgrazing, deep ploughing, and monocropping (C5 Box 5.1). These practices—partly in response to droughts or increasing population density in the Sahel region—contributed to soil degradation, increased wind erosion, and higher levels of dust (C13.4.3). Thus it has been suggested that the combination of human and natural factors led to the severe loss of land productivity and subsequent famines. However, long-term remote sensing studies indicate extensive recovery of vegetation productivity after the droughts, suggesting that it was almost completely controlled by rainfall (C22 Box 22.2, C13.3.2, C19.2.3).

Because productivity was restored in many parts of the Sahel region, the relationship between famine, drought, and desertification is not clear. The complex interactions between regional and local biophysical conditions and human intervention make it difficult to determine cause-and-effect of desertification correctly. More reliable data in Sahel are needed to better understand the magnitude of desertification and to reduce uncertainties for policy-makers. It is clear, though, that the sustainability of livelihoods based on ecosystems experiencing serious droughts or desertification depends on appropriately tailored management approaches.

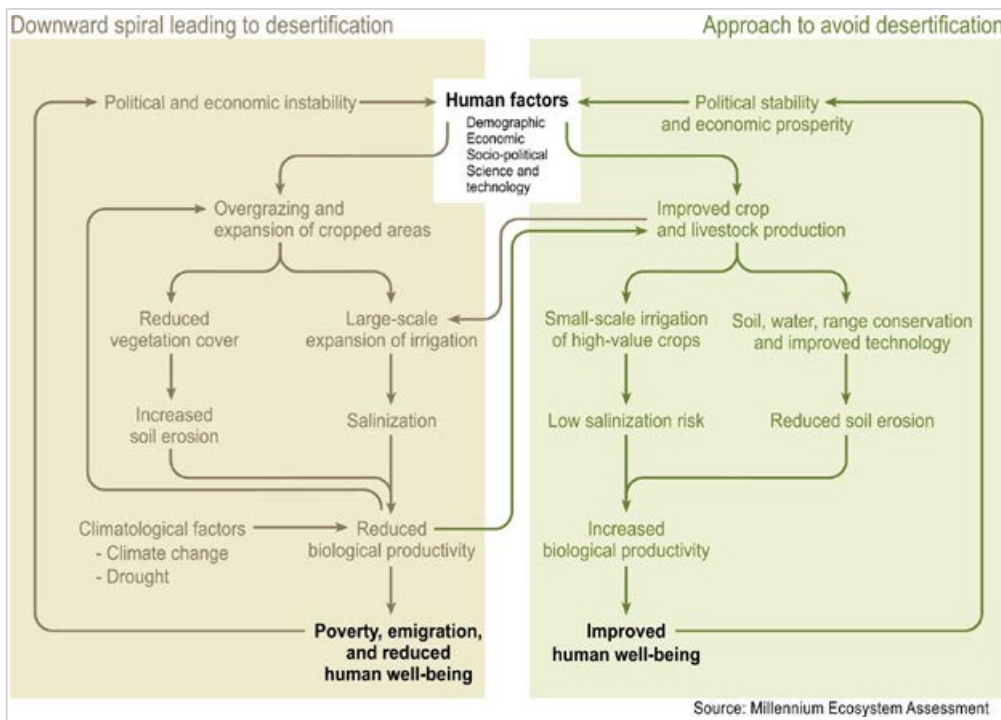


Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.20

### Annex 3:

#### Figure 1.1. Schematic Description of Development Pathways in Drylands

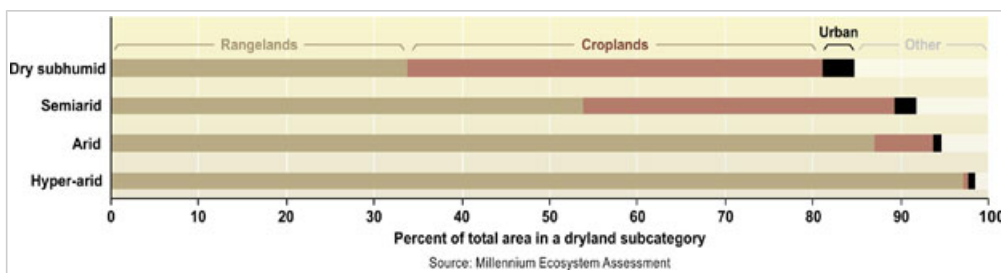
This is a schematic graphic showing how drylands can be developed in response to changes in key human factors. The left side of the Figure shows developments that lead to a downward spiral of desertification. The right side shows developments that can help avoid or reduce desertification. In the latter case, land users respond to stresses by improving their agricultural practices on currently used land. This leads to increased livestock and crop productivity, improved human well-being, and political and economic stability. Both development pathways occur today in various dryland areas. (C22 Figure 22.7)



Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.4

### Annex 4:

#### Figure 1.2. Land Uses in Drylands

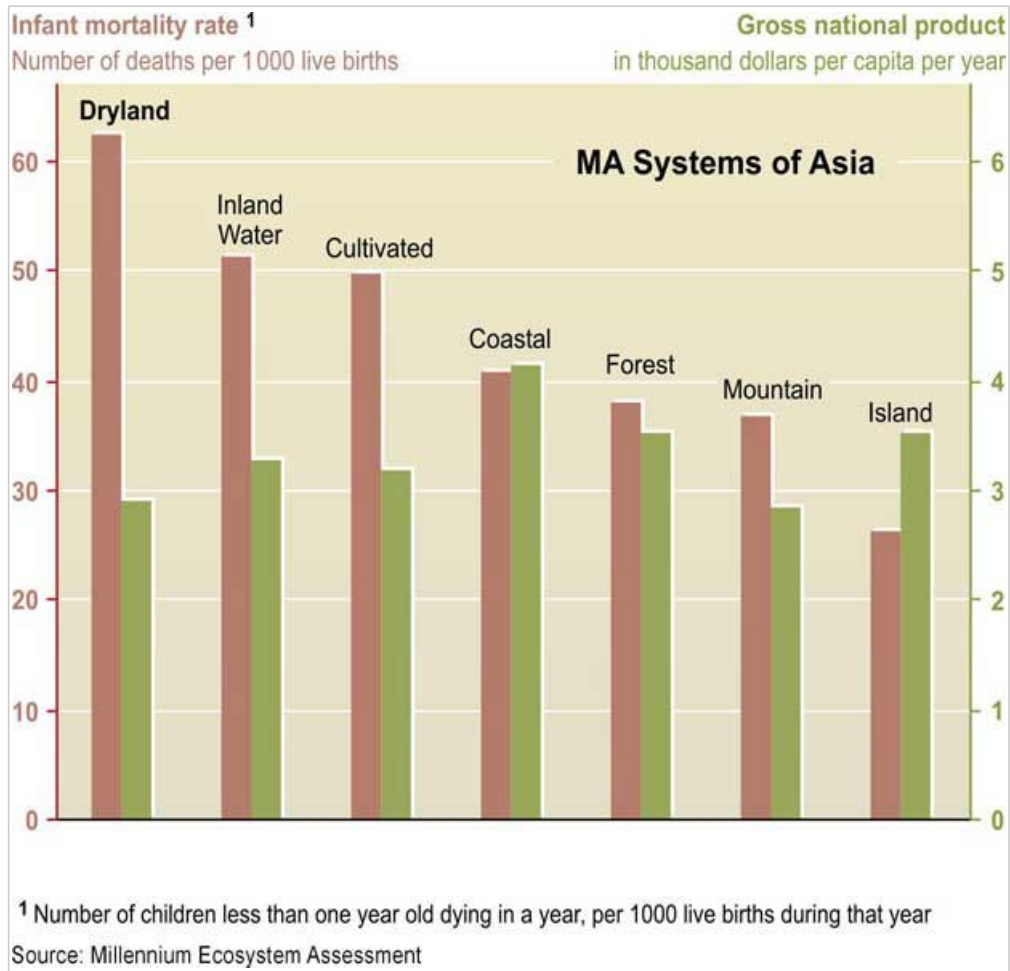


Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.6

**Annex 5:**

**Figure 2.1. Comparison of Infant Mortality and GNP per Person in Drylands and Other MA Systems in Asia**

(C22 Figure 22.12)






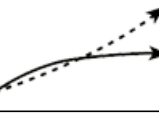
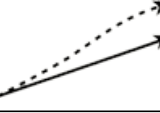
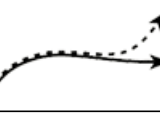


Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.7

## Annex 6:

### Figure 4.1. Key Desertification-related Findings of the MA Scenarios

Rates of change in the extent of desertified areas in the drylands: Solid lines indicate the best case; dashed lines indicate the worst case for desertification in each of the MA scenarios.

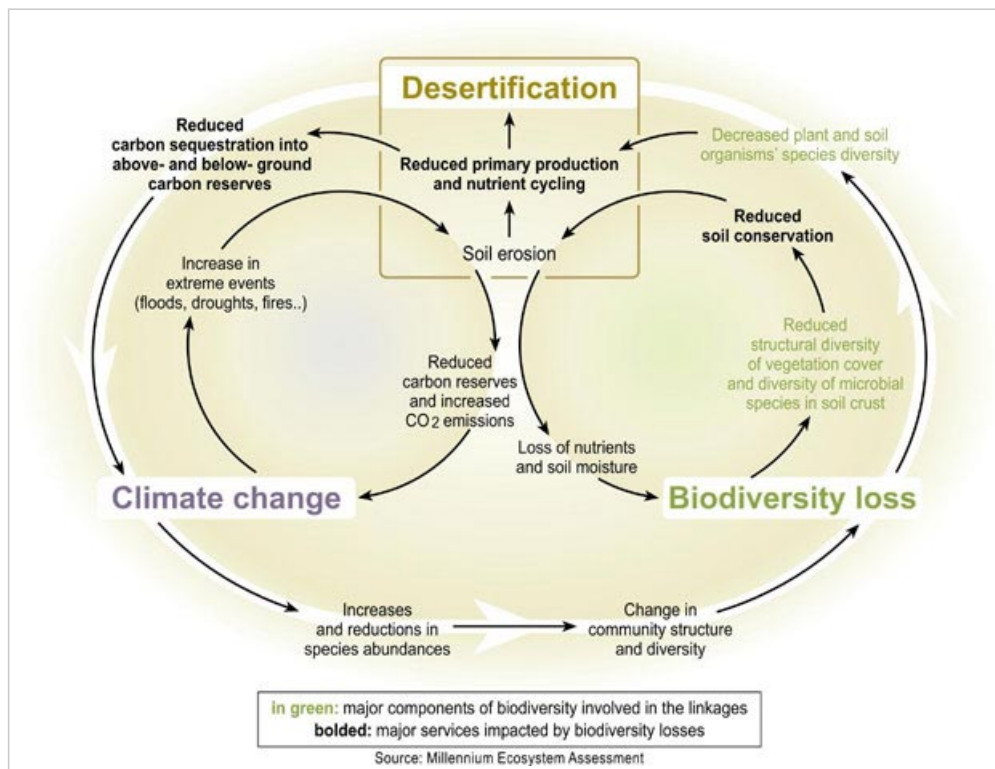
Scenarios:	Globalized		Regionalized	
	Reactive	Proactive	Reactive	Proactive
				
	<b>Global Orchestration</b>	<b>TechnoGarden</b>	<b>Order from Strength</b>	<b>Adapting Mosaic</b>
Desertification trends:				
- - - - -> worst case —————> best case				
Pressure exerted by 3 desertification factors:				
<b>Irrigation</b>	decreasing	increasing	increasing	remaining the same
<b>Poverty</b>	decreasing	increasing	<b>strongly increasing</b>	increasing   remaining the same
<b>Climate Change</b>	<b>strongly increasing</b>	remaining the same	<b>strongly increasing</b>	increasing

Source: based on MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.12

## Annex 7:

### Figure 6.1. Linkages and Feedback Loops among Desertification, Global Climate Change, and Biodiversity Loss

The major components of biodiversity loss (in green) directly affect major dryland services (in bold). The inner loops connect desertification to biodiversity loss and climate change through soil erosion. The outer loop interrelates biodiversity loss and climate change. On the top section of the outer loop, reduced primary production and microbial activity reduce carbon sequestration and contribute to global warming. On the bottom section of the outer loop, global warming increases evapotranspiration, thus adversely affecting biodiversity; changes in community structure and diversity are also expected because different species will react differently to the elevated CO<sub>2</sub> concentrations.



Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.17

## Annex 8:

### Table 1.1. Key Dryland Ecosystem Services

<b>Provisioning Services</b> <i>Goods produced or provided by ecosystems</i>	<b>Regulating Services</b> <i>Benefits obtained from regulation of ecosystem processes</i>	<b>Cultural Services</b> <i>Nonmaterial benefits obtained from ecosystems</i>
<ul style="list-style-type: none"> <li>• provisions derived from biological productivity: food, fiber, forage, fuelwood, and biochemicals</li> <li>• fresh water</li> </ul>	<ul style="list-style-type: none"> <li>• water purification and regulation</li> <li>• pollination and seed dispersal</li> <li>• climate regulation (local through vegetation cover and global through carbon sequestration)</li> </ul>	<ul style="list-style-type: none"> <li>• recreation and tourism</li> <li>• cultural identity and diversity</li> <li>• cultural landscapes and heritage values</li> <li>• indigenous knowledge systems</li> <li>• spiritual, aesthetic, and inspirational services</li> </ul>
<b>Supporting Services</b> <i>Services that maintain the conditions for life on Earth</i>		
<ul style="list-style-type: none"> <li>• soil development (conservation, formation)</li> <li>• primary production</li> <li>• nutrient cycling</li> </ul>		

Source: MA Desertification Synthesis Report [see <http://www.millenniumassessment.org/documents/document.355.aspx.pdf>] (2005), p.5

## Partners for this publication

The Levels 1 & 2 of this Digest are summaries of "Ecosystems & Human Well-being: Desertification Synthesis", a report published in 2005 by the Millennium Ecosystem Assessment (MA).

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