

UNIT 1 TROPICAL ENVIRONMENTS

Recommended Prior Knowledge As is the case for all of the Advanced Geography Options completion of the core modules is expected. The tropical Environments option builds on the knowledge and understanding gained in the compulsory core units of *Atmosphere and Weather* and *Rocks and Weathering*.

Context The focus in this option is on the **humid tropics**. i.e. those regions that have high temperatures and high annual rainfall or a seasonal distribution of rainfall.

Outline Study of the physical environment is the starting point with consideration of the climatic characteristics across the humid tropics which can then lead into discussion of the vegetation, soils and landforms of these areas. Case study material and examples should be included wherever appropriate and **one** case study illustrating some of the problems of sustainable management of **either** a tropical rain forest **or** a savanna is an essential part of the option.

Resources: Geofile online at Nelson Thornes and Geofactsheets at www.curriculumpress.co.uk are two excellent subscription online resources.

Textbooks referenced below: Digby, B ed. (2000) *Global Challenges* Heinemann; Heelas, R (2001) *Tropical Environments: Contrasting Regimes and Challenges* Nelson Thornes; Meg and Jack Gillett (2003) *Physical Environment: A Case Study Approach* Hodder and Stoughton; Guinness P and Nagle, G (1999) *Advanced Geography: Concepts and Cases* Hodder and Stoughton; Money, DC (2000) *Weather and Climate* Nelson; Nagle, G (2000) *Advanced Geography* Oxford University Press; O'Hare, G (1990) *Soils Vegetation and Ecosystems* Oliver and Boyd; Warburton, P (2001) *Atmospheric Processes and Human Influences* Collins; Waugh, D (2000) *Geography: An Integrated Approach* Nelson Thornes 3rd edition; Woodfield, J (2000) *Ecosystems and Human Activity* Collins 2nd edition. *Geography in Focus* (2000) Cook, I, Hordern, B, McGahan, H, Ritson, P Causeway Press Ltd.

1.	TROPICAL ENVIRONMENTS	<p>Introduction The intention should be to convey an overview of the option at the outset. Study a world map of the major biomes Consider latitudinal distribution Relate to the global climate map and global population distribution Emphasise the humid tropics/low latitudes and links between the sub-sections of climate, vegetation and soils in the syllabus through these maps. EXERCISE: Give climate data for selected stations eg equatorial climate, savanna climate monsoon climate. Plot figures, describe in detail climatic</p>	<p>General: amazonia.com is a comprehensive web site. www.gis.psu.edu/geog121/re mote/rondonia_75html www.dpi.inpe.br/Amazoniapg 13.html</p> <p>www.worldclimate.com Has a good range of climate data for a selection</p>	<p>Any Atlas Nagle p.210 excellent map of the world vegetation zones/biomes Woodfield p.15</p> <p>Heelas p. 8 as a starting point</p>
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		<p>characteristics of each as a lead in to explanation June 2003 Q2 (a) Good climate data –could be a useful teaching aid.</p> <p>WHY IS THE TROPICS AN ISSUE? Brief, general discussion of wilderness areas, outstanding physical environments, biodiversity, resources, endangered species and the threats posed by indiscriminate exploitation, need for conservation. <i>Development of tourism – links to human geography SoW units 2 & 3</i></p>	of stations round the world	<p>Digby p.38</p> <p>p.12-13 Heelas</p>
1.1	Tropical Climates	<p>The foundations will have been laid at AS through <i>Atmosphere</i> and <i>Weather</i> See SoW 2.2 Earth-Atmosphere energy budget and general circulation etc.</p> <p>Good starting point- general circulation of the atmosphere. Focus on the Hadley cell. Formation of ITCZ, low pressure at the Equator, descending air at 30° N and S, producing high pressure. Associated wind belts-trade winds. Migration of thermal equator according to the seasons. Relate to the resultant changing position of pressure and wind belts, on-shore/offshore winds and resultant rainfall.</p> <p>Relationship of earth to sun as it moves to produce seasonal variations in temperature.</p> <p>November 2002 Q2(a) was specifically about the ITCZ and its influence upon precipitation.</p> <p>EXAMPLES</p> <p>1. West Africa. Aptly demonstrates the change from Equatorial to Savanna climate with seasonal variation in rainfall.</p> <p>It may be appropriate to introduce the West African ecocline (vegetation transect) to demonstrate links between climate, vegetation and human activities</p> <p>June 2003 Q2 (b) The ecocline would be an ideal example for such a question which asks about the</p>		<p>Garrett and Nagle p.411 Waugh p.226 Nagle p.157 Digby p.39</p> <p>Waugh p.228</p> <p>Gillett p.110-111 Fig.1</p> <p>Digby p.41 Money p.87</p>

1.2	<p>Tropical Ecosystems</p> <p>VEGETATION</p>	<p>relationship between rainfall and vegetation.</p> <p>2. Indian sub-continent- Monsoon climate. Sub-tropical jet stream and relation to surface conditions November 2003 Q1 (a) June 2002 Q1 (a)</p> <p>Well annotated maps can be very useful for both examples and can be used in an exam answer for explanatory purposes.</p> <p>This section needs an introduction to the ecosystem as a concept, and its structure, functioning and development over time. Soil characteristics and formation is also included. Focus on TRF and Savanna ecosystems</p> <p>Productivity- rate of energy production usually on an annual basis. Gross Primary Productivity(GPP) Total energy production including respiration. Net Primary Productivity-(NPP)-is the total amount of energy transferred from sunlight into organic matter (photosynthesis) minus the energy lost via respiration. It is expressed as a rate g/m²/yr. Biomass- total mass of living organisms present in an area. Expressed as mass per unit area measured as dry weight. Food chain/webs Trophic levels – a feeding level within a food chain from which energy is lost. Biodiversity a term used to describe the variety of species, both floral and faunal within an ecosystem.</p>		<p>Money p.37-9 Warburton p.145-154- excellent section Nagle p.173 Has excellent diagrams Waugh p.239-40</p> <p>Waugh Ch.11 p.286-306 Nagle Chapter 10 O’Hare Ch.4 p.94-106 Woodfield p.4-11</p>
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		<p>Nutrient cycling-Gersmehl diagrams, June 2002 Q2(a); Nov 2003 Q1(b) Plant succession, climax vegetation, plagioclimax, serres, seral stages, sub-climax. June 2002 Q1(a)</p> <p>Tropical Rain Forests- structure, characteristics, adaptations, nutrient cycling. Relationship to climate/reasons for the nature of the forest/large biomass/ high productivity etc.</p> <p>Could introduce case study material here and consider both human and physical factors which determine the nature of the forest or it can be done as a separate section after all the theory is covered.</p> <p>Savanna- Characteristics, adaptations of vegetation to seasonal variation of rainfall, nutrient cycling, productivity rates. Compare with TRF and explanation of differences. Spatial variation of vegetation (ecocline) north to south across the savanna in West Africa to demonstrate the spatial variation in seasonal rainfall. June 2003 Q2(b) This question could have been answered very well using the West African ecocline.</p> <p>Basic background detail if soils have not been studied previously. Definition of soil, composition, structure, Factors which influence soil formation: climate, vegetation, relief, fauna, geology, time. Soil forming</p>		<p>Fig. 2 O'Hare has these diagrams as do most AL Texts</p> <p>Woodfield Ch.2 p.14-41 Waugh p.316-318 <i>The Rain Forest Paradox</i> Geog Review Sept 1998 p.7-9 Nagle p.212-3 O'Hare p.116-122 Heelas p.67-73 Excellent detail on all aspects of the natural environment of the TRF</p> <p>Nagle p.214-5 O'Hare p.126-7 Garrett and Nagle p.463-6 Heelas p.39-45</p> <p>Waugh Chapter 10 p.260 onwards. Has good visual presentation of soils</p>
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	<p>SOILS</p>	<p>processes: Precipitation:Evaporation ratios, leaching and upward capillary action; gleying; ferrallitisation; calcification, laterisation, duricrusting</p> <p>Soil profiles for tropical soils. Oxisol/latosols/ferrallitic soils. Familiarity with at least one tropical soil. Well annotated diagram will fulfil requirements. November 2002 Q1. requires at least one tropical soil profile.</p> <p>Catena- is a downslope sequence of soils which reflects differences in drainage conditions. The influential factors are slope angle, water table, aspect, vegetation and climate. Rock type is constant.</p> <p>NB See CIE Standards booklet for an excellent candidate response/possible model answer to a question on catenas. There is plenty of information here.</p> <p>The theme of this section of work should emphasise the link between process and form. It will be familiar from AS work. See the SoW for AS. 3.2 <i>Weathering and Rocks</i> 3.3 Slopes, processes and <i>development</i></p> <p>Weathering processes: Physical: Exfoliation, Dilatation, crystal growth, frost action, Chemical: Hydrolysis and hydration. Reminder of the Peltier diagram. Also latitudinal variation of weathering depths-link to basal surface of weathering November 2003 Q2(a) Good teaching aid in this question. Factors influencing weathering rates. Van't Hoffs Law, importance of water, rock structure-joints patterns- increasing surface area.</p>		<p>Heelas p.65-6 good Nagle p.193-4 Very good on zonal and equatorial soils. Good profile diagrams</p> <p>O'Hare p.50, p.119-120 Catena in Belize Waugh p.276 Nagle p.189 All refs have theoretical models of the catena.</p> <p>Fig. 3 An annotated diagram to show the characteristics of a soil catena.(tropical)</p> <p>Waugh p.40 Nagle p.40 has a diagram showing relationship between depth of weathering and climate</p> <p>See also Cook, Hordern et al (CHE) chapter 8</p>
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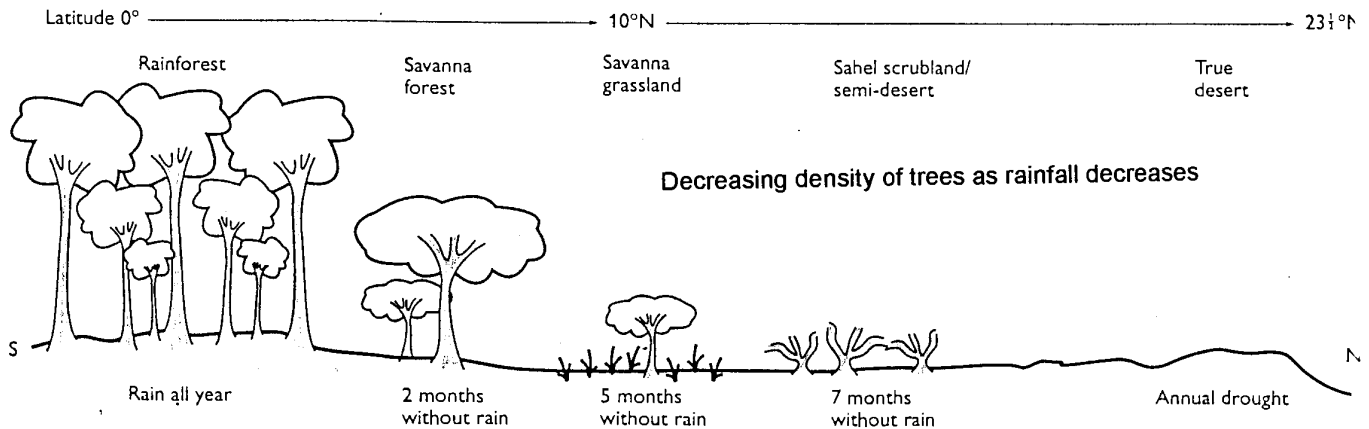
1.3	TROPICAL LANDFORMS	<p>Granite- characteristics of granite composition and structure. Weathering of granite-Hydrolysis. Weathering front-basal surface, joint pattern corestones, saprolite. Evolution of landforms: Etchplanation theory: deep weathering; exhumation by stripping-reasons for stripping, ie climate change, fluvial activity, vegetation removal, cyclical nature of the stripping. Pediplanation-uplift of a pediplain; vertical fluvial incision; pediment formation and role of water in lateral planation of these surfaces and relation to parallel retreat of slopes. (Link to option 4.2 desert landforms)</p> <p>November 2002 Q2 (b) June 2003 Q1 (a)</p> <p>Landforms: Inselbergs, ruwares, bornhardts, koppes. Tors</p> <p>Useful teaching aids: June 2003 Q1 (a) diagrams November 2003</p> <p>Mark schemes for these papers gives a good guide to content.</p> <p>Limestone: Weathering process: Carbonation-solution. Joint pattern bedding planes and vertical joints. Permeability. Tropical limestone forms: emphasise vertical nature of the weathering to produce scale of these landforms</p> <p>Landforms: Cockpit karst, tower karst, mogotes. Good examples: China and Caribbean</p> <p>June 2002 Q2 (b)</p>		<p>Cook, Hordern et al 376-385</p> <p>Nagle p.38-9. This is a key source Heelas p.58 passing reference Waugh p.198 short ref</p>
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1.4	<p>Case Study of TRF OR SAVANNA ECOSYSTEM</p>	<p>Big idea in this section is sustainability in relation to the functioning of the physical environment and human use of that environment in order to maintain its resources. Carrying capacity, soil erosion, leaching, infertility. Link to human activities. Management strategies. Discussion should include evaluation of the success of the management.</p> <p>TRF Deforestation, problems associated within the physical environment soil erosion, leaching, consequent infertility break down of nutrient cycles loss of productivity NPP. Changing albedos, implications for global climate change. Therefore extend local effects to global impact. Also forests as carbon sinks link to atmospheric pollution and climate change. Loss of agricultural potential. Carrying capacity, sustainable population levels, indigenous populations. Human activities: Sustainable-bush fallowing, commercial large scale agriculture-plantations ranching. Other activities: mining, tourism-ecotourism.</p> <p>(Food for thought-Mature TRF produces as much CO2 as it absorbs. It is only when it is growing that it acts as a sink. Apparently it would be best to chop down all the TRF, use the wood for building and replant so that the TRF re-grows absorbing more CO2!!)</p> <p>Savanna- Rainfall reliability, drought, desert margins-Sahel –use the West African example again. Overpopulation, nomadic pastoralism indigenous populations changes to sedentary agriculture, way of life, pressure on the natural environment. Desertification eg. Sahara margins- Sahel. Possible</p>	<p>Garrett and Nagle p.530 Heelas p.86-90 theme of sustainability</p> <p>Digby (GC) p.89-105 Very good accessible section</p> <p>Heelas p.74-85 Case Study of Brazil Woodfield p.30-7 Gola Forest Sierra Leone Woodfield p.30 Excellent flow digram to show effects of deforestation on albedo</p> <p>Money p.87 Warburton p100-101 Waugh p.335-338 Case Study 12 Garrett and Nagle p.524-529 Excellent section on desertification The Challenge of Seasonality in the Tropics-</p>
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		<p>aspects- Masai, Fulani tribes. Tourism-Safari Parks. Management Strategies. Water availability.</p> <p>There is case study material in many textbooks</p> <p>November 2002 Q2(b) June 2003 Q1(b) November 2003 Q2 (b)</p> <p>Pasoh Forest Malaysia- has all the necessary ingredients of physical environment and human activities which threaten the natural environment and conservation/protection measures/management</p>		<p>Savanna areas Digby (GC) p. 36-48 Geog Review Nov 2003 p.24-6 <i>Desertification in Southern Africa</i></p> <p>Geography Review September 1996</p>
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Fig 1

West Africa An Ecocline (Vegetation transect)



Equatorial rainforest

Savanna forest-savanna grassland

Savanna grassland-sahel

Tropical desert

CLIMATE

- Temperature 26–30°C — range 4°C
- Annual precipitation: around 2000 mm; double maximum just after the equinoxes in March and September
- Daylight around 12 hours all year
- High humidity
- Very few limiting factors to vegetation growth

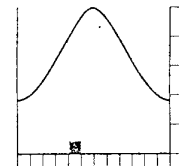
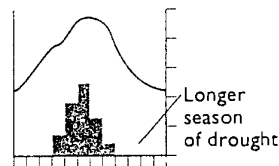
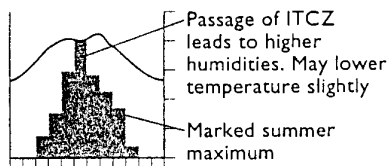
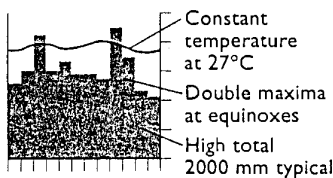
- Temperature 23–33°C — range 10°C
- Annual precipitation around 800–900 mm; summer maximum at solstice; rainfall spread over 7 months
- Daylight 11–13 hours

- Temperature 22–36°C — range 14°C
- Annual precipitation: 300–500 mm; summer maximum rainfall spread over 3–5 months
- Daylight 10–14 hours

- Temperature 10–40°C — range 30°C
- Annual precipitation can be zero; sometimes up to 100 mm in flash flood
- Very low humidity
- Daylight 8–16 hours

• Seasonal drought becomes an increasingly limiting factor to vegetation growth

CLIMATE GRAPHS



ECOSYSTEM

- Tall, broad-leaved evergreens in continuous growth
- Canopied, stratified forest with a layered structure
- High species diversity
- Constant heat and humidity lead to high primary productivity with many ecological niches and a large biomass
- Rapid nutrient cycling

- Mixed grassland with trees; clearings of woody shrubs and tall trees
- Drought-resistant trees such as acacia and euphorbia appear as it starts to get drier (10°N)

- Tall savanna grass; isolated, small, drought-resistant trees; all vegetation develops protection against fire and animal predators

- Xerophytic plants such as cacti, yucca and tamarisk are adapted to arid conditions
- Slightly wetter stream course areas support scrub
- Limited species

NPP (kg/m²/yr) 2.2
Biomass (kg/m²) 45.0
Tropical red earths

NPP (kg/m²/yr) 1.2
Biomass (kg/m²) 9.0
Lateritic soils

NPP (kg/m²/yr) 0.9
Biomass (kg/m²) 4.0

NPP (kg/m²/yr) 0.2
Biomass (kg/m²) 0.6
Desert soils

LAND-USE

- Traditional shifting agriculture in remote areas; otherwise subsistence bush fallowing
- Enormous range of tree crops; some plantations such as oil-palms and cocoa
- Range of vegetables and staple crops
- Forest exploitation

- A mixture of forest and grassland crops, grown according to the wet and dry seasons
- Crops include millet, maize, cotton and vegetables

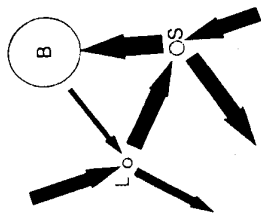
- Largely cattle rearing by tribes following nomadic routes
- Severe droughts in recent years; desertification of sahel
(Desert margins)

- Very limited settlement except at oases
- Some mining settlements for oil or precious metals
- Nomads herd camels

WORLD BIOMES

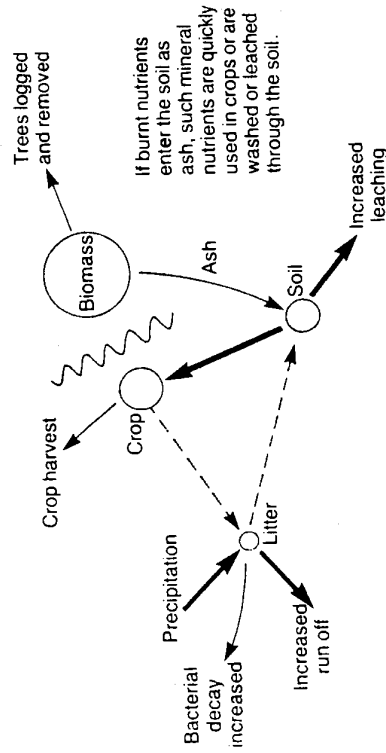
Nutrient cycling- summary sheet

Fig 2

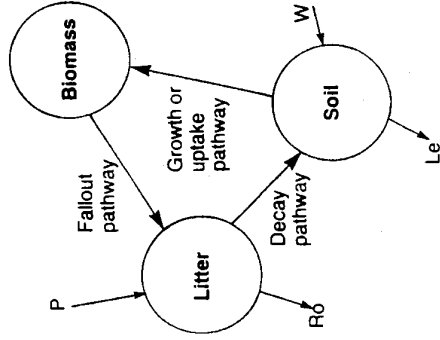


Nutrient store
 B Biomass P Precipitation
 L Litter Ro Run off
 S Soil Le Leaching
 → Nutrient flows W Weathering

Interference in the nutrient cycle of tropical rain forest by forest clearance and cultivation

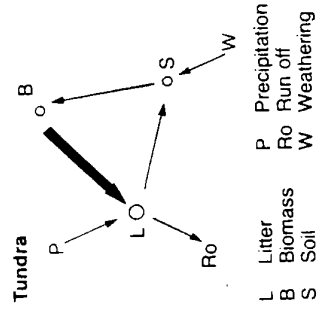


Model of nutrient circulation, input and loss in an ecosystem (Source: Gersmehl, 1976)

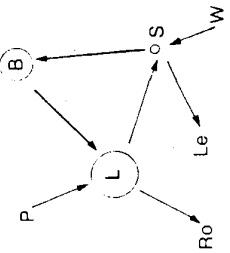


W Weathering
 Ro Run off
 Le Leaching
 P Precipitation

Nutrient cycling in the tundra, illustrating a low rate of both circulation and storage. Inputs from weathering and outputs from run off are also negligible. (Source: Gersmehl, 1976)

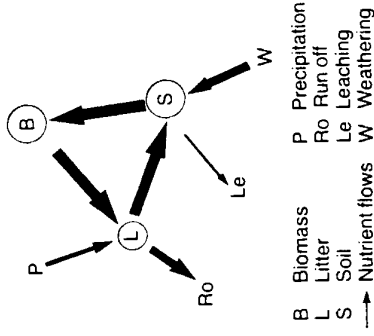


(a) Boreal forest

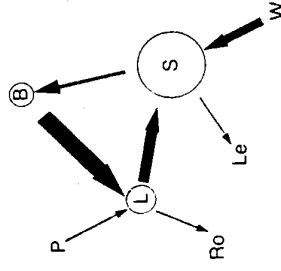


(b) Deciduous forest

(b) Savanna



(a) Steppe



Nutrient cycling in arid deserts, showing slow rates of circulation but a large potential reserve of plant nutrients in the soil (Source: Gersmehl, 1976)

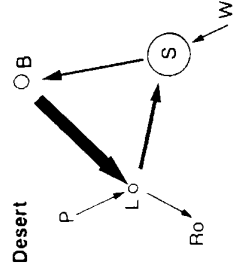
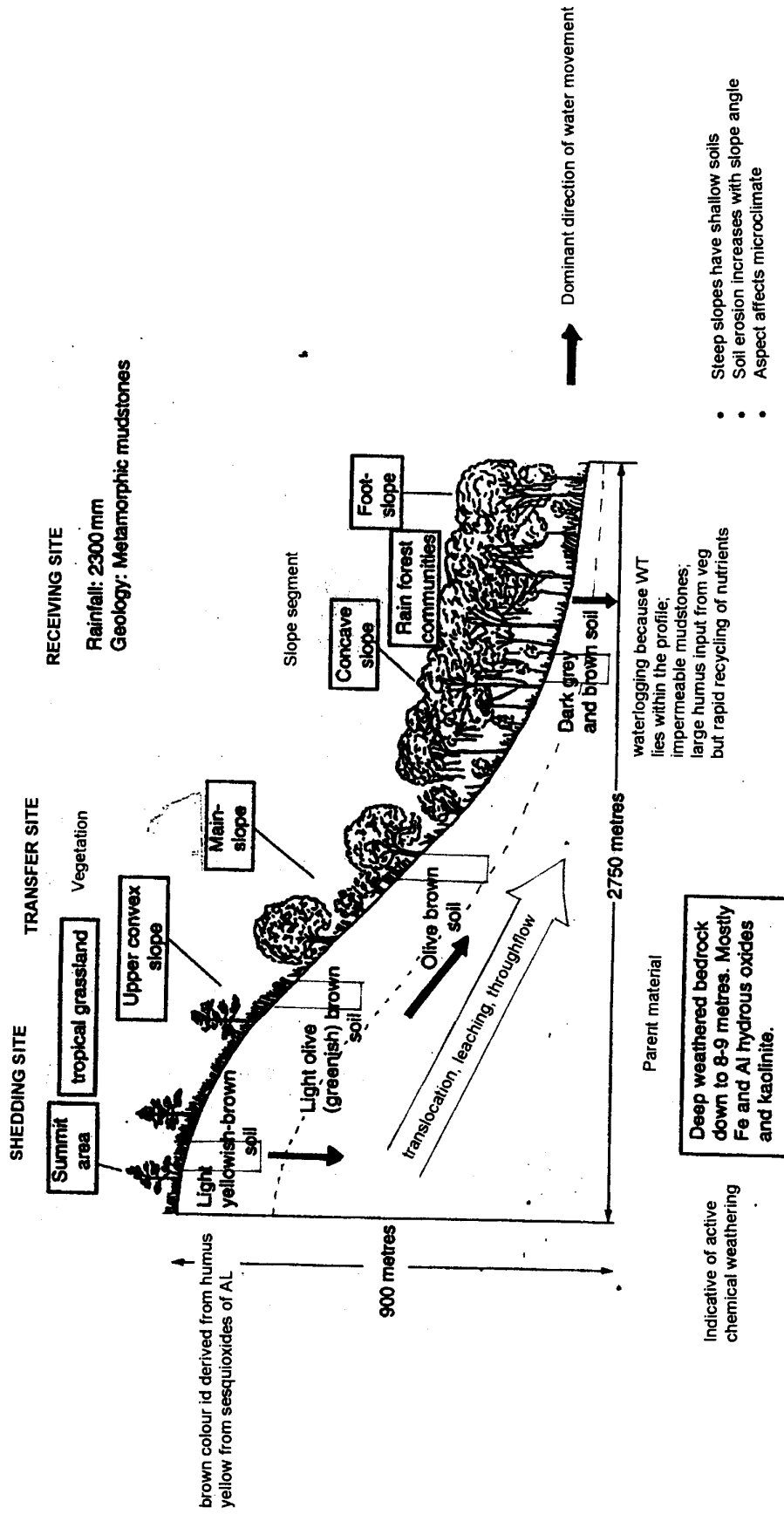


Fig 3. A TYPICAL SOIL CATENA

the relationship between soils and vegetation down a slope in a tropical area.



This catena is similar to a podzol-brown earth-gley sequence typical of humid temperate latitudes. See Nagle p.189