
**Environmental management —
Guidelines for establishing good
practices for combatting land
degradation and desertification —**

**Part 1:
Good practices framework**

*Management environnemental — Lignes directrices pour
l'établissement de bonnes pratiques pour combattre la dégradation et
la désertification des terres —*

Partie 1: Cadre de bonnes pratiques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 207, *Environmental management*.

A list of all parts in the ISO 14055 series can be found on the ISO website.

In the development of this document, ISO Guide 82 has been taken into account in addressing sustainability issues.

Introduction

Land degradation and desertification are fundamental and persistent problems that have long been recognized. They are caused by climate variability (e.g. drought and floods), other natural factors and unsustainable human activities, such as over-cultivation, overgrazing, deforestation, over-extraction of water, impacts of construction activities and unsustainable irrigation practices. These activities can lead to loss of vegetation and biodiversity, declining water supply and water quality, soil erosion and loss of soil fertility and structure. The consequences in the medium to long term are loss of agricultural and economic productivity, loss of soil quality and function and loss of ecosystem services, including biodiversity loss, and adverse social impacts.

Land degradation is estimated to affect up to 20 % of the world's drylands, according to the Millennium Ecosystem Assessment (2005) [46], and 25 % of cropland, pasture, forests and woodlands globally, according to FAO (2011)[32]. In addition, one third of the earth's population, i.e. 2 billion people, are potential victims of the increasing effects of desertification (UNEP, 2007[22]). Land degradation is both a significant driver of climate change through lack of favourable conditions for plants capturing carbon dioxide from the atmosphere and change in surface characteristics affecting solar reflectance (albedo) and is predicted to be exacerbated by climate change. Degradation and desertification greatly reduce ecosystem resilience to climate change.

Land degradation affects land productivity, and impacts directly on human livelihood and health and, in extreme cases, causes loss of life. Societies suffer from decreased access to adequate supplies of clean water, deterioration in air quality, threats to food security and declining economic status. These effects can be felt at all scales from the local to the global and by all people but especially the poor and the vulnerable.

Recognizing the significance of land degradation leading to desertification in dryland areas, the United Nations Convention to Combat Desertification (UNCCD)[18] was developed to combat desertification and mitigate the effects of drought in dryland regions, particularly in sub-Saharan Africa. The UNCCD recognizes desertification as a social and economic issue as much as an environmental concern. Therefore, it has a major focus on fighting poverty and promoting sustainable development in areas at risk of desertification. Parties to the UNCCD agreed to implement national, regional and sub-regional action programmes, and to seek to address causes of land degradation, such as unsustainable land management. This document is intended to complement and support the activities of the UNCCD by providing guidance to land managers on the establishment of good management practices that, when implemented, will reduce the risk of land degradation and desertification and assist in rehabilitation of lands affected by degradation. Land managers expected to benefit from the standard include land users, technical experts, private and public organizations, and policy makers involved in the management of land resources for ecological, productivity, economic or social objectives.

The purpose of this document is to provide guidelines for developing good practices to combat land degradation and desertification in arid and non-arid regions.

NOTE ISO/TR 14055-2 will provide regional case studies illustrating application the framework of this document to a range of land degradation cases.

This document refers to actions or interventions undertaken with the purpose of preventing or minimising degradation of land or, where land is already degraded, aiding the recovery of degraded land to improve productivity and ecosystem health.

This document seeks to provide a flexible approach to the implementation of good practices to combat land degradation and desertification by allowing for different types and scales of activities so that the guidance in this document can be applied to all activities and be relevant to public and private use. It aims to be applicable to the range of geographical, climatic, cultural and other circumstances. [Figure 1](#) illustrates the relationship between the guidelines for developing good practices presented under this document and environmental management systems and good practice programmes as they apply to land management.

Combatting land degradation is critical to achieving sustainable development and hence good practices programmes need to seek to attain a balance between environmental, social and economic goals. These goals are interdependent and need to be mutually reinforcing. For example, the capacity of individual land managers and communities to implement good practices for combatting land degradation can be limited by immediate challenges of poverty and hunger. Conversely, combatting land degradation will contribute to greater socio-economic as well as environmental resilience.

Provision of guidance on establishing good practices for managing land degradation and desertification benefits both land users and the wider community and can assist in increasing their resilience to climate change. It can also complement government policies to combat land degradation and desertification and contribute to objectives of parties to the UNCCD.

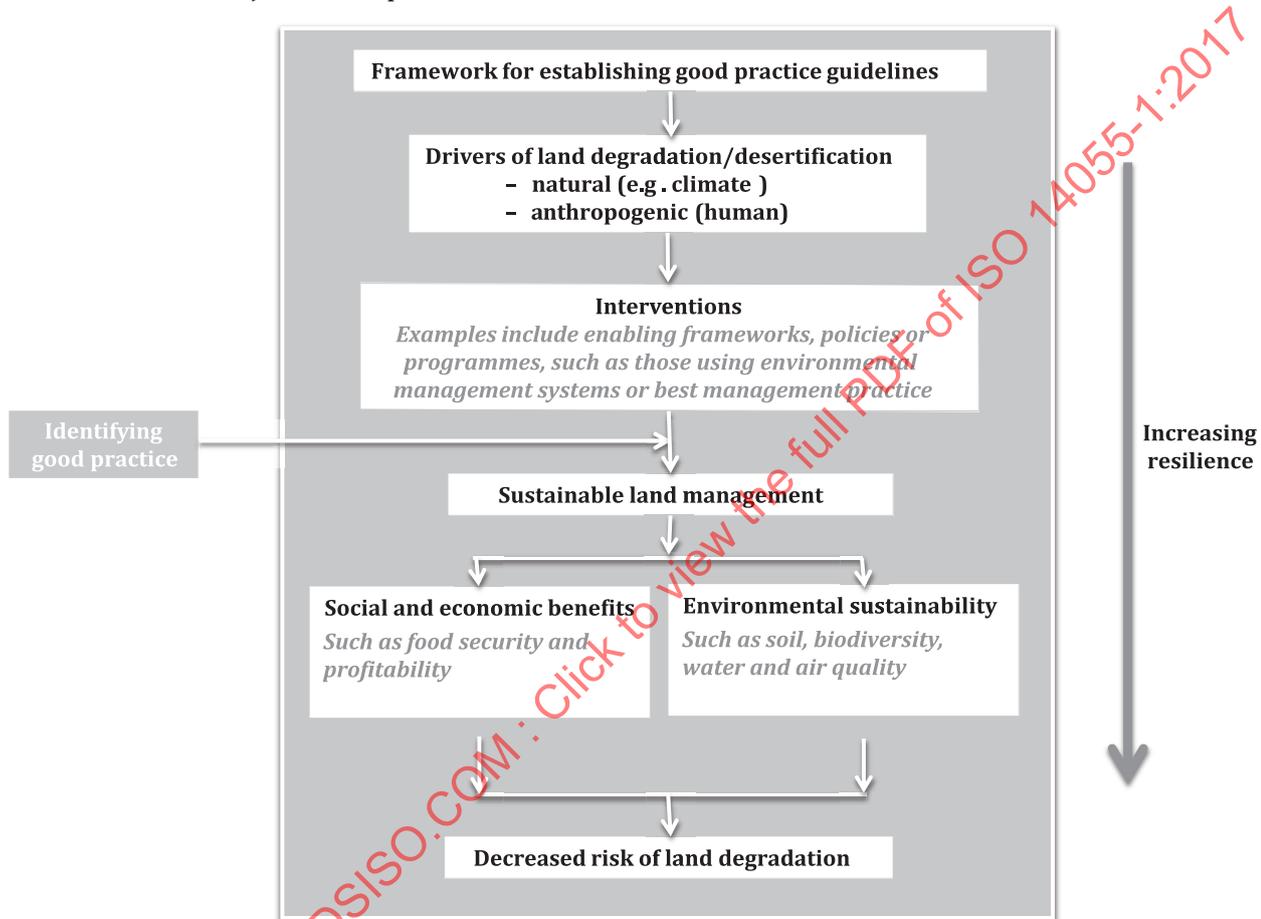


Figure 1 — Framework for establishing good practices for combatting land degradation and desertification

Environmental management — Guidelines for establishing good practices for combatting land degradation and desertification —

Part 1: Good practices framework

1 Scope

This document provides guidelines for establishing good practices in land management to prevent or minimize land degradation and desertification. It does not include management of coastal wetlands.

This document defines a framework for identifying good practices in land management, based on assessment of the drivers of land degradation and risks associated with current and past practices. Guidance on monitoring and reporting implementation of good practices is also provided.

This document is intended for use by private and public sector organizations with responsibility for land management and will allow an organization to communicate implementation of good practices.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 Terms related to combatting land degradation and desertification

3.1.1 ecosystem

dynamic complex of plant, animal and micro-organism communities and their non-living *environment* (3.1.7) interacting as a functional unit[SOURCE: CBD^[15], Art.2]

3.1.2 ecosystem service

benefit people obtain from *ecosystems* (3.1.1)

Note 1 to entry: Benefits include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth.

[SOURCE: UNEP^[22]]

3.1.3

good practice

method that has been proven to work well and produce good results, and is therefore recommended as a model

Note 1 to entry: Note to entry: Methods or techniques described as good practice have usually been tested over time and validated, in the broad sense, through repeated trials before being accepted as worthy of adoption more broadly.

[SOURCE: FAO Good Practices Template^[34], modified]

3.1.4

bio-productive capacity

capacity of *ecosystems* (3.1.1) to produce biological materials and to absorb waste materials

Note 1 to entry: Bio-productive capacity is also sometimes referred to as bio-capacity or biological capacity.

[SOURCE: Global Footprint Network^[16], modified]

3.1.5

biodiversity

variability among living organisms from all sources including, among others, terrestrial, marine and other aquatic *ecosystems* (3.1.1) and the ecological complexes of which they are part

Note 1 to entry: Biodiversity includes diversity within species, between species and of ecosystems.

[SOURCE: CBD^[15], Art.2]

3.1.6

habitat

place or type of site where an organism or population naturally occurs [SOURCE: CBD^[15], Art.2]

3.1.7

environment

surroundings in which an organization operates, including air, water, *land* (3.2.1), natural resources, flora, fauna, humans and their interrelationships

Note 1 to entry: Surroundings can extend from within an organization to the local, regional and global system.

Note 2 to entry: Surroundings can be described in terms of *biodiversity* (3.1.5), *ecosystems* (3.1.1), climate or other characteristics.

[SOURCE: ISO 14001:2015, 3.2.1]

3.1.8

sustainability

goal of *sustainable development* (3.1.9) which encompasses environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their needs

Note 1 to entry: Environmental, social and economic aspects interact and are interdependent. They are referred to as the three pillars of sustainability.

Note 2 to entry: Sustainability is a comparative concept, not a state or absolute value.

[SOURCE: ISO 13065:2015, 3.48]

3.1.9

sustainable development

development that meets the environmental, social and economic needs of the present without compromising the ability of future generations to meet their own needs

Note 1 to entry: Derived from the Brundtland Report.

[SOURCE: ISO Guide 82:2014, 3.2]

3.1.10

interested party

person or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity

Note 1 to entry: Customers, communities, suppliers, regulators, non-governmental organizations, investors and employees.

[SOURCE: ISO 14001:2015, 3.1.6, modified — Note to entry has been deleted.]

3.1.11

capacity building

building human, scientific, technological, organizational, institutional and resource capabilities

Note 1 to entry: These capabilities can differ between countries.

[SOURCE: UNCED^[56], Agenda 21, Chapter 37, modified]

3.1.12

off-site effect

effect that occurs away from the principle area of *land degradation* (3.2.13) or site of activity directly affected by *good practice* (3.1.3) actions

EXAMPLE Sediment loads into coastal marine systems due to land degradation at the source of a stream or river.

Note 1 to entry: The concept of off-site effect can also describe impacts in the future of a current intervention.

3.1.13

forest

land (3.2.1) spanning more than 0,5 ha with trees higher than 5 m and a canopy cover of more than 10 percent or trees able to reach these thresholds *in situ*, not including land that is predominantly under agricultural or urban land use

Note 1 to entry: According to FAO, stands in agricultural production systems, such as agroforestry systems when crops are grown under tree cover, fruit tree plantations and oil palm plantations, are excluded. FAO provides additional explanation about what a forest includes.

[SOURCE: FAO Forestry Paper 163^[31], modified — Additional explanation about what a forest includes has been omitted and Note 1 to entry has been added.]

3.1.14

deforestation

direct human-induced conversion of *forest* (3.1.13) *land* (3.2.1) to non-forest land [SOURCE: UNFCCC, 2006^[23]]

3.1.15

salinization

soil degradation (3.2.16) brought about by the increase of salts in the soil

Note 1 to entry: Salinization is also sometimes referred to as salination.

[SOURCE: FAO Soils Portal,^[38] modified]

3.1.16

drought

naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect *land* (3.2.1) resources and production systems

Note 1 to entry: Droughts can become longer or more intense due to climate change as a result of human activities.

[SOURCE: UNCCD^[18], Art.1c]

3.1.17

arid, semi-arid and dry sub-humid areas

areas, other than polar and sub-polar regions, in which the ratio of annual precipitation to potential evapotranspiration falls within the range from 0,05 to 0,65[SOURCE: UNCCD^[18], Art.1g]

3.2 Terms related to land

3.2.1

land

terrestrial bio-productive system that comprises soil, plant cover, other biota and the ecological and hydrological processes that operate within the system[SOURCE: UNCCD^[18], Art.1e]

3.2.2

rangeland

grassland and open woodland suitable for grazing

Note 1 to entry: Rangeland includes *land* (3.2.1) on which the native vegetation is predominately grasses, forbs (small species of flowering plants) and shrubs, and is managed as a natural *ecosystem* (3.1.1).

[SOURCE: UNCCD/LDD (1994)^[19], modified]

3.2.3

wetland

land (3.2.1) inundated with water, whether natural or artificial, permanent or temporary, that is static or flowing, brackish or salt

Note 1 to entry: Marsh, fen, *peatland* (3.2.6) and pans.

[SOURCE: Ramsar Convention on Wetlands^[17], Art.1, modified]

3.2.4

coastal wetland

salt water and fresh water *wetlands* (3.2.3) located within coastal *watersheds* (3.2.19)

Note 1 to entry: Coastal wetlands are found in the areas between *land* (3.2.1) and open sea that are not influenced by rivers, such as shorelines, beaches, mangroves and coral reefs.

[SOURCE: United States Environmental Protection Agency^[24]]

3.2.5

arable land

land (3.2.1) under temporary agricultural crop, temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow[SOURCE: FAOSTAT^[37], modified]

3.2.6

peatland

wetlands (3.2.3) with a thick water-logged organic soil layer (peat) made up of dead and decaying plant material

Note 1 to entry: Peatlands include moors, bogs, mires, peat swamp *forests* (3.1.13) and permafrost tundra.

[SOURCE: Wetlands International^[25]]

3.2.7

land use change

change in human use or management of *land* (3.2.1)

[SOURCE: ISO/TS 14067:2013, 3.1.8.4, modified — Definition of “direct land use change” has been adapted.]

3.2.8**organic matter**

matter consisting of plant and/or animal organic materials, and the conversion products of those materials

[SOURCE: ISO 11074:2015, 2.1.8, modified — Example has been deleted.]

3.2.9**soil quality**

all current positive or negative properties with regards to soil utilization and soil functions

Note 1 to entry: Soil quality describes the capacity of soil to function, sustain plant and animal productivity, maintain or enhance water and air quality, and support human health.

[SOURCE: ISO 11074:2015, 2.1.15, modified — Note 1 to entry has been added.]

3.2.10**soil fertility**

current status of a soil with respect to sustainable plant growth

Note 1 to entry: Soil fertility refers to the quality of a soil that enables it to provide nutrients in adequate amounts, form and balance for the growth of specified plants or crops.

[SOURCE: ISO 11074:2015, 5.1.9, modified — Note 1 to entry has been added.]

3.2.11**soil structure**

arrangement of particles and *organic matter* (3.2.8) to form aggregates which produce macro structures and micro structures in the soil

[SOURCE: ISO 11074:2015, 2.1.17]

3.2.12**crust**

surface layer of the soil, ranging in thickness from a few millimetres to a few centimetres, which is much more compact than the material beneath

Note 1 to entry: Soil crusting is associated with biological and chemical factors.

Note 2 to entry: A biological crust is a living community of lichen, cyanobacteria, algae and moss growing on the soil surface that binds the soil together.

Note 3 to entry: A precipitated, chemical crust can develop on soils with high salt content.

[SOURCE: Bulletin 69, FAO, 1993^[28], modified]

3.2.13**land degradation**

form of deterioration of the natural potential of *land* (3.2.1) that affects *ecosystem* (3.1.1) integrity, either in terms of reducing its sustainable ecological productivity or in terms of its native biological richness and maintenance of resilience

Note 1 to entry: FAO describes land degradation as having a wider scope than both *soil erosion* (3.2.15) and *soil degradation* (3.2.16), covering all negative changes in the capacity of the ecosystem to provide goods and services (including biological and water-related goods and services).

[SOURCE: GEF^[40]]

3.2.14

desertification

process of *land degradation* (3.2.13) in *arid, semi-arid and dry sub-humid areas* (3.1.17) resulting from various factors, including climatic variations and human activities

Note 1 to entry: Land is degraded when it can no longer support the same plant growth it supported in the past, and the change is permanent on a human time scale.

[SOURCE: UNCCD[18], Art.1a]

3.2.15

soil erosion

removal of soil by the physical forces of water and wind

Note 1 to entry: Soil erosion can be a slow process that continues relatively unnoticed or can occur rapidly, removing large amounts of soil in a single event.

Note 2 to entry: Unsustainable anthropogenic activities can increase the risk of erosion.

3.2.16

soil degradation

change in *soil quality* (3.2.9) resulting in diminished capacity of the *ecosystem* (3.1.1) to provide goods and services[SOURCE: FAO Soils Portal [38], modified]

3.2.17

land management

process of managing the use and development of *land* (3.2.1) resources[SOURCE: FAO Land Tenure Manuals, No 2, FAO, 2006[29]]

3.2.18

water table

upper surface of standing or naturally flowing ground water below which the ground is saturated with water, except where that surface is impermeable

[SOURCE: ISO 6107-3:1993, 89]

3.2.19

watershed

catchment

area of *land* (3.2.1) where all of the water that is under it or drains off of it goes into the same place[SOURCE: United States Environmental Protection Agency[24]]

4 Principles

4.1 General

The principles outlined in this clause are the basis for the guidance provided in this document and for its application.

The overall objective of the guidance provided in this document is to develop good practice programmes for combatting land degradation and desertification to maintain or improve productivity, biodiversity and other ecosystem services, and to aid sustainable land management. Respect for the principles set out in this clause will assist in developing and implementing good practices that are consistent with the needs of interested parties and their economic, social, cultural and spiritual values related to the land.

4.2 Sustainable development

Good practices for combatting land degradation and desertification contribute to sustainable development by balancing economic, social, and environmental development and aiding management of

land for productivity and ecosystem services while avoiding burden shifting to other regions or future generations.

4.3 Transparency

In developing good practices for combatting land degradation and desertification, there is a need for openness about decisions and activities that affect society, the economy and the environment. There is a need for willingness to communicate in a clear, accurate, timely, honest and complete manner to interested parties to make decisions on use of the good practices with reasonable confidence.

4.4 Social responsibility

A good practices framework for prevention or minimization of land degradation should be developed in consultation with interested parties and should be responsive to the views and needs of all participants, including indigenous peoples, local communities and vulnerable groups. Participation in developing a good practices framework should be encouraged.

As stated in ISO 26000, in developing good practices for land management, it is important to take account of the impacts of decisions and actions on society and the environment through behaviour that recognizes:

- the rights of all land users, e.g. small scale farmers and indigenous communities, to derive food security and sustainable economic benefit from their land;
- the expectations of interested parties, e.g. land managers and local communities;
- environmental sustainability of the ecosystem;
- relevant international agreements.

4.5 Partnership

Good practices should allow opportunities for interested parties to cooperate in partnerships to enhance their efforts in combatting land degradation and desertification

4.6 Scientific approach

When making decisions on good practices to combat land degradation and desertification, preference should be given to knowledge based on natural sciences (physics, chemistry, biology) and social and economic sciences. Examples of applications of natural science include, but are not restricted to, remote sensing, direct measurement of physical and chemical properties of soils, water resources, and ecosystem characteristics (see [A.2.1](#)).

If scientific evidence is not available, reference may be made to expert opinion and traditional land management knowledge, relevant and valid within the geographical scope of the land being considered. Bringing together traditional or local knowledge with scientific understanding in “hybrid knowledge” can provide strength in addressing sustainable development issues.

Decisions on good practices for combatting land degradation and desertification based on value choices should only be used if neither a scientific basis exists nor a justification based on other scientific approaches or international conventions is possible. Choices should be justified.

NOTE Value choices in good practices for combatting land degradation and desertification can relate to selection of data sources, land management practices, and other elements of establishing good practices.

4.7 Good governance

Good practices should take into consideration good governance, including:

- taking account of availability of resources (human and economic) for implementing good practices to combat land degradation and desertification;
- making provision for measuring, monitoring and reporting on good practices implementation;
- developing a mechanism for review of implementation of good practices and recommendations for improvement;
- ensuring accountability and transparency.

4.8 Alignment with national, regional and international initiatives

Good practices for combatting land degradation and desertification should be aligned with national, regional and international initiatives, guidance and frameworks.

4.9 Respect for human rights

In developing good practices for land management, recognition of both the importance and the universality of human rights should be taken into consideration including, but not restricted to, the rights of indigenous people, vulnerable groups and local communities.

5 Identification of factors contributing to land degradation and desertification

5.1 General

Those in public and private sector organizations with responsibility for land management and for implementing good practices for combatting land degradation and desertification should take information provided in this clause into account when identifying good practices to ensure they are effective, practical and consistent with sustainable development.

5.2 Drivers of land degradation and desertification

5.2.1 Overview of factors affecting the function of ecosystems

[Figure 2](#) illustrates natural factors and human activities that affect ecosystem function in a way that could lead to land degradation and desertification. Factors contributing to land degradation and desertification are extremely diverse and the diagram is not intended to include all contributing factors across the full range of ecosystems and circumstances subject to land degradation and desertification.

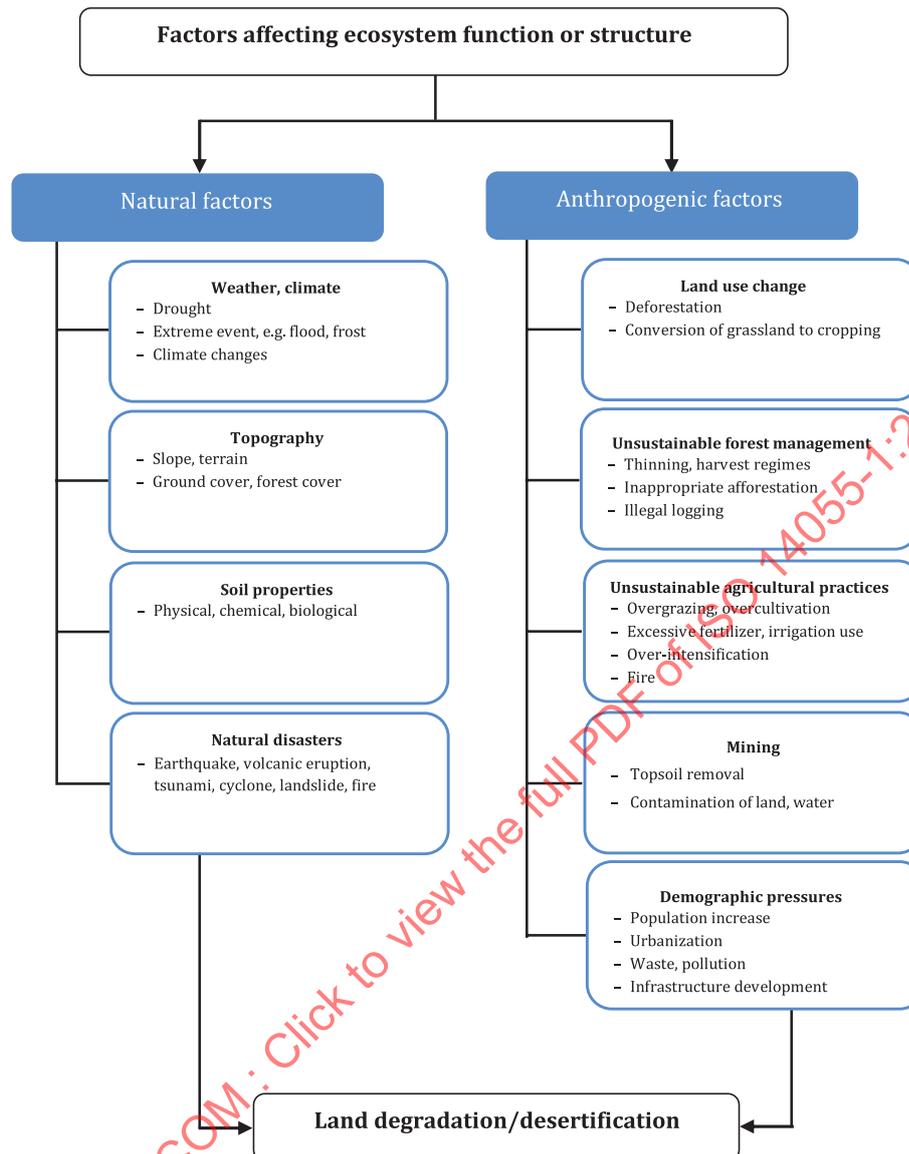


Figure 2 — Examples of major natural and anthropogenic factors that may lead to land degradation and desertification

5.2.2 Natural factors contributing to land degradation and desertification

5.2.2.1 General

Identification of natural drivers of land degradation requires observations and understanding of landscape characteristics that increase vulnerability to loss of productivity and ecosystem functionality when combined with human activities. The examples given in this clause illustrate natural drivers of land degradation and desertification noting that contributing factors will vary between regions and circumstances.

NOTE [Annex A](#) provides more information on natural factors that contribute to land degradation and desertification.

5.2.2.2 Weather and climate

Variability in climate and weather, including extreme weather events, are underlying drivers of land degradation and desertification. Elements to be considered in developing good practices to reduce the

risk of land degradation and desertification include the risks of droughts, floods and extreme rainfall events, high solar radiation, extreme temperatures and wind. The threat of land degradation is likely to be exacerbated by climate change due to increasing climate variability and more frequent and severe extreme weather events.

5.2.2.3 Topography

Slope and terrain affect run-off and permeability of the soil, and can increase vulnerability of soils to water erosion. Examples of degradation influenced by slope and terrain include landslides, loss of fertile topsoil and soil organic matter (SOM), run-off of nutrients and agricultural chemicals and gullying on hill slopes.

5.2.2.4 Soil properties

Soil physical, chemical and biological characteristics including soil structure, bulk density, organic matter content, salt content and microbial activity, affect soil vulnerability to degradation processes such as erosion.

5.2.2.5 Natural disasters

Natural disasters such as wildfires, earthquakes, volcanoes, tsunamis, cyclones and floods can result in changes to soil and vegetation characteristics of ecosystems and lead to biodiversity loss, habitat loss, decline in productivity and other forms of land degradation.

5.2.3 Anthropogenic factors contributing to land degradation and desertification

5.2.3.1 General

Identification of anthropogenic drivers of land degradation and desertification requires understanding of the impacts of human activities in combination with natural factors that increase the vulnerability of land to loss of productivity and ecosystem function.

NOTE [Annex B](#) provides more information on anthropogenic factors that can contribute to land degradation and desertification.

5.2.3.2 Land use change

Land use change may include deforestation for agriculture, urban expansion or infrastructure. It also refers to conversion of permanent pastures to cropping. Land use change may lead to loss of above-ground and below-ground biodiversity, increase in invasive species, loss of soil carbon, decline in soil quality, change in landscape hydrology and increased vulnerability to erosion.

5.2.3.3 Unsustainable forest management

Unsustainable forest management practices or afforestation activity that does not take into consideration suitability for local conditions and vegetation communities can result in loss of biodiversity, changes in catchment hydrology, increased risk of wildfire, changes in natural fire regimes, increased risk of water or wind erosion following harvest and long-term negative socio-economic outcomes.

5.2.3.4 Unsustainable agricultural practices

Agricultural practices that are unsustainable and contribute to land degradation and desertification include:

- over-cultivation, causing decline in soil structural stability, depletion of nutrients, loss of soil carbon and decline in water holding capacity;

- overstocking and overgrazing by domestic livestock, especially in arid and semi-arid rangelands and during drought or dry periods, which may result in loss of ground cover, increased vulnerability to erosion and loss of natural perennial species;
- inappropriate agricultural practices in both irrigated and dryland farming areas that can increase the risk of build-up of salts in the surface soil and lead to decline in chemical and physical properties and loss of soil microbial activity;
- unsustainable cultivation on sloping lands, such as mountain slopes and hillsides, without proper soil conservation practices, increasing the risk of erosion or landslides;
- excessive use of chemical fertilizers on crops or pasture, which can result in nutrient run-off and leaching, causing eutrophication and loss of water quality in freshwater or coastal systems, and emissions of nitrous oxide, which is a strong greenhouse gas;
- over-intensification of agriculture and inappropriate farming systems, which can lead to decline in soil nutrients and soil quality and increases in organic deposition and nutrient concentrations in adjacent water sources.

Note 1 to entry Thresholds for defining overgrazing, over-cultivation or over-intensification and perceived risk of negative effects on agricultural production will vary regionally and with local conditions.

5.2.3.5 Mining and other industrial activities

Mining and other industrial activities, such as manufacture of bricks, may lead to land degradation due to alteration of soil structure through excavation, removal of topsoil, and dumping of mined soil and contaminated waste. This may lead to the loss of soil fertility, loss of biodiversity and contamination of ground and surface water.

5.2.3.6 Demographic pressures

Demographic pressures, including infrastructure development and urbanization, contribute to land degradation through loss of arable lands, changes in hydrology and impacts of human waste and pollution. These pressures will increase with increasing population and competition for land resources, which may result in further encroachment on natural ecosystems, forests and agricultural lands.

5.2.3.7 Unsustainable biomass extraction for energy

Use of firewood, crop residues and cow dung as an energy source, in a way that reduces SOM content, vegetation and forest cover and that can also affect rainfall patterns and catchment hydrology, will contribute to land degradation.

5.3 Forms of land degradation

5.3.1 Soil erosion

5.3.1.1 Soil erosion by water

Types of soil erosion by water include:

- sheet/inter-rill erosion or surface wash by runoff water removes topsoil with loss of nutrients and SOM and results in decline of soil fertility and decrease in infiltration capacity;
- gully erosion or gullying, which results in the development of deep incisions, down into the subsoil, due to concentrated runoff;
- landslides, mudflows or mass movements of soil that occur locally and often cause widespread serious damage;

— riverbank erosion that occurs through lateral erosion of rivers cutting into riverbanks.

Off-site effects of water erosion include deposition of sediments and nutrients, downstream flooding, siltation of reservoirs, waterways and lagoons, and pollution of water bodies with eroded sediments.

5.3.1.2 Soil erosion by wind

Loss of topsoil by wind action is most common in arid and semi-arid climates, but may also occur in regions that are more humid. Wind erosion is nearly always preceded by a decrease in the vegetative cover of the soil.

Off-site degradation caused by wind erosion include covering of terrain with windborne particles from distant sources, which may contain contaminants from mining activities, e.g. mining dust, asbestos.

NOTE In arid and semi-arid climates, natural wind erosion is often difficult to distinguish from human-induced wind erosion; natural wind erosion is often exacerbated by human activities, such as cultivation or overgrazing.

5.3.2 Deterioration of soil chemical properties

5.3.2.1 Soil fertility decline

Soil fertility decline and reduced organic matter content may occur due to “soil mining” when nutrient removals through harvesting, biomass burning, leaching, etc. are not sufficiently compensated by inputs of nutrients and organic matter such as through addition of manure, crop residues and other organic amendments, chemical fertilizers, or via flooding. This type of degradation may also include nutrient oxidation and volatilization.

5.3.2.2 Acidification

Acidification is a process of decrease in soil pH over time. It can occur under natural conditions over thousands of years in high rainfall areas while rapid acidification can occur under intensive agricultural practices.

Practices that accelerate acidification include applying acidifying fertilizers, e.g. ammonium-based nitrogen fertilizers, to naturally acid soils at rates in excess of plant requirements, leaching of nitrate nitrogen from ammonium-based fertilizers out of the root zone, and continual removal of plant and animal produce and waste products from fields.

5.3.2.3 Salinization and alkalization

Salinization is the accumulation of salts in soil and water to levels that affect human and natural assets (e.g. plants, animals, aquatic ecosystems, water supplies, agriculture and infrastructure). Dryland salinity occurs where salt in the landscape is mobilized and redistributed closer to the soil surface and/or into waterways by rising groundwater. It may be caused by removal of deep-rooted trees, shrubs and grasses, and replacing with shallow-rooted species. Irrigation salinity occurs due to increased rates of seepage and groundwater recharge causing the water table to rise bringing salts into the plant root zone.

Alkalization occurs when a net increase in exchangeable sodium takes place. The main human cause of alkalization of soils is the use for irrigation of surface or ground water that contains relatively high proportions of sodium bicarbonates and less calcium and magnesium. Alkaline soils have low agricultural productivity due to decreased nutrient availability, low infiltration capacity and frequent waterlogging.

5.3.2.4 Soil pollution

Soil pollution may occur due to contamination of the soil with toxic materials. Sources may be local (e.g. waste that is inappropriately managed, untreated industrial discharges and local mining operations) or diffuse (e.g. atmospheric deposition).

NOTE Sources of contamination can include leachate from waste storage sites and overland flow from spill ponds. These might be due to poor management practices or extreme weather events.

5.3.3 Deterioration of soil physical properties

5.3.3.1 Compaction

Compaction due to trampling or the weight and/or frequent use of machinery causes deterioration of the soil structure by reducing porosity, increasing bulk density and consequently reduced infiltration rate and water holding capacity.

5.3.3.2 Sealing and crusting

Sealing or crusting is the clogging of pores with fine soil material and development of a thin impervious layer at the soil surface obstructing the infiltration of rainwater.

5.3.3.3 Waterlogging

Waterlogging occurs when drainage is impeded and the soil becomes saturated with water, limiting availability of oxygen to plant roots and microorganisms, and affecting soil chemical processes.

5.3.3.4 Subsidence

Subsidence or downward movement of soils may occur naturally, e.g. if caves collapse, or as a result of activities such as mining. Subsidence of organic soils may occur due to drainage of peatlands or low-lying heavy soils.

5.3.4 Degradation of soil biological properties

Loss of bio-productive capacity of soils may occur due to activities such as excessive use of agrochemicals or construction and mining operations that decrease soil microbial biomass and potential for agricultural productivity.

5.3.5 Degradation of soil water properties

5.3.5.1 Aridification

Aridification (long-term drying), which is often measured as a reduction of average soil moisture content, may be caused by changes in water balance, lowering of water tables or reduced ground cover. This results in reduced agricultural production, soil degradation, ecosystem changes and decreased water catchment runoff.

5.3.5.2 Change in surface water quantity or quality

Change in the quantity of surface water, such as altered flow regimes, drying up of rivers and lakes or decline of surface water quality due to increased sediments and pollutants in fresh water bodies, affect ecosystem function and agricultural productivity.

5.3.5.3 Change in groundwater level or quality

Change in groundwater and aquifer level may occur due to lowering of groundwater table as a result of over-exploitation or reduced recharge of groundwater, or higher groundwater table, e.g. due to excessive

irrigation waterlogging. Decline in ground water quality may occur, e.g. due to salt water intrusion or pollutants infiltrating into the aquifers, changes in water cycling and recharge of surface water.

5.3.5.4 Wetland area buffering capacity

Reduction of the buffering capacity of wetland areas decreases the resilience of ecosystems to flooding, run-off, droughts and pollution.

5.3.6 Degradation of ecosystem structure and biodiversity

5.3.6.1 Reduction of vegetation cover

Reduction in vegetative cover to establish settlements or for agricultural use decreases habitats and biodiversity and increases the area of bare or unprotected soil with potential for erosion and land degradation.

5.3.6.2 Loss of habitats

Loss of natural habitats occurs due to decreasing vegetation diversity in forest and agricultural lands resulting in a decline in biodiversity.

5.3.6.3 Decline in biomass

Replacement of forest after clear felling with secondary forest of reduced productivity results in lower biomass often with reduction in species diversity and reduced carbon stocks.

5.3.6.4 Change in fire regimes

Wildfires or prescribed burning of forest, bush, grazing and crop lands (e.g. by slash and burn of forests or burning of crop residues) can result in decline in above-ground biodiversity through loss of native species, including palatable perennial grasses, spread of invasive species and diseases and decline in below-ground species including earthworms, termites and microorganisms (such as bacteria and fungi).

6 Guidelines for establishing good practices and monitoring their implementation

6.1 Objectives for good practices to combat land degradation and desertification

6.1.1 General

When developing a framework for identification of good practices, the objectives should be clearly defined to ensure that efforts to combat land degradation and desertification will be practical and effective and will avoid the risk of adverse effects on sustainability locally or in other regions.

6.1.2 Objectives to consider when establishing good practices

6.1.2.1 Maintain or improve productivity

Good practices should prevent further loss of productivity and improve yields in land that is already degraded. Long-term food production and future food security are threatened by soil degradation, loss of prime agricultural land to non-farm uses and other elements of land degradation.

NOTE According to the World Meteorological Organization^[52], approximately 16 % of global agricultural land already has reduced yields due to degradation.

6.1.2.2 Decrease vulnerability to climate variability

A framework for identifying good practices should consider ways to increase resilience of ecosystems and communities to climate variability, especially drought, and extreme weather events that are recognized as major factors contributing to land degradation. Land degradation and desertification may increase vulnerability of ecosystems to climate variations, thus exacerbating the risk of further degradation.

6.1.2.3 Increase resilience to climate change

A framework for identifying good practices to combat land degradation should consider ways to increase resilience to the impacts of climate change and to mitigate the threat of future climate change. Climate change will add an additional pressure on natural and managed ecosystems, including agricultural, forestry and protected areas, that is predicted to exacerbate the risk of land degradation. Combatting land degradation and desertification will contribute to climate change mitigation by maintaining and enhancing carbon stocks in soil and biomass.

6.1.2.4 Maintain or improve ecosystem services

A framework for identifying good practices should recognize ecological functionality in different ecosystems, value ecosystem services and protect or restore vulnerable natural and managed ecosystems. Land degradation and desertification cause a decline in the goods and services provided by ecosystems including cultural values, productivity for food and fibre, carbon sequestration potential, and maintaining air quality and hydrological function.

6.2 Identifying applicable good practices

6.2.1 Identify regionally relevant land degradation and desertification factors

Identify natural and anthropogenic drivers contributing to land degradation and desertification affecting the region (see [Clause 5](#)). These drivers may be associated with past, current or potential natural factors and human activities.

6.2.2 Identifying legality and restrictions in the land use

6.2.2.1 Legal requirements and land use restrictions

Identify legal requirements and land use restrictions applicable to the land area, as appropriate, according to each national and local area.

6.2.2.2 Non legal land use measures

Set internal performance criteria, e.g. limiting the amount of sediment discharged to rivers flowing into sensitive ecosystems, fisheries, reservoirs for human water supply, or restricting human activities within a certain range of a watershed.

6.2.3 Criteria for good practices to combat land degradation and desertification

6.2.3.1 Basis for good practices

Using the principles set out in [Clause 4](#), good practices should be developed to address drivers of land degradation and desertification identified in [5.2](#). These good practices should act to minimize the risk of land degradation and desertification and assist recovery of any existing degradation by contributing to measures that are sustainable and maintain or improve the productive potential of the land, ecosystem structure and function and the quality of ecosystem services.

6.2.3.2 Criteria for good practices

Good practices should act to combat land degradation and desertification by:

- preserving and increasing the productive characteristics and qualities of the soil;
- conserving biodiversity within natural ecosystems, agricultural lands, and plantation forests including protecting endangered species;
- conserving the integrity of waterways, watersheds and the quality of water;
- managing the impacts of anthropogenic activities such as mining, urbanization and land use changes.

6.3 Framework for planning and implementing good practices

6.3.1 General

A framework for implementing good practices to combat land degradation and desertification consists of a cycle of action through steps to:

- a) develop a good practices action plan;
- b) implement the good practices action plan;
- c) monitor and evaluate the impact of the action plan;
- d) periodically review the results and iteratively refine the action plan.

See [Figure 3](#).

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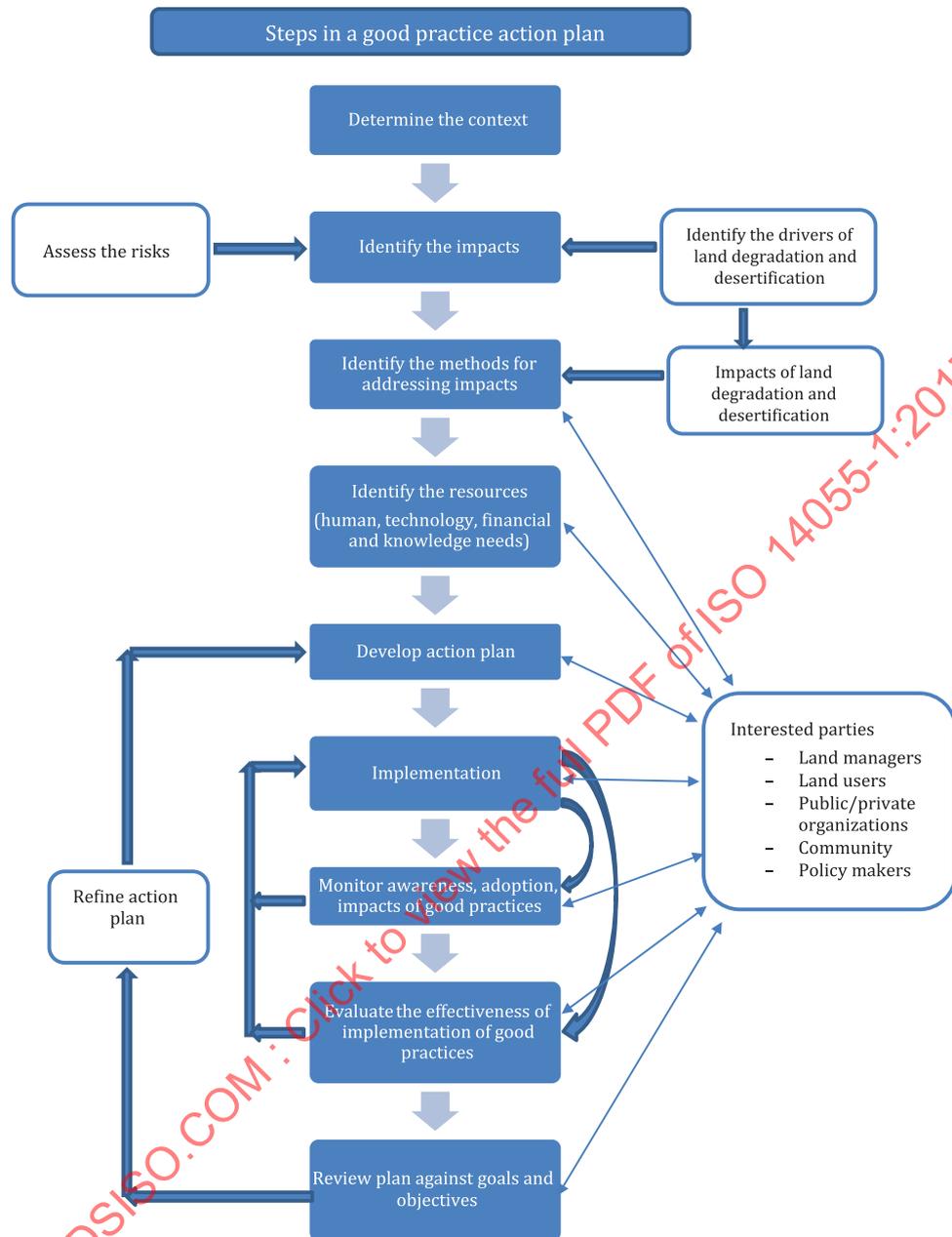


Figure 3 — Steps in a good practice action plan

6.3.2 Developing a good practices action plan

- a) Determine the context in which the land degradation has occurred/may occur, including the needs and expectations of the relevant interested parties.
- b) Identify the land degradation problem, which may be related to past or current practices.
- c) Identify the drivers of land degradation including the impact of past/current practices.
- d) Assess the risk of future land degradation under projected changes, e.g. climate change, demographic change.
- e) Assess the impact of land degradation on sustainability and the interested parties.
- f) Identify methods to address the significant impacts, including good practices based on the situation and location; method selection should include cost-benefit analysis.

- g) Identify what is to be monitored and the monitoring cycle necessary to determine the effectiveness of the methods selected.
- h) Identify the resources needed and those actually available.
- i) Develop an action plan to implement the methods and monitor the results within the resources available.

6.3.3 Implementing the action plan for good practices

6.3.3.1 General

Implementation of the action plan for good practices to combat land degradation and desertification should include active and ongoing cooperation between interested parties at all levels of responsibility.

6.3.3.2 Interested parties with regional responsibility

Those with regional responsibility should:

- communicate good practices to land users and other stakeholders;
- encourage development of partnerships and collaborative activities;
- monitor availability of economic and human resources;
- where necessary, provide appropriate training and capacity building.

6.3.3.3 Interested parties with responsibility for local land use

Those with direct responsibility for local land use should:

- implement sustainable practices appropriate to their land based on the action plan;
- work cooperatively with other land users and local community within the region.

6.3.4 Monitoring the effectiveness of implementation of the action plan

6.3.4.1 General

The awareness and adoption of good practices can normally be measured within a shorter period than outcomes of the actions, i.e. as a decrease in the extent or severity of land degradation or desertification. Some outcomes of the implementation of good practices may take considerable time (e.g. decades) before being evident or fully effective. The outcomes may also result in changes off-site. Awareness and implementation of good practices and changes in land condition should be monitored.

6.3.4.2 Monitoring awareness and adoption of good practices

Relevant techniques for monitoring awareness and implementation of good practices may include:

- land holder surveys across the region;
- verbal reporting;
- other discussions or records as part of regular on-going communication.

6.3.4.3 Monitoring the effectiveness of implementation of good practices for land degradation

Data should be collected at suitable and practical time intervals to monitor land, soil, water and biodiversity condition indicators appropriate to the local circumstances. Indicators of land degradation and desertification should be applicable to the local conditions. Where available, indicators of land

degradation defined by authoritative organizations such as UNCCD should be used and may be appended to this document. Guidance for indicators of land degradation in non-arid lands may also be developed from these indicators or from other appropriate authoritative sources. Monitoring techniques may include:

- direct reporting by land users;
- use of remote sensing data for land cover, e.g. using aerial or satellite imaging;
- direct monitoring and measurement of indicators such as soil quality, sediment loads or forest density;
- review of critical incidents such as chemical spillages or landslides.

NOTE For forms of land degradation, see [5.3](#).

6.3.5 Reviewing and refining the good practices action plan

Based on the findings of the monitoring and measurement programme, the suitability, adequacy and effectiveness of the good practices action plan should be evaluated as part of continual improvement. The programme of periodic review should be appropriate to the objectives and regional circumstances, e.g. annual review. The results of the review should form the basis of iterative improvement in the good practices action plan and its implementation, noting that improvements in land condition may take several years to become apparent and that available resources may change over time.

6.4 Communication

Communication should include the exchange of information relevant to the interested parties and purpose. Characteristics of an effective communication strategy include:

- direct communication with local groups and other relevant interested parties, e.g. workshops, drama/plays, media;
- appropriate language and methods of communication, e.g. face-to-face meetings;
- ensuring opportunities for informal two-way conversations;
- utilizing existing communication channels;
- timeliness;
- inclusiveness by ensuring all interested parties are consulted;
- reinforcement of messages;
- maintaining contact and being responsive;
- providing opportunities for sharing of experiences and lessons learnt to build collective knowledge;
- gathering and responding to feedback;
- recording outcomes of consultation;
- publication in reports or technical journals.

Annex A (informative)

Natural factors contributing to land degradation

A.1 General

A range of natural factors can make landscapes more vulnerable to degradation and when combined with human activities this risk can result in varying degrees of land degradation and desertification from which recovery may be very slow or impossible. Climate and extreme weather events exert a strong influence over vegetation type, biomass and diversity. Precipitation and temperature determine the potential distribution of terrestrial vegetation and constitute the principal factors in the genesis and evolution of soil. Precipitation also influences vegetation production. In wet climates, precipitation supports growth of rich forests but if these are cleared, intense precipitation can lead to landslides and water erosion. In dryer environments, precipitation controls the spatial and temporal use of land for grazing and when precipitation is very low favours the nomadic lifestyle.

Vegetation cover becomes progressively thinner and less continuous with decreasing annual rainfall. Dryland plants and animals display a variety of physiological, anatomical and behavioural adaptations to moisture and temperature stresses brought about by large diurnal and seasonal variations in temperature, rainfall and soil moisture. The generally high temperatures and low precipitation in the drylands lead to poor organic matter production and rapid oxidation. Low organic matter leads to poor aggregation and low aggregate stability leading, in turn, to a high potential for wind erosion. The severity, frequency and extent of erosion are likely to be altered by changes in rainfall amount and intensity and changes in wind. Changes in vegetation cover are likely to result from short-term changes in weather and from longer-term climate change. In turn, this is likely to affect SOM dynamics and vulnerability to erosion.

Volcanic eruptions can cause local land degradation due to the deposition of lava and ash, change in surface soil structure and permeability, and damage to vegetation. In the longer term, volcanic soils can become highly fertile.

Elements to be considered in developing good practices to reduce the risk of land degradation and desertification include intense or extreme precipitation events, floods, droughts, dust storms, hazards (e.g. health, transport effects), ecological productivity brought about by changes in climatic and weather factors such as temperature, rainfall, wind speed, solar radiation, evaporation and environmental change including climate change.

A.2 Weather and climatic factors

A.2.1 Climate variations

Weather and climate are underlying drivers of land degradation, in both arid to semi-arid regions and non-arid regions. Climatic stresses include high soil temperature, seasonal excess water, short duration low temperatures, seasonal moisture stress and extended moisture stress. In drier environments, precipitation patterns (distribution and amount) control the spatial and temporal use of land.

Drought is a natural event originating from a deficiency of precipitation, which results in shortage of water for some processes, activities or groups. It is the consequence of a reduction in the amount of precipitation over an extended period of time, usually a season or more in length. In association with other climatic factors, such as high temperatures, high winds and low relative humidity, the severity of the drought event is aggravated. Flooding resulting from high seasonal rainfall or high intensity

rainfall events is also a major driver of land degradation, especially in combination with topographical features such as slope and poor soil structure.

Changes in weather and climate factors, in particular temperature and precipitation, have profound impacts on the bio-functionality of land and/or soil quality. These are manifested by changes during the cropping season (planting date), frost incidence (cold spells), reduced soil microbial activity, reducing vegetation cover, limited water resources as well as changes in land-use practices (e.g. conversion of lands into other uses) and depletion of soil nutrients. For example, in drylands, a shift in the onset of planting dates due to climate change has been reported. Erosional features due to loss of biomass and vegetative cover are a consequence of erratic and highly variable rainfall. Similarly, changes in the river flow regime will impact on potential stream sediment loading and the availability of water for irrigation. Ecosystems integrity and services are therefore negatively impacted leading to overall loss in environmental quality.

A.2.2 Extreme precipitation events

Rainfall events can give rise to serious episodic events (e.g. overland flow and runoff) depending on intensity of precipitation; duration of precipitation; the wetness of the ground and the response of the catchment. Runoff water losses will result in limited water availability to plants.

A.2.2.1 Drought

Higher evapotranspiration and more sunshine hours (solar radiation) increase the occurrence/prevalence of droughts in many ecological settings. For example, highly variable and seasonal precipitation and dry spells limit water resources to sustain crops, with subsequent effects on poverty and reduced food and fibre production and consequently the livelihoods of most communities.

A.2.2.2 Floods and storms

Floods emanate from intense rainfall events coupled with inadequate drainage systems, whereby the soil infiltration capacity is exceeded. Land use change which denudes cover may lead to soil surface crusting, poor soil structure and hence less infiltration. Floods can lead to water erosion, landslides, and damage to property, infrastructure and general well-being. Some floods are associated with storms like hurricanes, sea rises and other extreme events. Globally, such events are predicted to increase with climate change. In some drylands, a shift from generally well-spread rains to intense rainstorms is causing degradation in terms of direct loss of agricultural production as well as moisture stress and crop failures. Health-related challenges exist, e.g. fever, malaria and other related water borne diseases; as well as provision of adequate sanitation.

A.2.3 Extreme temperature events

A.2.3.1 Heat waves

Heatwaves are predicted to increase globally due to the effects of climate variability and change (IPCC, 2007^[41]), as well as urbanization through urban heat islands. The confined urban setting has a lot of waste energy in the form of heat. One of the indicators of climate change is temperature increase, with adverse impacts on people, their living environment, biodiversity as well as water resources use. Heatwaves have pose challenges in many spheres of life, including through elevated human deaths, especially affecting the elderly. In addition, heatwaves put a huge pressure on electricity consumption with positive feed-forward on climate change through higher energy consumption. High temperatures negatively affect daily livelihood activities (e.g. productivity decline due to inability to work under extreme day temperatures). This may lead to food insecurity and decreased livelihood assets through low yields, poverty, malnutrition and disease.

A.2.3.2 Frosts and cold spells

Cold spells are generally caused by weather systems typified by cold air masses, occurring especially during the winter season. These cold air masses negatively affect ecosystem goods and services. For

example, frosts decrease agricultural production due to crop failure and mortality of livestock. In the Polar and Arctic regions, extreme cold can lead to loss of human life, while in some cold regions provision of services such as transport and water supply (e.g. due to frozen water pipes) is interrupted. Cold spells also increase costs of maintenance and aspects of daily living including provision of services such as high energy consumption. Cold spells also increase the risk of fatalities from hypothermia amongst the homeless and poor.

A.3 Topography

Sloping topography is a driver of land degradation where land management practices for agriculture, urban development and mining disturb natural ecosystem stability, particularly in high rainfall regions (World Bank, 2008^[59]). Sustainable forest management practices can protect against land slippage or landslides on steep slopes, thus mitigating land degradation on slopes. Landslides occur most frequently in areas of steep slopes, deep highly erodible soils, weathered and jointed bedrock, usually after periods of intense and prolonged rainfall. They may be triggered by earthquakes. Retaining forest ecosystems which have greater stability and resilience to extreme weather events such as heavy rainfall can also play a key role in adaptation to climate change. In addition to deforestation and removal of vegetation cover, excavation during infrastructure development and the weight of large buildings can increase the risk of landslides on sloping topography.

A.4 Soil properties

The vulnerability of soil to degradation, including erosion, depends on physical, chemical and biological properties, including the following:

- a) soil physical properties:
 - soil texture;
 - soil structure;
 - water holding capacity;
 - soil bulk density and porosity;
 - permeability and hydraulic conductivity;
 - drainage properties;
 - electrical conductivity;
- b) soil chemical properties:
 - soil fertility (nutrient status);
 - cation exchange capacity;
 - soil acidity;
 - soil salinity;
 - soil alkalinity;
- c) soil biological properties:
 - soil microorganisms;
 - soil flora and fauna;
 - SOM (soil carbon);

- ground cover.

A.5 Natural disasters

A.5.1 Wildfires

Wildfires, which may occur naturally or be started by humans, affect natural environments and may cause loss of property and lives. For example, fires on the veldt cause direct loss of vegetation, with implications for land use and resource condition and availability. Wildfires tend to occur mostly in seasonally distinct climates, e.g. wet followed by dry. They may result in aerosols in smoke that adversely affect air quality and health. Meteorological conditions and vegetation type/state (e.g. fuel load) influence the intensity of the fires, which, in turn, determines the degree of nutrient loss, tree mortality and the impact on ecosystem dynamics.

A.5.2 Volcanic eruptions

Volcanoes are perforations in the earth's crust through which molten rock and gases escape to the surface. Volcanic hazards originate from two classes of eruptions namely explosive and effusive.

Explosive eruptions originate in the rapid dissolution and expansion of gas from the molten rock as it nears the earth's surface. Explosions pose a risk by scattering rock blocks, fragments, and lava at varying distances from the source.

Effusive eruptions refer to material flow rather than explosions are the major hazard. Flows vary in nature (mud, ash, lava) and quantity and may originate from multiple sources. Flows are governed by gravity, surrounding topography, and material viscosity.

Hazards associated with volcanic eruptions include lava flows, falling ash and projectiles, mudflows, and toxic gases. Volcanic activity may also trigger other natural hazardous events including local tsunamis, deformation of the landscape; floods when lakes, streams and rivers are dammed, and create landslides.

Annex B (informative)

Anthropogenic factors contributing to land degradation

B.1 General

Urbanization, infrastructure development (e.g. roads), replacing vegetation with hard and continuous impermeable surfaces and buildings, and agricultural development all affect the functioning of ecosystems and the resilience of land to degradation. Agriculture occupies more area than any other land use and has caused varying degrees of degradation in many regions of the world. The change of land use from natural forest, savannah or grassland ecosystems has affected the integrity and functioning of ecosystems. Agriculture has brought removal of vegetation, tillage, burning, introduction of new plant and animal species, and excessive use of agrochemicals to the ecosystems. In arid and semi-arid regions, natural factors (see [Annex A](#)) often make the regions vulnerable to degradation when human activities disturb the natural fine balance in ecosystems. In regions that have higher productivity, farming systems focused on developing high yielding varieties of crops, intensive cultivation, and use of chemical pesticides and herbicides have caused problems including:

- excessive disturbance through mechanical tillage;
- declining stocks of soil carbon;
- degradation of soil biological quality and soil microbial populations;
- reduced soil moisture storage;
- excessive use of mineral fertilizers;
- poor water infiltration and increased runoff;
- compaction and poorly developed root systems;
- run-down of nutrient levels.

Interaction between natural and anthropogenic drivers of land degradation is complex, involving biophysical, social and economic factors. Poorer people, for whom food production is often an immediate need, are likely to be farming land that is steeper and has shallower, less fertile soils and lower rainfall (World Bank, 2003^[58]). These fragile environments are more susceptible to land degradation and the poor are likely to have less capacity to adopt long-term sustainable land management practices and have greater risk of being caught in a cycle of land degradation, poverty and food insecurity (ODG, 2006^[48]).

B.2 Land use change

Loss of forest cover commonly results in loss of associated native plants and animals and consequently degradation of the diversity and integrity of regional ecosystems with downstream effects on ecosystem services. Between 1990 and 2015 there was a net loss of 129 000 000 ha of forest globally. The amount of forest cleared each year remains high with natural forest area having decreased by a net 6,500 000 ha/year for the period from 2000 to 2015. This was a reduction in net loss compared to the period from 1990 to 2000 of 10,600 000 ha/year, according to FAO (2015)^[35]. The main driver of forest loss globally is expansion of agricultural land, which occurs from small-scale farmers to large multinational companies. Other drivers of deforestation include expansion of settlements, infrastructure and mining.