# 6

# Water resources assessment

### Introduction

Water resources, their management and any degradation are important to land resource components in most dryland assessment sites. Water resources degradation and effects of land degradation on water quantity and quality should be assessed in more depth in areas where this is reported to be a critical issue. Of particular concern are:

– the effective use of rainwater for direct consumption, for productive purposes and for recharging surface and ground-water supplies;

– the reduced water quality through pollution, salinization and over-exploitation (by domestic, agricultural, forest and industrial uses);

– the reduced water quantity / availability for consumption (human and animals) and other uses because of drought or over-exploitation of water sources;

– the maintenance of the hydrological regime (i.e. recharge of groundwater, flood control – in catchments and watersheds)an important ecosystem service;

– the extent and performance of water resources management alongside soil, land use and vegetation management for mitigating effects of desertification, drought, and climate change.

## Water indicators and assessment methods

There are three main components to assess the water resources in the local assessment area:

1. A review of the secondary information (see Section 5.2 in Part 1 of Manual (FAO, 2011a));
2. A key informant interview on water resources Tool 6.1 below); and
3. Field measurements of biophysical indicators for specific water sources including the effects and effectiveness of various water conservation, harvesting and irrigation measures (Tool 6.2, below).

It is important to *triangulate and thereby validate the information* derived from these three tools and sources of information. Water is a cross-cutting issue, so it is also important to relate the information on water resources with other sections of the assessment (vegetation, soil and livelihoods).

## Tool 6.1  Key informant interview on water resources in the study area

The key informants for this exercise should be members of the community who are knowledgeable of the water resources in the local area. A small group (male and female) should be selected following the community focus group discussion (Tool 1.1). The interview focus is on changes in water resources quality, quantity, and availability. It should cover on-site information (water sources, watering points, evidence of runoff etc.) and wider off-site or ecosystem effects of land use / management practices (e.g. impacts of losses from surface runoff and evaporation from bare ground); the effects on the hydrological regime (e.g. change in water flow and availability, depth of water table, drought periods and peak flood levels etc.).

The information needs to reflect:

- ✖ the status and trends (S) of the water resources in terms of water quality, quantity and the hydrological regime (S);
- ✖ change in demand or pressures on water resources (P) and related drivers (D);
- ✖ the impacts (I) of changes in water quality and availability on productivity, livelihoods and the environment;
- ✖ some actual and possible policy or management responses (R) to conserve and / or manage water resources.

The focus group discussion with the community members and the reconnaissance visit / transect walks (Chapters 1 and 2) should answer questions on the general state and trends of the water resources in the study area. However, with accompanying land users and key informants, the team should complete their assessment by visiting most water sources in the study area(s) and answer some of the following questions.

[**Note:** as with all questionnaires, the questions have to be reviewed by the team prior to the field assessment, in order for them to be adapted and specific to the local context.]

**In the study area, discuss the following issues with land users and key informants:**

### 1. Changes in hydrological regime and water supply

**1.1 Changes in the hydrological regime and sediment-related processes such as:**

- ✖ surface runoff;
- ✖ peak flow / floods;
- ✖ base flow / dry season flow;
- ✖ ground water recharge;
- ✖ soil moisture recharge;
- ✖ erosion and sediment load.

(For example, high runoff could influence the size and severity of gullying and the quantity of sand deposited in reservoirs);

### 1.2 Drought / flood risk and incidence:
- ✖ Do serious droughts / floods occur in the area? How frequent are the drought / flood events? Have they become more or less common in the last 10 years? Why do local people think this is happening (i.e. such as bare, compacted or crusted soils increasing runoff and hindering infiltration, the use of less drought resilient crop species, the deviation of streams / oueds)/
- ✖ What is the period of drying up / flooding (months and interval)?
- ✖ What are the main impacts they have on the different livelihoods activities?

### 1.3 Changes in water quality of the different water sources and their causes:
- ✖ Pathogens;
- ✖ Nutrients and organic matter;
- ✖ Pesticides and other persistent organic pollutants;
- ✖ Salinity.

(For example, lower, stable or increasing pollution or salinity.)

### 1.4 Changes in water availability:
Types of surface and ground water sources, their number, their uses (e.g. human consumption, livestock, agriculture, industry), their size / capacity and any trends (e.g. decreasing, stable, increasing surface and / or ground water levels).

[**Note:** here it is important to understand causes of any changes in depth and quality of the ground water table. For example, in a pilot area in China, the water table had fallen some 2 metres over a number of years but local experts did not know the impact / relative importance

of pumping for irrigation and household use or tree planting. The extent of land use changes need to be monitored and linked to water information (available form water authorities etc.)].

### 1.5 Distance and access to water:
- ✖ What is the approximate distance (km) and time (min) taken to reach water for: i) domestic consumption in the dry and wet seasons and for ii) livestock watering in the dry and wet seasons? Any changes in the last 10 years?
- ✖ How far (km) are the main grazing areas from nearest potable water source in: i) the dry season and i) the wet season? Has this changed over the last 10 years?

## 2. Water resources management and changes in demand

### 2.1 Demand on water:
Water use, water withdrawal, and water infrastructure:
- ✖ What changes have there been in demand on water and water withdrawals in the last decade for the different water uses (e.g. number of dried-up wells / boreholes)?
- ✖ How is the water supply managed and by whom? Is the management sustainable and equitable?
- ✖ Do all people in the community / area have equal rights to use water resource? If not what are the differences?

### 2.2 Water resources management
Have there been changes in the last 10 years in water conservation, water harvesting activities and irrigation:
- **a- Soil and water conservation:** What techniques are used to optimise moisture and water capture, retention, infiltration and groundwater recharge? Have they

been effective in enhancing productivity / reducing degradation by wind and water erosion / maintaining surface and ground water supply? The answers could include one of more of the following:

- Bench terraces (level, forward or backward sloping);
- Contour bunds / banks (level, graded, semi-circular, v-shaped, trapezoidal etc.);
- Graded ditches, waterways and cut-off drains;
- Level ditches / pits (infiltration, retention, sediment and sand traps);
- Soil cover and mulching.

**b- Water harvesting:**

What are the water harvesting techniques present? Is the water collected used for agriculture, domestic use and / or livestock watering? How common is this harvesting (i.e. common, present, negligible)? The answers could include one of more of the following:

- Dams, tanks, reservoirs and pans to store excessive water;
- Roof catchment and cisterns;
- Negarim, half moon, zai etc..

**c- Irrigation:**

What are the types of irrigation systems are operational? What is the proportion of each type? The answers could include one of more of the following:

- Flood (%);
- Sprinkler (%);
- Drip (%);
- Pressure hose (%).

[It would also be useful to note any systems which are no longer operational and why.]

**d- Are these measures effective in ensuring water use efficiency (high, moderate, low)?** In terms of:

- Water capture and retention;
- Meeting plant water requirement;
- Drainage and leaching;
- Losses such as pipe / canal leakages;
- Losses through runoff;
- Standing water and evaporation from bare soil.

**e- Constraints:** What are the constraints to more productive / effective use of water? in regard to:

- salinity;
- shortage / access;
- conflicts;
- cost.

**f- What are the impacts of the measures? in terms of:**

- productivity;
- income;
- health;
- reduced risk (crop failure, livestock mortality).

**g- What is the % of people applying these different water management techniques in the study area / community territory?**

## 2.3 Water policy, legislation and institutional aspects

(i.e. what are the arrangements for water allocation / water rights and water conflict resolution / byelaws on water resources use and their application? Have there been significant changes in the last 10 years and why?

## 3. Off-site / on-site impacts on water resources:

Land use management in the study area may affect the water resources outside of the study

area; as well as land use management outside of the study area may affect the water resources in the study area.

It is important to consider wider on-site - off-site causes of water resources degradation during the assessment, such as:

- ✖ increasing pressure / demand on the water sources, removal of natural vegetation, overgrazing, or inappropriate cultivation in the vital "sponge" areas of wetlands;
- ✖ drainage or permanent alteration of the water levels and flows to accommodate other use(s) of the water body (e.g. for building or irrigation purposes). This change can be caused by direct human interventions (e.g. drainage) or by a natural change such as change of a river course due to floods leading to sedimentation or deepening of the river channel or erosion of the banks.
- ✖ inflow of nutrients in run-off from fertilized farmland (causing rapid growth of algae in the water which depletes the oxygen supply in the water and may kill plant, fish and animal life);
- ✖ inflow of non-selective pesticides or herbicides in run-off from adjacent or upstream farm land - that effect water quality and impacts on animal and plant populations, also aquatic functions;
- ✖ changes in the water regime leading to increased floods, or reduced low flows (e.g. change of perennial to seasonal flow, perhaps attributable to draining of wetlands)
- ✖ human activity such as damming for water storage, irrigation or recreation and pollution in or close to the water body.

1. Does local land use and management (vegetation, soil and water) in the study area affect water resources in off-site/neighbouring areas? (Select impacts from Table 36 below or note additional impacts).

2. Does land use and management outside the study area affect the water resources in

TABLE 36  **Off-site /on-site impacts on water resources caused by land use and management**

| On / off-site impacts on water resources of land use and management |
| --- |

- Changes in water flow (peak, base)
- Floods during extreme events or the rainy season
- Sediment deposition/accumulation and dust storm
- Contamination by airborne pollutants (e.g. from industry, mining, urbanization) affecting vegetation, soil and water resources)
- Change in surface water availability during dry seasons/spells, droughts (e.g. river flows, lake levels, dams, ponds, etc.)
- Changes in the water course of a stream or "oued"*
- Change in ground water/subsurface water availability
- Change in water constraints (water-logging, water salinity)
- Change in water quality (for drinking, for agricultural or industrial use)
- Change in water retention capacity of dams and upstream lakes (water storage and regulation)
- Road damage due to intense rainfall, runoff and uncontrolled flow in Oueds
- Active erosion gullies (unstabilised)
- Increase in water extraction from increased numbers of private or illegal wells/ boreholes
- Other (specify)

* **Oueds** are dried out river beds, containing channels, ledges and deep ditches.

TABLE 37  **Causes of on / off-site impacts on water resources**

| Human induced causes | Natural causes |
|---|---|
| • Soil management (inappropriate / good)<br>• Crop and rangeland management (inappropriate / good)<br>• Deforestation and removal of natural vegetation (including forest fires)<br>• Over-exploitation of vegetation for domestic use<br>• Overgrazing<br>• Industrial activities and mining<br>• Urbanisation and infrastructure development<br>• Discharges (point contamination of surface and ground water sources, or excessive runoff)<br>• Release of airborne pollutants (urban / industrial activities)<br>• Disturbance of the water cycle / change in water level of ground water aquifers, lakes and rivers<br>• Over-abstraction/excessive withdrawal of water<br>• Other (specify) | • Change of seasonal rainfall<br>• Heavy / extreme rainfall (intensity and amounts)<br>• Windstorms / dust storms<br>• Floods<br>• Droughts<br>• Topography and effects on runoff, river flow regimes)<br>• Other natural causes (landslides, volcanic eruptions, earthquakes, highly fragile / susceptible natural resources, etc.)<br>• Other (specify) |

the study area? (Select impacts from list Table 35 or note additional impacts).

3. What are the human and natural causes of off-site impacts? (Identify the relevant causes from Table 37 and rank them in order of importance starting with the most important)

**Tool 6.2  Detailed biophysical assessment (state / trend) of specific water resources**

*Visit each important water source and conduct the following assessment with local key informants:*

Water Source (type):_____

GPS coordinates: _____

LUS / LUT:_____

Season: _____

**Water quantity:** *for each indicator, select the most appropriate answer from those provided below and give a short explanation.*

1. Water level:
   • Only a small fraction of the capacity of the water body e.g. a very small flow of water in a large riverbed;
   • Below to half of the capacity (average to limiting water conditions);
   • Above half of the capacity up to the upper limit of the capacity of the water body.

2. Water depth:
   • height of water in wells and boreholes (water table depth).

3. Potential loss of rainwater by soil evaporation:
   • High- Soil uncovered and bare during long periods of time;
   • Moderate- Soil partly and seasonally not covered;

- Low- Soil permanently covered (litter/live plants).

4. Loss of rainwater by runoff:
   - Clear signs of water loss by runoff and soil erosion: Rills or gullies, due to inadequate soil cover and/or lack of or ineffective soil and water conservation;
   - Signs of surface water runoff and some soil movement (sheet erosion)- moderate cover and/or some soil and water conservation;
   - No signs of surface water runoff due to good soil cover and soil and water conservation measures.

*Ask key informants:*

5. Does it hold water just during the wet season or throughout the year? How reliable is it (does it dries out)?

6. What is the demand on the water source for different uses (human consumption, livestock watering, agricultural irrigation or industry) (heavy, moderate, light, none)? Has the pattern of use changed over the last 10 years?

7. What % of the total amount of water used (withdrawn) is permitted (legal, regulated) and what % is illegal? Indicate any changes in the last 10 years.

**Water quality:** *for each indicator, select the most appropriate answer with a short explanation*

8. Colour and Turbidity:
   - Green and opaque from eutrophication or sewage;
   - Brown and opaque from sediment;
   - Transparent / normal colour.

9. Pollution by:
   - Water smelling or of unnatural colour;
   - Signs of animal faeces;
   - Presence of discharge pipes / canals, drainage inlets with substantial inflow of sewage and other effluents;
   - No visual sign of water pollution;
   - Coliforms / BOD / bacteria using field microbiological water kit;
   - Other chemicals and heavy metals (lab test).

10. Salinity:
    - Whitish salt deposits around the water point (Y / N);
    - Water conductivity value (EC) – salinity of both surface and groundwater.

*Ask informants on status and trends:*

11. What is the water quality? If polluted, what are the causes (e.g. increase use of fertiliser, sewage discharge, increase pesticide use, industrial pollution)?



PHOTO 27 **Use of a water kit to assess quality in a pond, Cuba**

12. Has there been a noticeable change in the quality of this water source over the last 10 years (describe the changes in amount, seasonality or quality of the water)?

The visual observations of local informants can be backed up by a water testing kit that can usually be obtained from local water authorities, see Photo 25

**Ecosystem and living aquatic resources:** *(for each indicator, select the most appropriate answer with a short explanation)*

13. Aquatic life (fish, insect) and diversity:
    - Absence or very limited visible life;
    - Presence of only aquatic species known to be tolerant to some pollution;
    - Presence of diverse aquatic species indicating good water quality (sensitive to pollution).

14. Algae and/or invasive aquatic plants:
    - Abundance of algae and / or invasive aquatic species;
    - Presence of algae and / or invasive aquatic species;
    - No algae or invasive aquatic species.

15. Fish stocks / productivity:
    - Abundant
    - Moderate
    - Few
    - None

## Additional measurements of water quantity and quality

These additional measurements can be made where there is a particular need to generate quantitative data on water resources perhaps to complement existing data sets / activities in the country or region concerned. Only limited detail on these methods is given here.

**Water quantity measurements:**

*Water point width*
To estimated water point width, in meters. This can be measured with a rangefinder or a measuring tape. In case of a lakes, ponds, dams and reservoirs then it is the average between the wider and narrower parts.

*Water point depth*
To estimate water point depth, in meters. This can be measured using a measuring stick or pole or a chain with a weight attached to the end. Manual measurement of depth is limited to 5-6 meters, so if the water point is deeper than 5-6m then indicate >6m.

*Water flow*
To estimate flow of rivers, streams and springs only (not ponds, dams or lakes), in litres/minute (l/min). This is estimated by recording the time taken (T) for a twig /stick to move a certain distance (L) (e.g.20 m) along the water surface. For a U shape channel water flow = (average Width x average Depth x L)/T. For a V shaped channel water flow = (average width/2 x Depth x L)/2.

**Water quality measurements:**

*Chemical and nutrient characteristics*
There are a variety of water quality variables, including temperature, electrical conductivity (a measure of the total dissolved salts), pH (an indicator of the water's acidity or alkalinity), chlorophyll A, total phosphorous, total nitrogen, dissolved oxygen, and water transparency (Secchi depth). These parameters can be measured with individual instruments or

with one combination instrument that includes several types of probes.

Changes to water quality often occur over long periods of time, making it difficult to determine the role of human activity as distinct from natural processes, for example, the impact of climate change. The use of long term data sets on water resources may assist to determine cause and effects.

*Turbidity*
Estimation of the degree of transparency or opaqueness of the water due to suspended particles and sediments. Usually measured using test/turbidity column/secchi disc, in meters.

*pH*
pH value of water (to be measured using pH meter or pH paper).

*Biological Oxygen Demand (BOD)*
Measure of the Biological Oxygen Demand (BOD an indication of oxygen availability and hence degree of contamination). To measure, use a BOD test kit.

*Sources of contamination*
The main sources of contamination of the water point.

*Aquatic species*
The presence or absence of certain chemical or biological indicators can reflect environmental conditions. Taxonomic groups, individual species, groups of species, or entire communities can be used as indicators. It is possible to use species presence/absence, and in some instances abundances and habitat characteristics to assess the condition of inland water ecosystems.

## Tool 6.3  Assessing degradation of river / stream banks and lake shores

Degradation of the river / stream banks may be caused by removing riverine (gallery) forests, by another change in land use nearby, or planting of inappropriate species. It has implications on the stability of the watercourse, also increasing risk of erosion, landslides and sedimentation which may undercut road bridges or influence downstream infrastructure such as dams or settlements.

By walking along a river or lake with local land users and / or key informants, assess the following indicators within 10-50 m from the bank / shore (depending on the size of the water body):
- ✖ What is the extent and severity (severe, moderate, low, none) of the bank degradation?
- ✖ What is the status of the river bank / lake shore vegetation? (select)
  - tree and bush vegetation is missing, the riverbank shows signs of cultivation, and is unstable or undercut with signs of active river bank erosion;
  - vegetation partly disturbed, cultivated land within less than 10 m of the river or lake shore;
  - stabilized by vegetation (mainly trees and bushes) and not cultivated or intensively used within 50 to 100 m.
- ✖ Are there signs of animal trampling on river / streams banks / lake shores? (select)
  - many entry points where animals have access to the water;
  - a few entry points where animals have access to water;
  - no signs of animals entering into the water.
- ✖ What are the other causes of degradation (e.g. landslip, erosion, undercutting) observed?

- Is there any danger of serious changes in the water course, landslips, etc. threatening: i) productive land, ii) settlements or human life or iii) infrastructures?
- What land management /restoration practices are in place on the adjacent land next to the river / streambank / lakeshore? To what extent are they being applied / respected (high, medium, low) and what is their effectiveness (poor, moderate, good)?
- What legislation and bylaws exist on river / stream bank protection and to what extent are they being respected / applied and if not why?

### Tool 6.4 Assessing livestock watering points

Land degradation by livestock through overgrazing and trampling around watering points in grazing lands / rangelands is a common phenomenon. See Photo 28.



PHOTO 28 **Degradation is often more severe close to water points due to livestock trampling and loss of vegetation, Tunisia**

In general, grazing effects decrease with distance from the watering point and, in some areas, effects are temporary so their impacts largely disappear as vegetation responds to rainfalls. Thus, the team should assess the extent and severity of the grazing gradients (i.e. systematic change in vegetation cover and species with distance from water which remain after the rainy season). This will indicate probable long term soil and vegetation damage with as a consequence reduced availability and quality of forage and increased erosion risk (i.e bare soils and associated signs of degradation in a radius of 50-500m around the watering point).

**Interviews with local herders** can provide information on:
- the distance to nearest alternative watering point;
- the trend in livestock numbers and species using the watering point in the wet and dry seasons and reasons for any changes (increase / decrease in pressure) - in the absence of precise data, local herders may be able to give approximate numbers;
- the existence and respect / application of rules and regulations to control livestock numbers and protect the water point, including duration of use and resting /closing of watering points and surrounding areas, local customs and bye-laws and national legislation;
- changes in vegetation (cover, palatable/ invasive species) as a result of changes in management practices
- problems associated with the use or opening up of a watering point, such as:
  - traditionally unused grass lands during the dry season become continually grazed or browsed by animals, which prevents or reduces natural vegetation recovery;

- permanent human settlements develop around watering points, which may increase deforestation for construction and fuel wood, permanent livestock numbers and land cultivation (where feasible);
- change in livestock species composition from drought tolerant (e.g. camels) to more water demanding species (e.g. cattle).

### Visual observations to assess extent and severity of degradation around watering points:

1. Ground cover:
   - more than 50% bare soil;
   - 10 – 50% bare soil;
   - 0-10% bare soil;

2. Erosion around the water point:
   - severe and extended erosion (rills, gullies);
   - some but limited sheet erosion or small rills);
   - no signs of erosion.

3. Soil crusting and soil compaction around the water point:
   - severe and extended soil compaction and crusting;
   - limited soil compaction and crusting;
   - no soil crusting or compaction.

4. Soil and water conservation measures in place:
   - absence of SWC measures to protect the water point;
   - some SWC to protect the water point but slight to moderately effective;
   - SWC techniques in place and effective in protecting the water point;

What is their effectiveness (good, moderate, poor)?

5. Livestock management, for example:
   - control of livestock numbers and distance between watering points in relation to environmental conditions and water demand;
   - seasonal movements and management regimes and their effectiveness in protecting, ensuring sustainability of watering points and surrounding grazing lands;
   - temporary limits / bans on use of watering points by large herds, to allow adequate time for recovery and restoration of natural vegetation.

6. Other management measures?

### Tool 6.5  Assessing degradation and management of wetlands

Wetlands include swamps, marshes, bogs and similar areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands are very important in drylands as they provide a range of important hydrological and ecological / biological functions (e.g. buffering of peak and low flows, purification of the water) and livelihood support functions (secure water supply during droughts, extreme events). Changes in these functions as a result of degradation or improved management measures should be assessed. The changes in a wetland may be the result from erosion and / or sedimentation, often due to human management activities such as wetland development for

irrigated farming or rainfed horticulture (see examples in Photo 29).

The assessment is looking at degradation (and conservation) in the wetlands and the related impacts on its multiple functions.

1. What are the types, severity and extent of degradation in the wetland?
   - Has the wetland area and hence the habitat it provides been reduced or affected through: i) cultivation; ii) afforestation or reforestation; iii) pollution; iv) hydrological cycle alterations; v) human management actions (e.g. intense grassland burning)?

2. Have there been changes in and impacts on the functions provided by wetlands (hydrological; ecological / biological and livelihood support) as a result of degradation or improved management measures?
   2.1 Productive capacity (e.g. livestock grazing, wild foods harvesting, construction materials and cultivation):
      - poor productive capacity;
      - moderate production- limitations;
      - good productive capacity (e.g. for animal grazing, wild food collection, and rice cultivation).
   2.2 Downstream flooding:
      - frequent and damaging flooding;
      - moderate water flow;
      - water well retained by the wetland.
   2.3 Biodiversity / indicator species:
      - greatly reduced of flora and fauna biodiversity relative to "normal" communities;
      - significant reduction in biodiversity relative to "normal" communities; "normal" or close to "normal" biodiversity levels.

3. What are the main causes in terms of human management activities? For example:
   - vegetation and soil erosion due to overgrazing or injudicious cultivation in the "sponge" areas of wetlands in the upper catchments of rivers;
   - fertilizer run-off from farmed land that may cause rapid growth of algae in the water (which depletes oxygen supply in the water and may kill plant, fish and animal life);
   - run-off of non-selective pesticides or herbicides that degrade natural animal and plant populations and affect water quality;
   - drainage or permanent alteration to accommodate building / planting of rainfed or irrigated crops;
   - damming for water storage, irrigation or recreation;
   - human activity and pollution in or close to the wetland (e.g. brick making);
   - change in productive capacity of the wetland for livestock grazing, wild foods harvesting, construction materials and cultivation;
   - increased downstream flooding (flood incidence and severity);
   - diminution of plant and animal biodiversity or indicator species of threatened habitat.

[**Note:** South Africa has developed and has successfully used as part of its LADA Local assessments for the assessment of wetlands, a "Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types" (Governmnet of South Africa, 2007). This document is available on the LADA website www.fao.org/nr/lada. It is recommended that this is tested and, as required, adapted for use in the other countries where wetlands health and integrity is an important issue.]
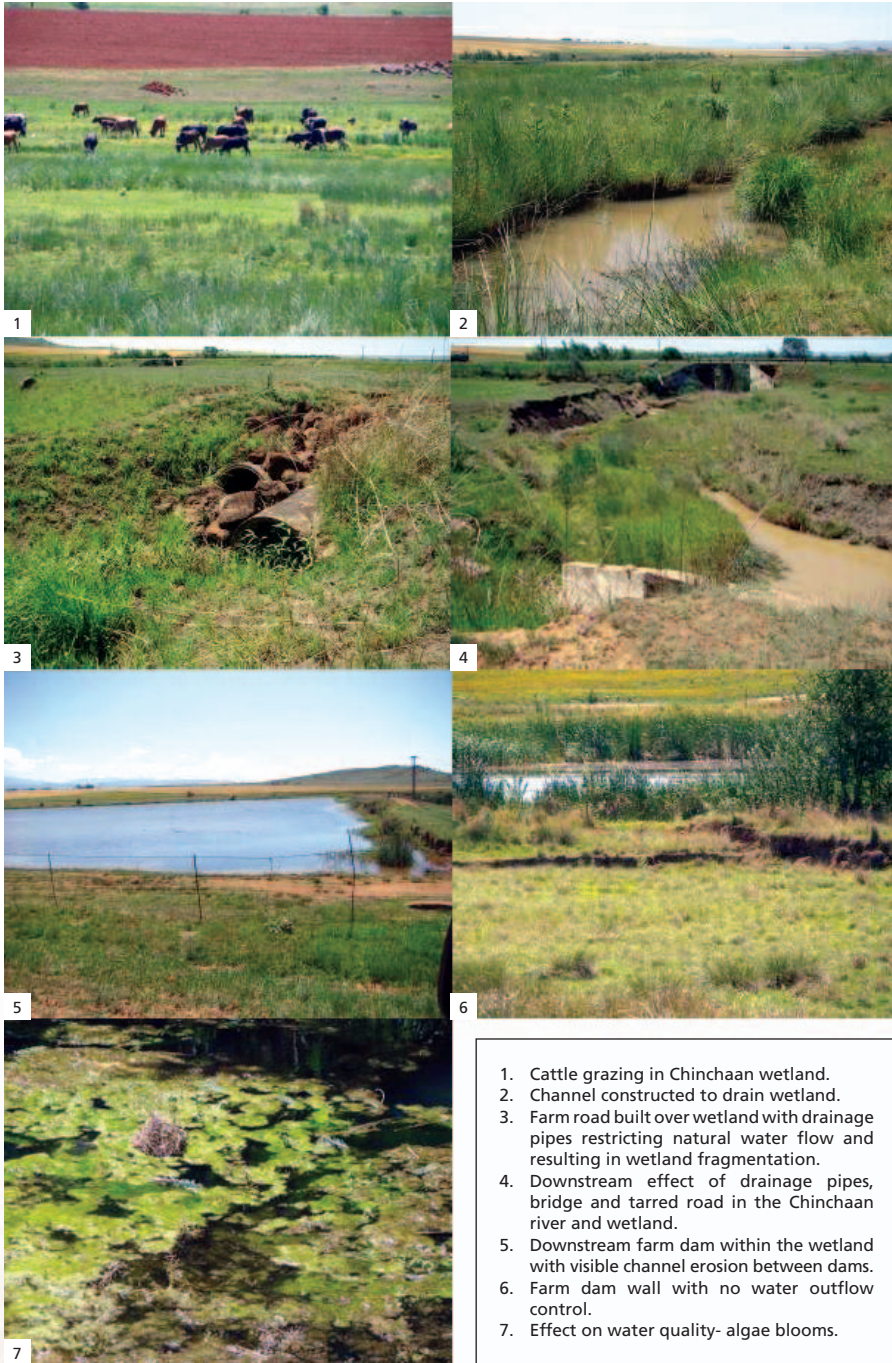
1. Cattle grazing in Chinchaan wetland.
2. Channel constructed to drain wetland.
3. Farm road built over wetland with drainage pipes restricting natural water flow and resulting in wetland fragmentation.
4. Downstream effect of drainage pipes, bridge and tarred road in the Chinchaan river and wetland.
5. Downstream farm dam within the wetland with visible channel erosion between dams.
6. Farm dam wall with no water outflow control.
7. Effect on water quality- algae blooms.

PHOTO 29  **Types of damage to a wetland (South Africa)**

## Tool 6.6  Assessing land degradation and management practices in irrigated lands

A separate manual has been prepared for assessing land degradation / management in irrigated lands "LADA for Irrigated Lands – an additional module for LADA-Local (McGarry, 2010). This is available on the LADA website www.fao.org/nr/lada. This aims to provide a quantified, improved understanding of the problem of salinity and sodicity (S&S) in irrigated lands, through the provision of specific tools to determine and interpret S&S levels in the soil and water and their causes (often the very surface or ground waters used for irrigation or underlying the irrigation areas). The aim is to help stakeholders identify and develop adapted integrated management systems (soil, water, crop, human management) for reducing degradation and improving productivity.



D. MCGARRY

PHOTO 29b  **Surface salinity evident as a white crust following irrigation of wheat crops, near Yinchuan, Ningxia province, central north China**