

## Appendix 2

### 1. Land Characteristics and Management Factors Involved in Sheet and Rill Erosion

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Sheet and rill erosion occur when the forces due to rainfall, flowing water and gravity overcome the cohesion and weight of the soil particles/aggregates	Vegetation *Structure, percent surface cover (including litter)  *leaf area, rooting depth and perenniality	*Exposure to surface soil *Intensity of raindrop impact *Infiltration/run-off ratio *Velocity of surface flow *Transpiration and hence infiltration rate and volume of surface flow	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as: Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Processes involved are:  Detachment of exposed soil by - raindrop impact - surface flow	Climate *rainfall intensity/duration  *seasonal rainfall/evapotranspiration regime	*Intensity of raindrop impact *Volume of water exceeding infiltration rate and hence volume of surface flow *Soil water content and hence infiltration rate and volume of surface flow.	
Transport by -rain splash -surface flow	Geology *permeability of rock or unconsolidated sediments	*Soil water content and hence infiltration rate and volume of surface flow	
Deposition	Topography *microrelief	*Infiltration/run-ff ratio *Velocity of surface flow	Contour cultivation, contour banking and strip cropping reduce slope length and affect microrelief
Surface flow occurs on any sloping surface when the rainfall rate exceeds the infiltration rate	*slope degree and length *slope and landform shape *position in landscape	*Volume and velocity of surface flow *Tendency to concentrate surface flow *Volume of run-on	
Off-site effects include increased sedimentation and run-on in streams and on lower lands	Soil *profile permeability  *depth and water-holding capacity *size/weight of surface particles/aggregates *cohesion of surface particles/aggregates, including tendency to slake and disperse *tendency to surface seal and hydrophobicity *percent of stone cover	*Infiltration rate and hence volume of surface flow *Infiltration/run-ff ratio *Detachment and transport  *Detachment  *Infiltration rate and hence volume of surface flow *Infiltration/run-off ratio and velocity of surface flow	The above management practices controlling biomass affect soil organic matter content, which in turn affects all listed soil characteristics except surface rock  Direct soil compaction and disruption by trampling, trafficking and cultivation affect soil permeability, water-holding capacity and size/weight and cohesion of aggregates

**2. Land Characteristics and Management Involved in Gully and Tunnel Erosion**

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Gully and tunnel erosion occur when the forces due to rainfall, flowing water and gravity overcome the cohesion and weight of the soil particle/aggregates	Vegetation *structure, percent surface cover (including litter)  *leaf area, rooting depth and perenniality	*Exposure of surface soil *Intensity of raindrop impact *Velocity of channelised flow and hence particle detachment and transport *Transpiration and hence infiltration rate and volume of surface and subsurface flow	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Processes involved are:			
Detachment of exposed surface soil by *raindrop impact *channelised overland flow *cracking	Climate *rainfall intensity/duration  *seasonal rainfall/evapotranspiration regime	*Intensity of raindrop impact *Volume of surface and sub-surface flow *Volume of surface and sub-surface flows via regulation of soil water content	
Detachment of subsoil by *subsurface flow in permeable strata and along cracks and tunnels *cracking	Geology *perviousness of rock or unconsolidated sediments	*Soil water content and hence infiltration rate and volume of surface and subsurface flow *Lateral or vertical movement of water	
Transport of particles/aggregates *channelised overland flow *subsurface flow *gravity collapse	Topography *microrelief (both of channel and catchment to a site) *channel slope degree and length  *position in landscape and catchment area	*Infiltration/run-off ratio *Velocity of surface flow *Infiltration/run-off ratio *Velocity of surface flow *Volume of surface and subsurface flows reaching site *Velocity of surface flow *Tendency to concentrate surface flow	Contour and diversion banking, strip cropping and contour cultivating reduce catchment slope length and catchment area; they also affect microrelief
deposition	*catchment slope degree and length *slope and land-form shape		Contour and diversion banking, strip cropping and contour cultivating reduce catchment slope length and catchment area; they also affect microrelief type amount of biomass production will affect soil organic matter content, which will in turn affect most listed soil characteristics
Gully erosion is regarded as having occurred when the channel is too deep to be crossed or cannot be obliterated by tillage	Soil *profile permeability  *depth and water-holding capacity  *size/weight of soil particles/aggregates *cohesion of particles/aggregates, including tendency to crack, slake and disperse *differential permeability within a horizon due to the presence of cracks and channels *percent stone cover	*Infiltration rate and hence volume of surface and subsurface flow *Lateral or vertical movement of soil water *volume of surface and subsurface flow  *Detachment and transport  *Detachment  *Movement of water along preferred channels  *Volume of surface flow	Soil disruption and compaction by trampling, burrowing, cultivation  And trafficking will affect profile permeability, water-holding capacity and size/weight and cohesion of soil particles/aggregates

### 3. Land Characteristics and Management Factors Involved In Stream Bank Erosion

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Stream-Bank erosion occurs when forces due to water movement along a stream channel are sufficient to detach and remove soil material from the stream-bank	Vegetation *structure, percent surface cover (including litter) *leaf area, rooting depth and perenniality	*Streambank stability  *Transpiration and hence infiltration rate and volume of surface flow *Volume and velocity of stream flow	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Processes involved are: Detachment of soil from stream-bank by *slaking *undercutting *collapse of bank	Climate *rainfall intensity/duration  *seasonal rainfall/evapotranspiration regime	*volume of water exceeding infiltration rate and hence volume of surface flow *Soil water content and hence infiltration rate and volume of surface flow	
Transport by channel flow	Geology *permeability of rock or unconsolidated sediments in the catchment	*Soil water content and hence infiltration rate and volume of surface flow	
deposition	Topography *Slope, degree and length	*Volume and velocity of surface flow	
	Soil *permeability of soils within the catchment *soil depth and waterholding capacity *cohesion of soil particles/aggregates including tendency to slake and disperse *size	*Infiltration rate and hence volume of surface flow *Infiltration/run-off ratio  *Detachment  *Detachment and transport	Contour cultivating, contour banking and strip cropping to reduce slope length  Restrict stream access by stock to less sensitive areas  Stabilise stream-banks with trees, shrubs and grasses

**4. Land Characteristics and Management Factors Involved in Wind Erosion**

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Wind erosion occurs when the force due to wind is sufficient to overcome the cohesion and weight of the soil particles and to allow their movement	Vegetation *structure, percent surface cover (including litter) *leaf area, rooting depth and perenniality	*Exposure of surface soil *Depth of zero velocity layer *Transpiration and hence soil moisture content and particle cohesion	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Processes involved are:	Climate *rainfall/evapotranspiration regime *wind strength *wind direction	*Soil moisture content and hence particle cohesion *Detachment and transport *Site exposure	
Detachment by abrasion and suction	Geology *perviousness of rock or unconsolidated sediments	*Soil moisture content and hence particle cohesion	
Transport by creep, saltation and suspension	Topography *microrelief, slope degree and position in landscape	*surface wind strength *Run-on, site drainage and hence soil moisture content and particle cohesion	Retention or construction of windbreaks, cloddy cultivation and ridging affect microrelief
Deposition by entrapment and reduced wind velocity	Soil *percent stone cover *size/weight of surface particles/aggregates *aggregate stability (influenced by factors such as presence of carbonates, iron oxides and organic matter, clay mineralogy and biological activity) *profile permeability, depth and water-holding capacity	*surface wind strength *Detachment and transport  *Detachment  *Soil moisture content and hence particle cohesion and weight of particles/aggregates	Soil disturbances such as trampling, cultivating affect aggregate stability  Any practices affecting biomass alter the organic matter content of the topsoil

**5. Land Characteristics and Management Factors Involved in Soil Creep**

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Soil creep occurs when the decrease in soil strength resulting from an increase in soil moisture is sufficient to allow the imperceptible and non-accelerating movement of the soils mass	Vegetation *leaf area, rooting depth and perenniality  *root depth and mass	*Transpiration and hence soil water content  *Anchorage of soil by roots	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Processes involved are:	Climate *seasonal rainfall/evapotranspiration regime	*Soil water content	
Infiltration of rainwater	Geology		
Wetting of soil	*perviousness of rock unconsolidated sediments	*Soil water content	
Soil movement by gravity	Topography *slope degree  *microrelief and position in landscape	*Lateral gravitational component  *Run-on, site drainage and hence soil water content	Earthworks, e.g terracing
	Soil *profile permeability  *texture and structure  *depth and waterholding capacity	*Infiltration *Soil water content  *Soil strength  *Soil water content	Compaction and soil disruption by stock and vehicles, and by cultivation will affect profile permeability and structure

**6. Land Characteristics and Mangement Factors Involved in Landslides**

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Landsliding occurs when the shear forces exceed soil/regolith strength: this generally occurs when soil regolith strength is reduced by an increase in water	Vegetation *leaf area, rooting depth perennality *total leaf area and canopy type  *root depth and mass	*Transpiration and hence soil water content *Volume of water held by canopy and hence volume available for infiltration *Anchorage of soil by roots	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Processes involved are:	Climate *seasonal rainfall/evapotranspiration regime	*Soil water content	
Infiltration of water	Geology *perviousness of rock or unconsolidated sediments	*Soil water content	
Wetting of basal plane	*wet strength or rock/regolith	*Shearing tendency	
Saturation of soil (mudflow)	*angle of dip	*Shearing tendency	
Shearing and movement of soil mass gravity	Topography *slope degree *microrelief and position in landscape	*Lateral gravitation component *Run-on, site drainage and hence soil water content	
Other processes that may be involved include:			
*loading of soil mass resulting in an increase I shear strength	Soil *topsoil permeability *presence of slowly permeable layer	*Infiltration/run-off ration *Water content of soil immediately above layer *soil strength	Compaction and soil disruption by stock and vehicles, and cultivating, will affect profile permeability
*removal of material from slope toe resulting in reduced slope support	*cohesion of particle/aggregates including tendency to slake and disperse		
Types of landslides covered by this table are:	*depth *clay mineralogy	*soil water content *Soil strength	
*rock and earth slides			
*earth flow (downslope movement of unsaturated soil and weathered rock on a lubricated basal shear plane)			
*mudflow (movement of saturated soil and rock)			
*combination slide/flows			

**7. Land Characteristics and Management Factors Involved in Leaching Of Nutrients**

<b>Processes</b>	<b>Land Characteristics affecting processes</b>	<b>Factors affected by land characteristics</b>	<b>Management factors that modify land characteristics</b>
Nutrient Loss involves the solution of cations and anions in water and their removal as the water percolates down through the soil	Vegetation *leaf area, rooting depth and perenniality	*Transpiration and hence soil water content and volume of percolating water	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
	Climate *rainfall/evapotranspiration regime	*Volume of percolating water	
Leaching of nutrients is considered here in terms of base cations. The main anion involved in nitrate, the concentration of which fluctuates according to season and surface management, including the use of legumes	Geology *permeability of rock or unconsolidated sediments	*Volume of percolating water	
	Topography *slope degree, microrelief, position in landscape and catchment are	*Run-on, site drainage and hence volume of percolating water	
	Soil *organic matter content *texture *clay mineralogy *water-holding capacity *profile permeability	*Cation exchange capacity (CEC) *CEC *CEC *infiltration/run-off ration *Volume of percolating water *Rate of water percolation	Control of biomass affects organic matter content water-holding capacity and profile permeability  Cultivation and compaction by trampling and trafficking affect water-holding capacity and profile permeability

**8. Land Characteristics and Management Factors Involved in Soil Compaction**

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Compaction is the increase in soil bulk density and the related decrease in macroporosity that occurs when the physical pressure on the soil exceeds the ability of the soil to resist deformation and/or when organic matter is oxidised	Vegetation *leaf area, rooting depth and perenniality *structure and species accumulation	*Transpiration and hence soil moisture content and soil strength *Type and quantity of organic matter  *Weight of plants *Root pressure on soil by growth and wind heave	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation    Clearing Trafficking    Fertilising Grazing        Trampling Harvesting    Burning
	Climate *rainfall/evapotranspiration regime	*Soil moisture content and hence soil strength	
Process involved is:	Geology *permeability of rock or unconsolidated sediments	*Soil moisture content and hence soil strength	
Closer packing of soil particles/aggregates	Topography *position in landscape, slope degree and microrelief	*Run-off, site drainage and hence soil moisture content and soil strength	Artificial drainage, contour banking, contour cultivation and strip cropping will affect soil moisture content
	Soil *texture and stone content  *structure (dependent on factors such as clay% and mineralogy, carbonate, iron oxide and organic matter content and biological activity) *organic matter content  *profile permeability, depth and water-holding capacity	*Soil strength *Minimum bulk volume attainable *Soil strength  *Resilience to deformation  *Soil moisture content and hence soil strength	Any practice that affects the vegetation will affect organic matter content Cultivating will increase oxidation of organic matter



**9. Land Characteristics and Management Factors Involved in Salting**

Processes	Land Characteristics affecting processes	Factors affected by land characteristics	Management factors that modify land characteristics
Salting occurs when stored salts derived from the atmosphere and from rock weather become concentrated in the root zone	Vegetation *leaf area, rooting depth and perenniality	*Transpiration and hence volume of water percolating to groundwater	All aspects of the vegetation are affected by selection of species and control of biomass by particles such as Cultivation      Clearing Trafficking      Fertilising Grazing          Trampling Harvesting      Burning
Current accessions are insignificant compared with salt storage, except along coastlines or beside saline lakes and Salinas	Climate *rainfall/evapotranspiration regime	*Volume of water percolating to groundwater *Accumulation of salts within root zone	Irrigation increases water intake and hence the volume of water percolating to groundwater
Processes involved are:	Geology *permeability of rocks and unconsolidated sediments	*Leaching of salts	
Long-term accession of salts in regolith	*clay content of rocks and sediments, often influenced by deep weathering	*Salt storage	
Infiltration and percolation of rainwater	*geological structure and differential permeability of strata	*Lateral movement of groundwater *Groundwater discharge *Depth of groundwater *Groundwater pressure	
Leaching of salts to groundwater	Topography *slope degree *change of slope *local elevation *position in landscape, slope degree and microrelief	*Lateral movement of groundwater *site of discharge *Depth to water table *Run-on, site drainage and hence volume of infiltrating water	Contour banking and cultivating affect microrelief, increasing infiltration Diversion banks reduce run-on and hence infiltration around discharge sites
Rise in water levels/pressure			
Lateral transmission of water/pressure			
Accumulation of salts within root zone by evapotranspiration in discharge areas			
Off-site effects include increasing salinity of streams, groundwater and built storages	Soil *permeability	*volume of water percolating to groundwater *Volume of water percolating to groundwater *Salt storage *Evaporation	Practices controlling biomass affect permeability, microporosity and water holding capacity directly or indirectly through effects on organic matter content
Pumping and drainage (mostly in irrigated areas) increase leaching of salts, reduce salt storage and lower groundwater levels/pressures, but disposal of extracted water and salts is a problem	*water holding capacity *depth and clay content *microrelief		