

# 1

## ANNEX

### Types and forms of erosion by water and by wind

#### 1. EROSION BY WATER

##### 1.1 Erosion by raindrop impact (« splash »)

**EROSION DEGREE: VERY WEAK; VALUE = 1**

This form of erosion is no longer visible after cultivation (ploughing, hoeing etc.)

Splash erosion is a two step process:

Break up of soil clods/aggregates and dispersion of soil particles by the kinetic energy of the raindrop impacting on the soil.

The dislodged particles may or may not be then moved down slope by surface runoff, and the detached soil particles resettle on the soil surface or are thrown onto plant stems and leaves (herbaceous vegetation or young seedlings).

##### 1.2 Sheet erosion

This is the type of erosion that results from runoff that spreads across the soil surface during rainfall (i.e. when the infiltration rate has been exceeded). It may take various forms and degrees.

- ⊗ Diffuse runoff:  
**EROSION DEGREE: VERY WEAK,  
VALUE = 1**  
This takes place during the rain as soon as the infiltration rate is exceeded and a film of water starts to move across the surface. Effects are limited to the transport of fine particles and development of a sandy film in small cultivation furrows (traces) or where the fine particles are trapped by small clumps of herbaceous vegetation. There may be occasional dislodging of small superficial roots.
- ⊗ Removal of surface soil particles:  
**EROSION DEGREE: WEAK,  
VALUE = 2**  
A very slight reduction in soil depth due to down slope transport of soil particles. Removal of the surface layer does not reach the next soil layer (subsoil). Some roots of grasses, annual plants or trees may be exposed.
- ⊗ Removal of surface soil with some excavation:  
**EROSION DEGREE: MODERATE,  
VALUE = 3**  
This is the most advanced form of soil loss, through removal of material and part of the soil profile with a tendency to develop into gullying. This state is accompanied by exposure of tree roots and exposure of the subsoil horizon.

### 1.3 Linear erosion

This is erosion due to concentrated runoff accompanied by scratching or scoring of the soil surface to various degrees.

- ⊗ Surface scratches:  
**EROSION DEGREE: WEAK,  
VALUE = 2**  
**The first traces resulting from fast, concentrated surface runoff** on sloping surface. The depth of the scratches does not exceed a few centimetres and are easily removed by cultivation.
- ⊗ Rills:  
**EROSION DEGREE: WEAK,  
VALUE = 2**  
**Soil erosion due to the grooving action** by many small rivulets and water channels caused by concentrated surface runoff. Rills do not exceed 30cm in depth and they can be readily removed by cultivation.
- ⊗ Small gullies:  
**EROSION DEGREE: WEAK,  
VALUE = 3**  
**These are shallow gullies less than 1m deep** that cannot be removed by ordinary cultivation.  
**Gullies:** more than 1m deep that may be individual gullies separated from others or contiguous.
- ⊗ Individual gullies:  
**EROSION DEGREE: MODERATE,  
VALUE = 3**
- ⊗ **Individual gullies accompanied by collapse of the gully sides and /or tunnel erosion** (subsurface erosion creates a tunnel that then collapses):  
**EROSION DEGREE: SEVERE,  
VALUE = 4**
- ⊗ Widespread gullies:  
**EROSION DEGREE : SEVERE,  
VALUE = 4**

- ⊗ Badlands:  
EROSION DEGREE VERY SEVERE,  
VALUE = 4

Linear erosion also occurs in areas that are periodically flooded in the beds of waterways, in flooding areas around “oueds”, in floodplains of rivers / alluvial deposition zones (known as “garaats”, and “sebkhas” in northern Africa...).

The suggested degrees (rills - 2, small gullies - 2; gullies - 3), may be scored at one degree less if there are no envisaged negative impacts on the hydrological regime (flow quantity and quality), on infrastructure along waterways or risk to people. However, if the risk is high the degree should be 4.

#### 1.4 Mass movement

Type of erosion caused by soil saturation and gravity and set off by intense and/or prolonged rainfall.

- Landslides;
- torrential lava flows (suggest remove ?);
- mudflows.

- ⊗ - Superficial mass movement:  
EROSION DEGREE: WEAK,  
VALUE: 2

This type of landslide affects non plastic materials (concave), clay soils with characteristic uneven terrain (**solifluction lens**) or other forms such as small **terracing**, or **creep**

- ⊗ Deep mass movement:  
EROSION DEGREE: MODERATE  
TO SEVERE, VALUE : 3 TO 4

More significant land or mud slides that may be localised or widespread. This includes **landslides in the form of a slab**, and **mudflows**.

The figure below illustrates one type of mass movement known as rotational concave landslide and shows the tongue (langue in French) of the landslide and the detachment plane (niche d'arrachement in French) (source Roose, 1994).

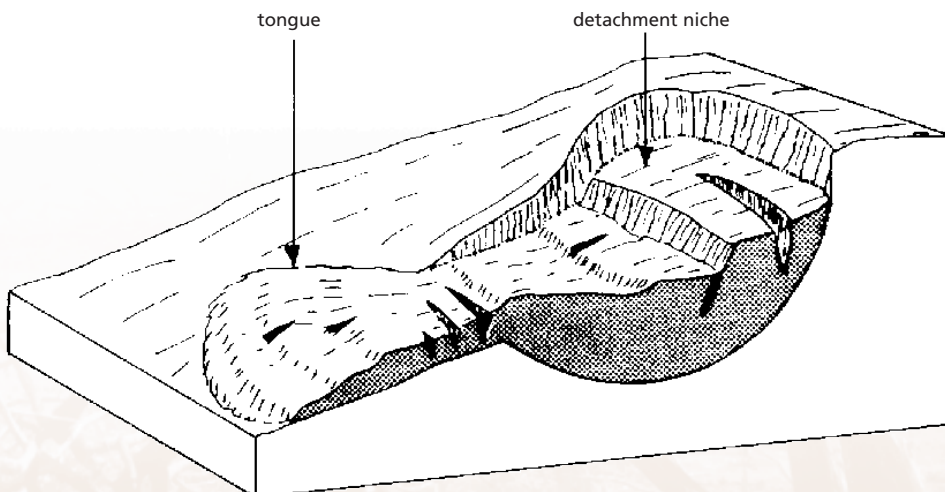


FIGURE 23 Rotational concave landslide

Mass movements (slow or fast) result from an imbalance between the soil mass, the stored water and vegetation cover, the friction forces of these materials on the weathered bedrock and the slope of the materials (limiting slope 30 to 40 degrees / 65 %). This imbalance can develop gradually on one or more slip planes following wetting or by exceeding the point of elasticity of the soil (slow landslides with deformation but without breaking up) or liquid materials (mudflows).

## 2. WIND EROSION

Wind erosion is the form of soil degradation by the action of the wind which abrades, transports and deposits soil / sand particles. These actions depend mainly on the type of soil, the climate, the vegetation cover, the speed and frequency of wind.

- Deflation
- Accumulation

### 2.1 Deflation:

DEGREE VERY WEAK TO SEVERE,  
VALUES FROM 1 TO 4

It is the action of removal of soil/sand particles which results in a loss of the surface soil layer, appearance of a stony surface and exposure of plant roots.

The degree of erosion depends on the abrasive power of the wind effect on the land, it varies from weak to severe, with values from **1 to 4** for the most severe.

Deflation is sometimes accompanied by **corrosion**.

### 2.2 Accumulation:

DEGREE FROM VERY WEAK TO  
SEVERE, WITH VALUES FROM 1 TO 4

It is the deposition of soil / sand particles that have been transported when the wind loses speed or becomes too laden. It can take several forms according to the power of aggression.

- Areas severely affected: well developed dune fields with or without vegetation
- Areas moderately affected: accumulation of material trapped at the edges of fields or along roads;
- Diffuse accumulations: sandy layers around herbaceous vegetation and fine sand deposits less than 2 to 3 cm depth; characteristic of areas only weakly affected by wind erosion.

# ANNEX 2

Some general and specific  
crop nutrient deficiencies

**Table of nutrient deficiencies and toxicities—generalised symptoms and conditions**

<b>Essential nutrient</b>	<b>Deficiency/Toxicity symptoms</b>	<b>Typical conditions</b>
Nitrogen (N)	Leaves (first older ones) turn yellow/ brown, plants are spindly, lack vigour and may be dwarfed.	Sandy soils under high rainfall conditions and soils low in organic matter, where leaching occurs.
Phosphorus (P)	Not easily detected from appearance. Where deficiency is severe plant will be stunted, the leaves will take on a purplish tint and the stem will be reddish in colour.	Acid soils rich in iron and aluminium oxides (i.e. red tropical soils)
Potassium (K)	Yellow/brown spots appear on older leaves and/or necrosis of edges.	More frequent on light soils (as K is concentrated in the clay fraction of soils).
Sulphur (S)	Leaves are stunted, with uniform chlorosis.	
Calcium (Ca)	Roots are usually affected first – growth is impaired and rotting often occurs. In vegetative growth, deficiency may show in distorted leaves, brown scorching or spotting on foliage or bitter fruit (e.g. apple) or blossom-end rot (e.g. tomato).	Acid soils, or alkali or saline soils containing high proportions of sodium.
Magnesium (Mg)	Interveinal chlorosis, first on older leaves.	Acid, sandy soils in areas with moderate to high rainfall. Often occurs in conjunction with Ca deficiency.
Iron (Fe)	Chlorosis of younger leaves.	Calcareous soils, poorly drained and with high pH. (In neutral and alkaline soils P may prevent the absorption of Fe.)
Manganese (Mn)	Chlorosis of younger leaves.	Badly drained soils, over-liming or deep ploughing of calcareous soils can lead to Mn deficiency, as can the presence of high levels of Mg. The combination of high pH values (> 6.5) and high levels of organic matter can immobilise soil Mn.
Zinc (Zn)	Symptoms vary with plant type – in cereals young plants display purpling, whereas in broad-leaved plants symptoms include interveinal chlorosis, reduced leaf size and sparse foliage.	Soils with high pH. Available Zn is reduced by the application of lime or phosphates.
Copper (Cu)	Chlorosis of the tips of the youngest leaves and die-back of growing points.	Peat soils, or leached sandy or acid soils.

**Table of nutrient deficiencies and toxicities—generalised symptoms and conditions (continued)**

Essential nutrient	Deficiency/Toxicity symptoms	Typical conditions
Boron (B)	In crops, other than cereals, the apical growing point on the main stem dies and lateral buds fail to develop shoots.	Sandy soils, dry conditions and liming can result in B deficiency.
Molybdenum (Mo)	Marginal scorching and cupping of leaves. Wilting is common in Brassicas.	Acid soils or soils with high pH. Mo deficiency can lead to N-deficiency as nitrate requires adequate supplies of Mo for metabolism. Mo availability can inhibit the uptake of Cu.
Chlorine (Cl)	Wilting of leaves.	Well-drained, sandy soils.
Sulphur Toxicity		Build up of sulphates as a result of irrigation
Manganese Toxicity	Brown spots and uneven chlorophyll in older leaves.	Soils with pH of < 5.0 (for susceptible species)
Copper Toxicity	Chlorosis of leaves and restricted root growth.	Soils with low pH
Boron Toxicity	Progressive necrosis of the leaves, starting from the tips and/or margins.	Soils with low pH
Aluminium Toxicity	Plants die after early growth.	Acid mineral soils, aggravated by low P status
Chlorine Toxicity	Burning of leaf tips, bronzing and premature yellowing of leaves.	Associated with irrigation using water containing chloride

**Identification of Nutrient Deficiencies:**

Observation of abnormalities in plants is a complicated and skilled task. Since nutrient deficiencies may be manifested in different ways depending on the crop in which they occur, particular criteria will be crop-specific. As an example, the visual indicators of nutrient deficiencies in several tropical crops are set out in the following table.



**Examples of deficiencies in several tropical crops**

	<b>Maize</b>	<b>Beans</b>	<b>Cabbage</b>
General	High N requirement and sensitive to low phosphate supply. Relatively sensitive to water stress.	Tolerant to a wide range of conditions, but only high yielding with high N.	Demanding of N, P and K. Moderately sensitive to water stress.
Nitrogen	Reduced vigour; leaves a pale green or yellowish colour.	Plants are small, leaves are pale green and older leaves turn yellow. Few flowers are produced.	Young leaves pale green, older leaves are orange, red or purple. Severe deficiency renders the crop useless.
Phosphorus	Stunted growth, delayed ripening and purplish leaf colour, especially during early growth.	Stems are dwarfed and thin, leaves lack lustre. Early defoliation occurs, starting at base of shoot.	Leaves are dull green with purplish tinge, margins die.
Potassium	Small whitish-yellow spots on leaves. Poor root system, plants are weak and may be blown down.	Chlorosis of leaves, with necrotic brown patches at margins between veins.	Leaves are bluish-green. Leaf margins may show scorching and tips of older leaves may die.
Sulphur	Somewhat similar to N-deficiency. Plants short and spindly. Younger leaves pale beige to straw in colour.	Stunted growth, yellowing leaves. Delayed flowering and development of beans. Reduced nodulation on roots.	Smaller plants, with yellowing leaves.
Calcium	Poor germination and stunted growth.	Growth is stunted and growing point may die. In severe cases plants turn black and die.	Leaves rolled up at margins, necrosis of rims and death of growing point.
Magnesium	Whitish or yellow striping between the leaf veins, followed by necrosis.	Older leaves show interveinal reddish-brown mottling.	Interveinal chlorosis and puckering of older leaves.
Iron	Alternate rows of green and white on leaves	At early stage, patternless paling in leaf colour; later stage, yellowing of leaf similar to N- deficiency.	Whitish streaks on leaves. Veins unaffected at first, but larger veins eventually turn yellow.
Manganese	Yellow and green striping along the length of the leaf.	Chlorosis, initially of young leaves, followed by necrotic spots in interveinal areas. Leaves will fall off and plants eventually die.	Leaves are of smaller size and exhibit yellow mottling between veins.



**Examples of deficiencies in several tropical crops (continued)**

	<b>Maize</b>	<b>Beans</b>	<b>Cabbage</b>
Zinc	Chlorotic fading of the leaves, with broad whitish areas.	Leaves and flower buds are shed	
Copper	Leaves become chlorotic and the tips wither.		Leaves chlorotic, heads fail to form, growth stunted.
Boron	New leaves show transparent stripes. Growing points die and ears may not develop.	Leaves turn yellow and then brown. No flowers or pods are produced.	Leaves are distorted, brittle, mottled along margins and wilted.
Molybdenum	Not common by itself, but indicators include scorched patches on leaves.	Leaves are smaller, pale in colour with interveinal mottling developing into brown scorched areas.	Older leaves become mottled, scorched and cupped. Margins are irregular and heart formation is poor.
Chlorine	Plants short with poorly-developed stubby roots	Cl essential for the symbiotic fixation of N in legumes. No nodulation and stunted growth	Stunted roots with excessive branching and poor wilted top growth
Copper Toxicity	Reduced growth, chlorosis and stunted root development.		



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