The influence of vegetation on flood change

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1. Introduction:

It has been suggested that land use change and climate change might lead to an altered magnitude and frequency of floods. However, the mechanisms underlying such **changes in flood generation** still need to be elucidated.

The **objective** of this study is to uncover how **changes in vegetation and concomitant changes in soil properties,** arising as a result of land use change or climate change, may translate into increased flood hazard over decadal or centennial timescales.

The **main focus** of the current study is on **changes in catchment response** (run-off generation) caused by altered vegetation and soil characteristics rather than changes in precipitation regime due to vegetation-climate feedbacks.

2.

Land use change and climate change **perturb vegetation to different extents**. The question then is whether such changes will significantly alter catchment response or not.

Perceptibility of change	Land use change	Climate change
Apparent (land cover maps)	Change in vegetation cover type (e.g. deforestation, grassland to arable land conversation)	Change in plant functional type (e.g. treeline shift to higher altitudes and latitudes, woody plants encroachment)
Less conspicuous (local knowledge)	Change in species composition (e.g. conversion of mixwood forest into monoculture, planting different crop)	Change in species composition (e.g. selective dieback of drought susceptible species)
Inconspicuous (more sophisticated measurements)	Change in species functioning (e.g. conversion of productive into non-productive cropland due to nutrient depletion and soil compaction)	Change in species functioning (e.g. reduced carbon reserves, decreased production of seeds)

4. How are interception, water infiltration and soil water storage influenced by vegetation cover and associated biological activity in soil?

Hydrological processes:

Interception

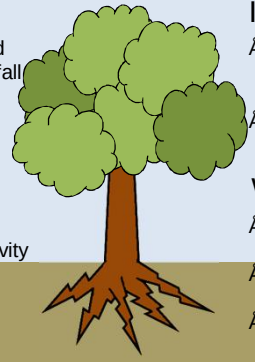
- Percent rainfall intercepted
- Characteristics of throughfall and stemflow

Water infiltration

- Topsoil infiltrability
- Subsoil hydraulic conductivity
- Preferential flow

Soil water storage

- Soil depth
- Water holding capacity of unit soil volume
- Soil moisture



Biological influences: (traits or processes)

Interception

- **Interception of precipitation by canopy:** leaf area index, plant architecture, leaf size, angle and hydrophobicity, bark roughness
- **Interception (storage) by litter:** litter layer mass, litter hydrophobicy

Water infiltration

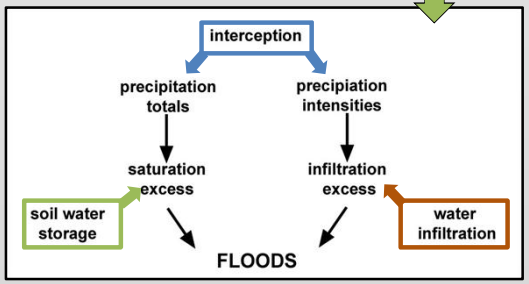
- **Sheltering by the litter and canopy:** prevention of soil sealing and crusting
- **Biotic influences on soil structure:** root activity, associated microbial activity, soil organic matter
- **Macropores created by biotic agents:** decayed root channels, meso- and macro-fauna

Soil water storage

- **Biotic influences on soil formation:** litter addition and decomposition, enhanced weathering (root activity, increased acidity due to respired CO_2)
- **Prevention of erosion:** slope stabilization by root systems, sheltering from water and wind
- **Biotic influences on soil structure:** root activity, associated microbial activity, soil organic matter
- **Transpiration:** reduction of soil moisture content
- **Sheltering by litter & canopy:** decrease in soil evaporation

3.

Changes in **interception**, **water infiltration** and **soil water storage** may lead to altered catchment response to precipitation.



5.

Vegetation affects catchment response directly, **during the flood generating rainfall event**, as well as indirectly, **through its effect on antecedent soil moisture conditions**.

	Flood generating precipitation	Antecedent conditions
Canopy and litter interception	+	++
Reduction of soil moisture by transpiration	-	++
Biotic influences on soil depth and structure	++	++

++ strong influence, + medium influence, - weak/no influence

6. Examples of change in vegetation and soil characteristics happening over decadal and centennial timescales that may lead to changed catchment response:

- Plant **acclimation** = structural and physiological adjustment to novel environmental conditions (e.g. the advancement in leaf flushing date in response to increasing temperature)
- **Migration** of species tracking the environmental change (e.g. the shift of species range to higher latitude in response to increasing temperature)
- **Dieback** of species triggered by environmental stress (e.g. Norway spruce dieback due to bark beetle infestation, quaking aspen decline due to drought)
- Development of **plow pan** (subsoil compaction) in arable soil
- Changes in **soil organic matter content** (e.g. due to soil plowing, enhanced soil erosion, changed microbial activity driven by changed temperature or moisture)

7. Future Directions:

- Look for these changes in vegetation and soil properties in real catchments and link them with altered hydrological behavior
- Model these changes and integrate them with other factors that may cause flood changes such as altered precipitation patterns and river training