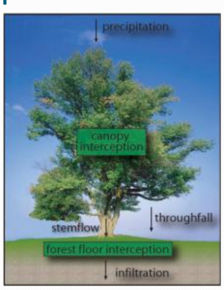
# Interception

GG22A: GEOSPHERE & HYDROSPHERE
Hydrology

## Interception components

- Three Main Components of Interception:

1. Interception Loss
2. Throughfall
3. Stemflow




## Interception loss

- The water that is retained by vegetation surfaces that is later evaporated into the atmosphere, or absorbed by the plant.
- Interception loss prevents water from reaching the ground surface and is regarded as a primary water loss.

## Throughfall

- The water which falls through spaces in the vegetation canopy, or which drips from the leaves, twigs and stems and falls to the ground.

## Stemflow

- The water which trickles along the stems and branches and down the main stem or trunk to the ground surface.

## Factors affecting interception loss from vegetation

1. Interception Storage:
   - the ability of vegetation surfaces to collect and retain precipitation.
   - capacity will be highest at the onset of rainfall when the vegetation is dry, when water is held by surface tension.

## Factors affecting interception loss from vegetation

2. Evaporation:
   - even when the interception storage capacity is exceeded water may be lost by evaporation off leaf surfaces, which increases in windy conditions, though the interception storage capacity may be reduced with increased windspeed.

## Factors affecting interception loss from vegetation

3. Duration of Rainfall: influences interception by determining the balance between reduced storage of water on vegetation surfaces and increased evaporative loss over time.
   - Total interception losses increase with duration of rainfall (but only gradually), though the relative importance of interception decreases with time.

## Factors affecting interception loss from vegetation

- The importance of interception decreases with time, due to duration of rainfall and changes in the interception storage capacity.

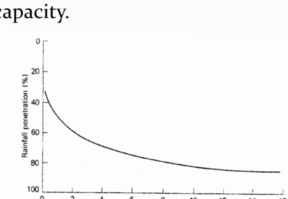
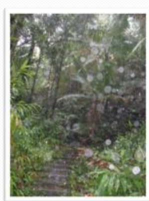



**Figure 3.1** *Relationship between the amount of rainfall reaching the forest floor (an approximate reciprocal of interception loss) and rainfall duration. Data for a mixed deciduous forest in Poland (based on an original diagram by Olszewski, 1976).*

## Factors affecting interception loss from vegetation

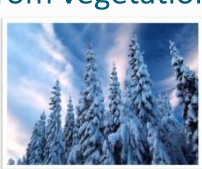
4. Rainfall Frequency: the highest levels of interception loss occur when the leaves are dry and interception storage is large, so the frequency of re-wetting is more significant than the duration and amount of rainfall.

## Factors affecting interception loss from vegetation



5. Precipitation Type: the contrast between rain and snow.

## Factors affecting interception loss from vegetation



- Snow clings to leaves and branches more, but interception loss is limited due to low temperatures and evaporation rates.
- May be a contrast between coniferous and deciduous trees

## Factors affecting interception loss from vegetation

6. Type and Morphology of the Vegetation Cover:
   - different vegetation types have:
     - Different interception storage capacities
     - Different aerodynamic roughness characteristics
     - Different rates of evaporation from their surfaces.
   - Interception losses are generally greater from trees than other types of vegetation (grasses and agricultural crops)
     - due to the greater aerodynamic roughness of trees in promoting increased evaporation in wet conditions
     - or to their higher interception capacities (in some cases) especially when wetted and dried frequently.

## Interception by trees, forests and woodlands

- Interception losses are greater from coniferous forests than from deciduous woodlands.

## Interception by trees, forests and woodlands

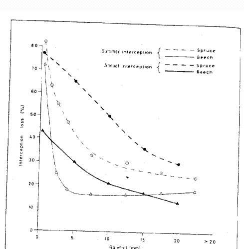



**Figure 3.5** *Interception losses from spruce and beech forests (based on data from F. E. Eidmann, quoted by Penman, 1963, and from E. Hoppe quoted by Geiger, 1957).*

- Both sitka spruce forests and beech woodlands show a reduction in the relative importance of interception loss as rainfall amounts increase, but interception is greater from spruce.

## Interception by trees, forests and woodlands

- Water droplets tend to cling to separate conifer needles, but run together on deciduous leaves and drip as throughfall or flow as stemflow.
- Coniferous trees also have a more open texture and allow for a free flow of air leading to more evaporation.

## Interception by trees, forests and woodlands

- Coniferous trees intercept rainfall at about the same rate from summer to winter, but deciduous trees intercept more during full leaf.

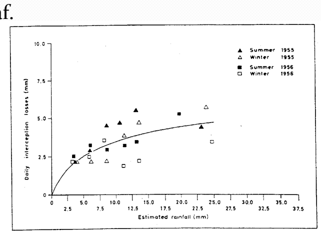
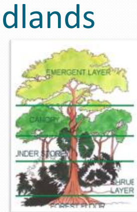
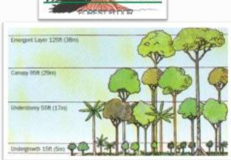


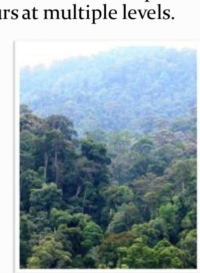

**Figure 3.6** *Seasonal interception losses from sitka spruce (from an original diagram by Law, 1958).*

## Interception by trees, forest and woodlands

- The canopy is also important in forests and interception occurs at multiple levels.

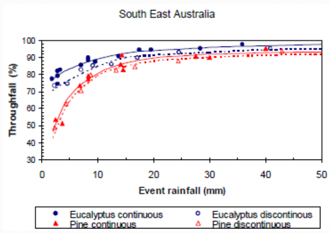




## Interception by trees, forest and woodlands

- Throughfall increases (and interception loss decreases) as the amount of rainfall increases.




Crockford & Richardson (1990)

## Interception by grasses and shrubs

- Mature grasses and shrubs have a continuous cover and their interception storage capacity may be similar to trees.
- Grasses have a higher aerodynamic resistance to air flow and have a shorter growing season, so total interception is considerably less than for woodlands and forests.



## Interception by agricultural crops

- Interception by crops is small in relation to forested areas.



## Interception by agricultural crops

- Interception generally increases with increasing crop density, though after a certain density is attained, interception increases only slightly.

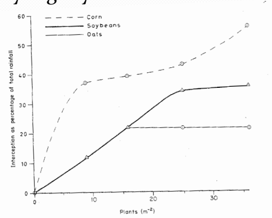


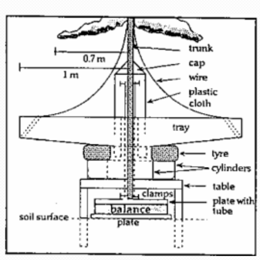

**Figure 3.7** *Interception by three agricultural crops (based on data from Woollny quoted by Baver, 1956).*

## Measurement of interception

- Gross precipitation
  - Raingauge in clearing or above canopy
- Throughfall
  - Network of raingauges
  - Sheet gauges
- Stemflow
  - Collecting collars around trees

## Measurement of interception

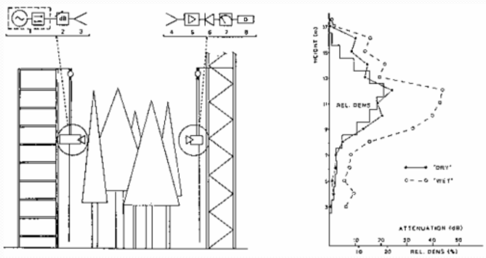
- Weigh the tree…




Lundberg (1993)

## Measurement of interception

- Microwave attenuation



## Interception statistics

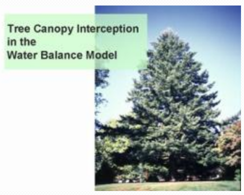
| Vegetation | Location | Throughfall | Stemflow | Evaporation |
|---|---|---|---|---|
| | | as % of gross precipitation | | |
| Scots Pine | Norfolk | 67 | 2 | 31 |
| Sitka Spruce | Highland Scotland | 69 | 3 | 28 |
| Beech | Hampshire | 82 | 4 | 14 |
| Maritime Pine | SW France | 87 | 1 | 12 |
| Laurel Forest | Canary Islands | 57 | | 43 |
| Cloud Forest | Puerto Rico | 59 | 2 | 39 |
| Tropical forest | Amazon | 89 | 2 | 9 |
| Savannah forest | Venezuela | 76 | 1 | 23 |

## Interception statistics

| Vegetation | Storage capacity (mm) |
|---|---|
| Oak | 0.8 to 1 |
| Sitka Spruce | 2 to 3 |
| Eucalyptus | 0.2 to 0.6 |
| Douglas fir | 2.4 |
| Cypress | 0.5 to 0.8 |
| Slash pine | 0.38 to 0.5 |
| Heather | 1.1 |
| Lowland tropical | 0.74 to 1.15 |

*expressed as mm depth over the area covered by the crown*

## Interception and the water balance




- What is the role of interception in the water balance?
  - Does it have a neutral, negative or positive effect on the catchment water balance?

1. Neutral Hypothesis.
2. Net Loss of Water.
3. Net Gain of Water.

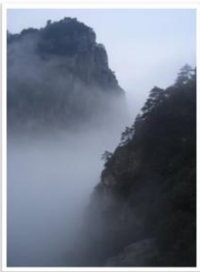
## Interception and the water balance

- Neutral Hypothesis:
  - there is only a certain amount of energy available for evaporation which will be used either in transpiration (loss of water from within the leaves of the plant), or interception loss (evaporation from the leaf surface).

## Interception and the water balance

- Net Loss of Water:
  - intercepted water evaporates much faster than transpired water, because aerodynamic resistance to water vapour flux is less than the physiological resistance imposed by the vegetation canopy to transpiration.
  - The aerodynamic resistance to vapour flux is also low for wetted vegetation surfaces and is lower for trees compared to other vegetation.
  - Interception loss may also occur by evaporation at night when transpiration has ceased.
- Interception represents a net loss of water whenever interception loss is the dominant evaporative component.

## Interception and the water balance



- Net Gain of Water:
  - especially where horizontal interception takes place in forested areas of high relief, where fog or low clouds are prevalent.

## Interception and the water balance

- In these conditions of high atmospheric humidity, trees may extract moisture from the air, which would not have fallen as rainfall.
- Water droplets are formed by direct condensation onto the leaves, twigs, pine needles, especially during fog or low clouds, or where fog is moving off the sea.

## Interception and the water balance

- In Horizontal Interception or Fog Drip, both throughfall and stemflow become the most significant components of interception.
  - Fog drip occurs on the windward edge of upstanding vegetation, and on high crests and ridges. In these conditions, fog drip may exceed precipitation by a factor of 2 or 3.

## Summary

- Interception loss; throughfall; stemflow
- Factors affecting interception loss:
  - storage, evaporation, rainfall duration, rainfall frequency, precipitation type, type and morphology of vegetation cover.
- Trees/ forest vs. grasses vs. agricultural crops
- Measurement of interception
- Interception and the water balance