Window 14.3 ***Forests and runoff***

There are many reasons why the removal of a forest cover and its replacement with pasture, crops or bare ground have such important effects on streamflow. A mature forest probably intercepts a higher proportion of rainfall, tends to reduce rates of overland flow, and promotes soils with a higher *infiltration* capacity and better general structure. All these factors will tend to produce both a reduction in overall runoff levels and less extreme flood peaks, though this is not invariably the case.

Reforestation of abandoned farmlands reverses the effects of deforestation: increased interception of rainfall and higher levels of evapotranspiration can cause a decline in water yield to rivers. This can cause problems for human activities.

Reviews of catchment experiments from many parts of the world have pointed to two conclusions:

- Pine and eucalypt forest types cause an average change of 40 mm in annual flow for a 10 per cent change in cover with respect to grasslands; that is, a 10 per cent increase in forest cover on grassland will decrease annual flow by 40 mm, and a 10 per cent decrease in cover will increase annual flow by the same amount.
- The equivalent effect on annual flow of a 10 per cent change in cover of deciduous hardwood or scrub is 10–25 mm: that is, if 10 per cent of a grassland catchment is converted to hardwood trees or scrub vegetation, the annual runoff will decrease by 10–25 mm.

The increase in annual flow that results from tree or scrub removal tends to be most marked in two particular environments: those with very high rainfall and those with very low rainfall. In the former, evaporation from forest will tend to be higher than that from other land covers because of high levels of rainfall interception. In the latter, evaporation from forest is likely to be higher than from other land covers because forests, composed of trees that have deep root systems, are better able to make use of soil and groundwater reserves.

Having discussed changes in annual flows, now let us turn to a consideration of how forest removal influences low-season flows and flood peaks. The higher losses from forests in wet seasons from rainfall interception and increased losses in dry seasons from transpiration (because of the deep root systems of trees) both tend to increase soil-moisture deficits in dry seasons compared to those under other land uses. On the other hand, in forests at high altitudes, where there is a lot of water deposition on to trees from clouds, this may provide a significant component of the dry-season flows into rivers and also increase runoff. The same applies in areas with high-intensity storms where high-intensity rainfall may lead to high levels of surface runoff. The higher infiltration rates under indigenous forest compared with other land uses may help soils and their below-ground aquifers to recharge themselves. In steeply sloped areas forests may have the additional benefits of reducing landslips and preserving the soil aquifer which may be the source of dry-season flows. Both these effects of afforestation may therefore benefit stream flows in the low season.

When it comes to flood peaks there is still a great deal of controversy as to how important forest cover is with respect to the largest types of event. Some authors suggest that management practices associated with forestry (e.g. the building of roads, culverts and drainage ditches) or subsequent activities (e.g. grazing) which promote the flood, by causing compaction of the soil and reducing its infiltration capacity, increase this type of hazard.

Summary of the effects of some land-use changes on stream runoff

Land-use change	*Hydrological component affected*	*Principal hydrological process involved*
Afforestation (deforestation has the opposite effects in general)	Annual flow	Increased interception Increased transpiration in dry periods
	Seasonal flow	Increased interception and increased dry-period transpiration reduce dry-season flow Drainage improvements associated with planting may increase dry-season flows Cloud water (mist and fog) deposition on trees will augment dry-season flows
	Floods	Interception reduces floods by removing a portion of the storm rainfall, and allowing soil moisture storage to increase
Agricultural intensification	Water quantity	Alteration of transpiration rates affects runoff Timing of storm runoff altered through land drainage
Draining wetlands	Seasonal flow	Lowering of water table may induce soil-moisture stress, reduce transpiration and increase dry-season flows Initial dewatering on drainage will increase dry-season flows
	Annual flow	Initial dewatering on drainage will increase annual flow Afforestation after drainage will reduce annual flow
	Floods	Drainage method, soil type and channel improvement will all affect flood response