Hydrogeology, the missing link between IWRM and WASH

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Pro memoriam

The fundamental hydraulic equation is

$$P = E + EPT + R + I + \Delta S,$$ where

P = Precipitation at local level will evolve to

E = Evaporation (physical process)

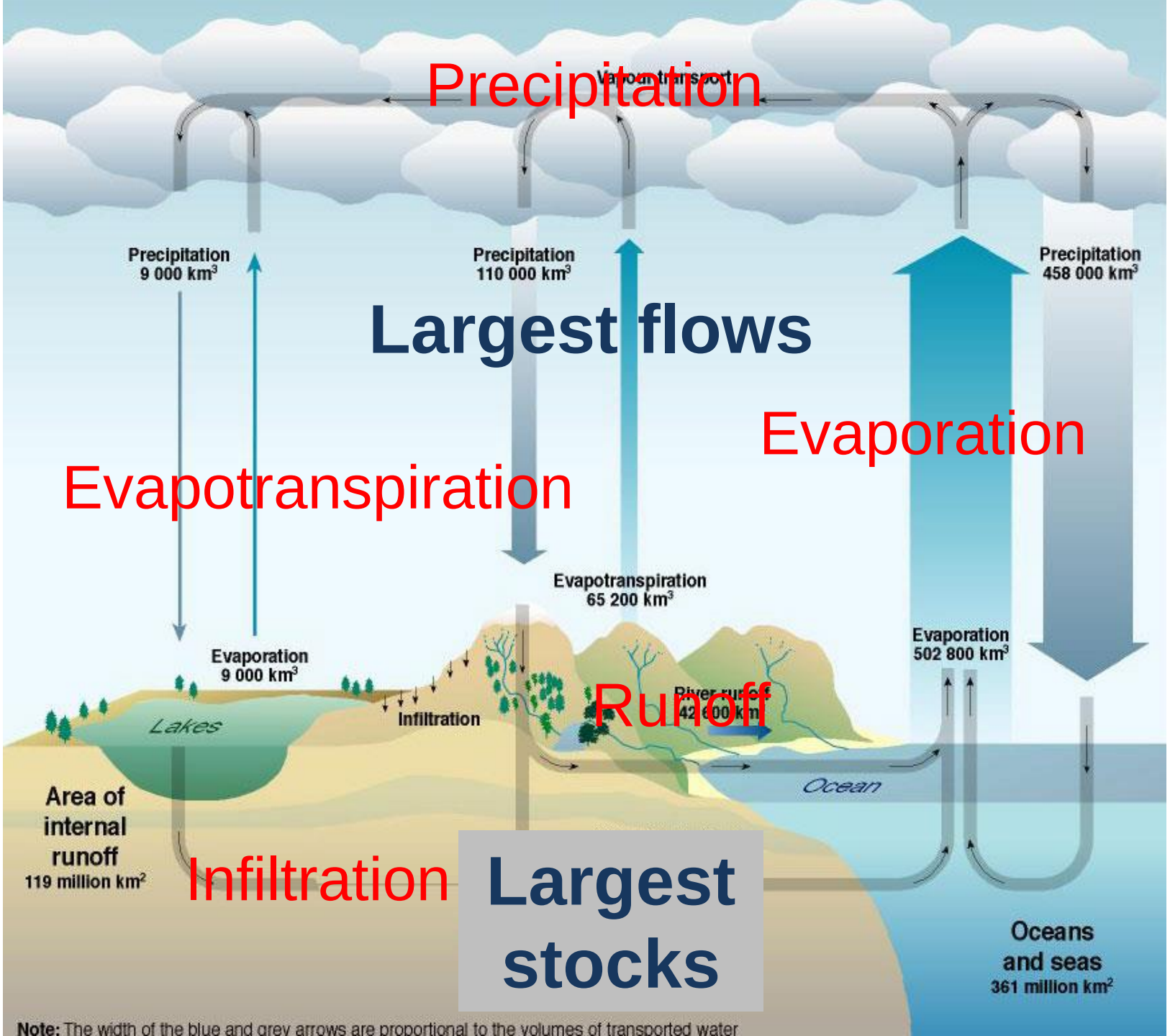
EPT = Evapotranspiration (biological process)

R = Runoff or

I = Infiltration and possibly **ΔS** a variation of groundwater stock

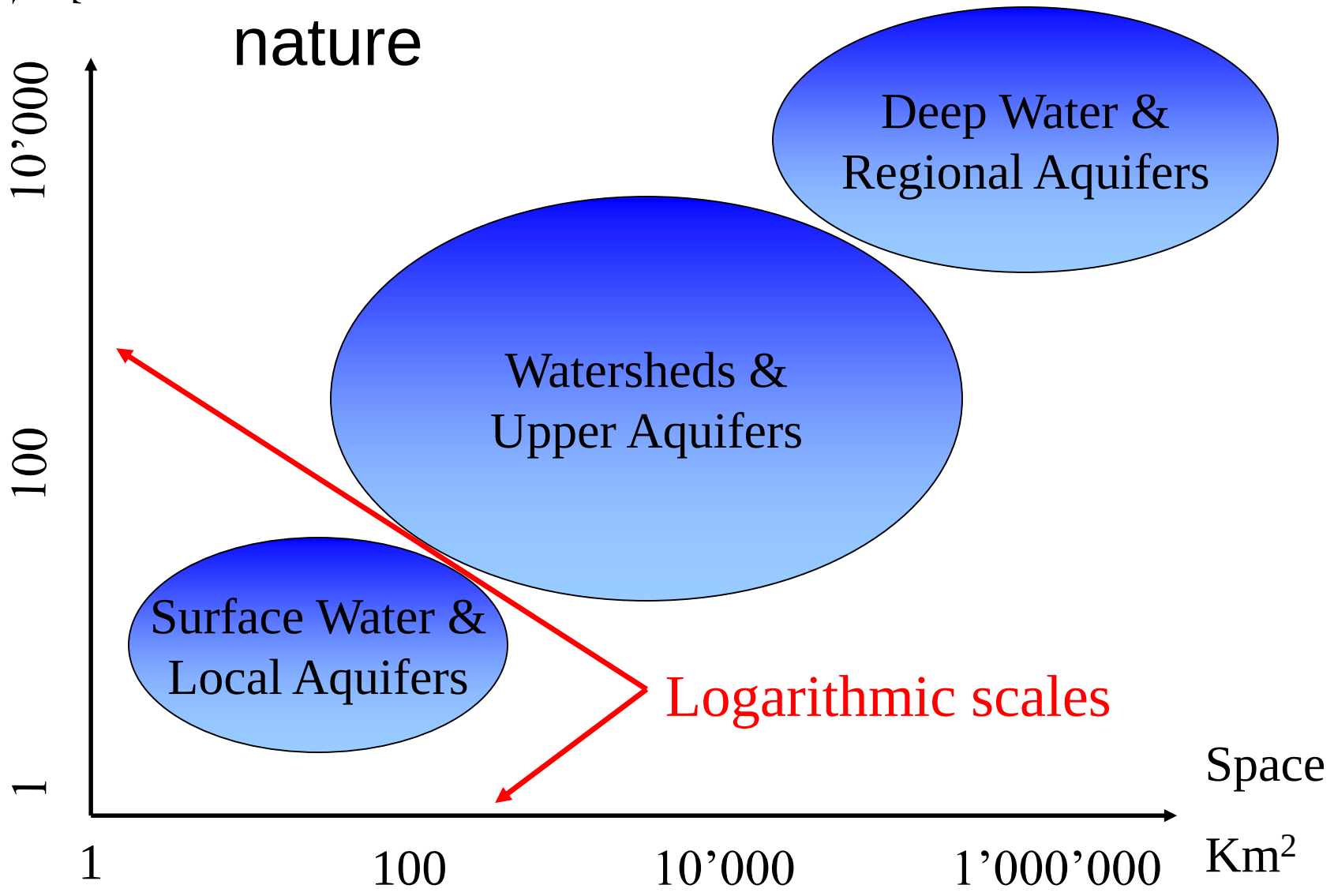
Where is water on Earth?

Major stocks of water	Volume (1 000 km3)	% of total water	% of total freshwater
Salt water			
Oceans	1338000	96.538%	0
Saline/brackish groundwater	12870	0.929%	0
Salt water lakes	85	0.006%	0
Inland waters			
Glaciers, permanent snow cover	**24064**	**1.736%**	**68.697%**
Fresh groundwater	**10530**	**0.760%**	**30.061%**
Ground ice, permafrost	300	0.022%	0.856%
Freshwater lakes	91	0.007%	0.260%
Soil moisture	16.5	0.001%	0.047%
Atmospheric water			
vapour	12.9	0.001%	0.037%
Marshes, wetlands*	11.5	0.001%	0.033%
Rivers	2.12	0.000%	0.006%
Incorporated in biota*	1.12	0.000%	0.003%
Total freshwater	**35029.14**		100.000%
Total water	**1385984.14**	100.000%	

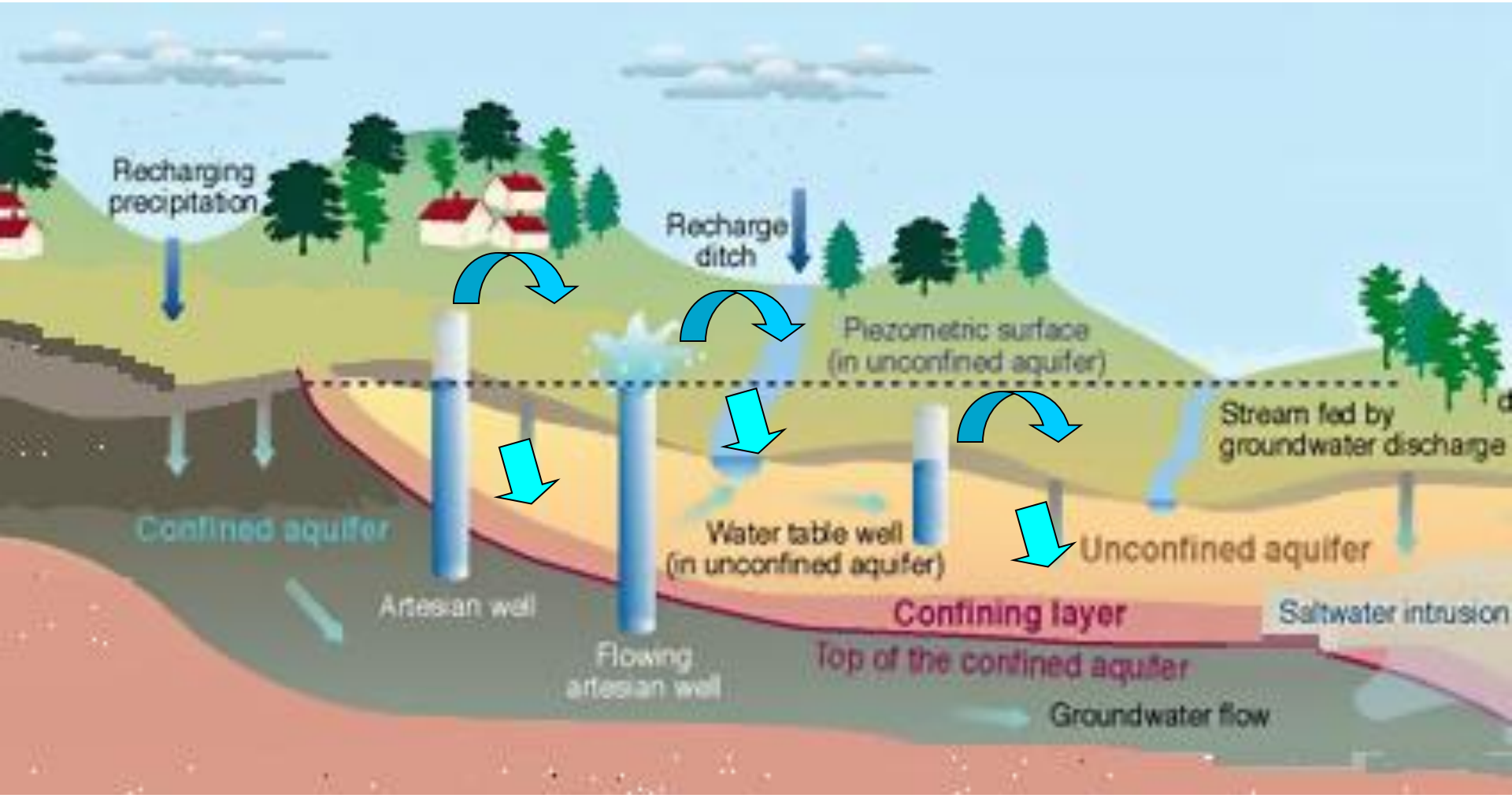


Note: The width of the blue and grey arrows are proportional to the volumes of transported water

Time and space scales in Water Management are of a logarithmic nature



Man-made impacts on Water Cycle

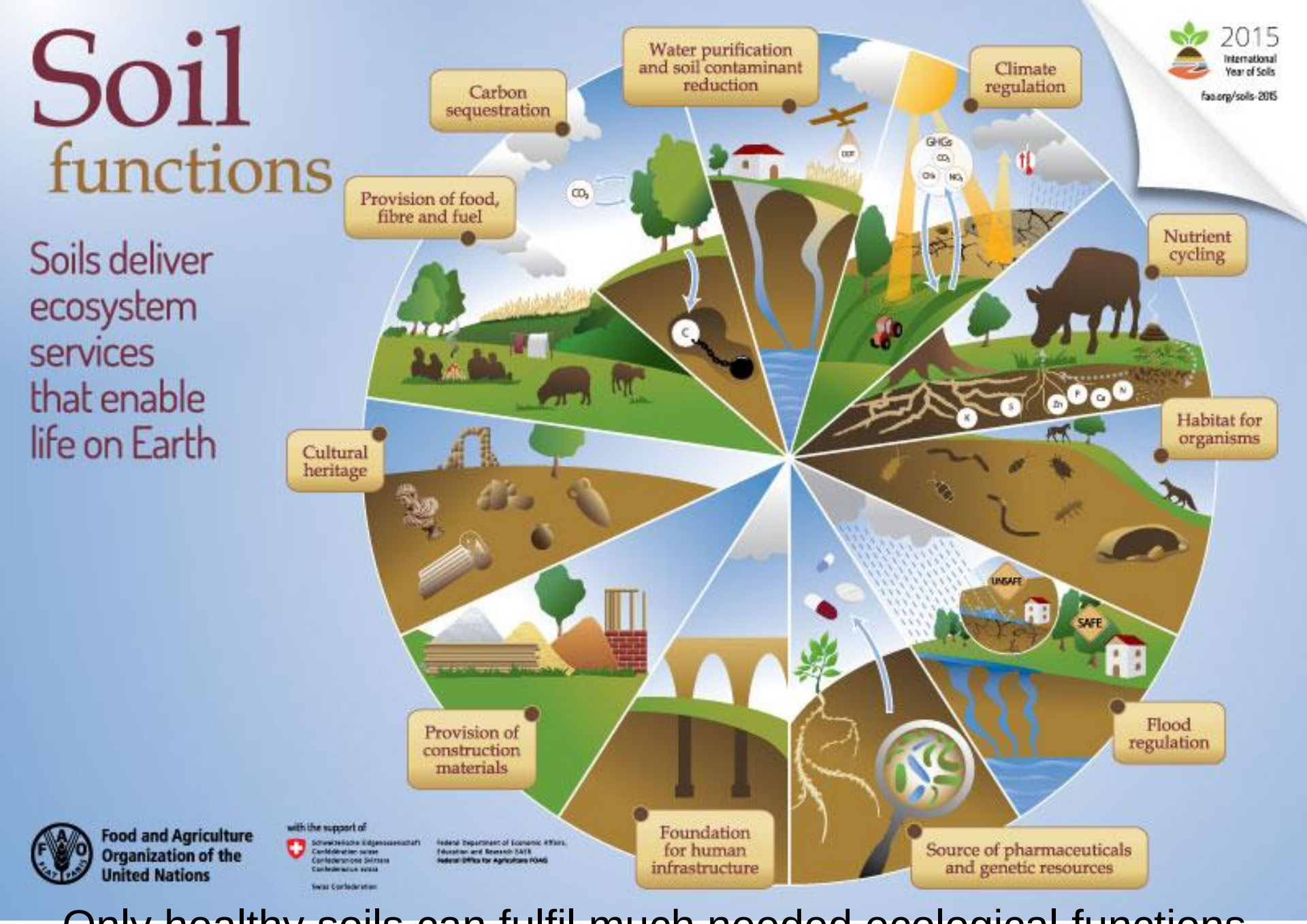


Where can we influence the water cycle?

- **Precipitations are almost completely independent of human action** and are possibly becoming less regular
- Artificial storage of water on the surface increases **evaporation** while **EPT** is very much influenced by land use and agriculture practices.
- **Runoff** is higher in urbanized areas but **can be reduced with adequate techniques.**
- **Infiltration** **can be favored by adapted land use and agriculture practices**, while the subsoil can be used for storage without evaporation.
- **Water quality** can only be maintained **if water is immediately treated** after it has been polluted

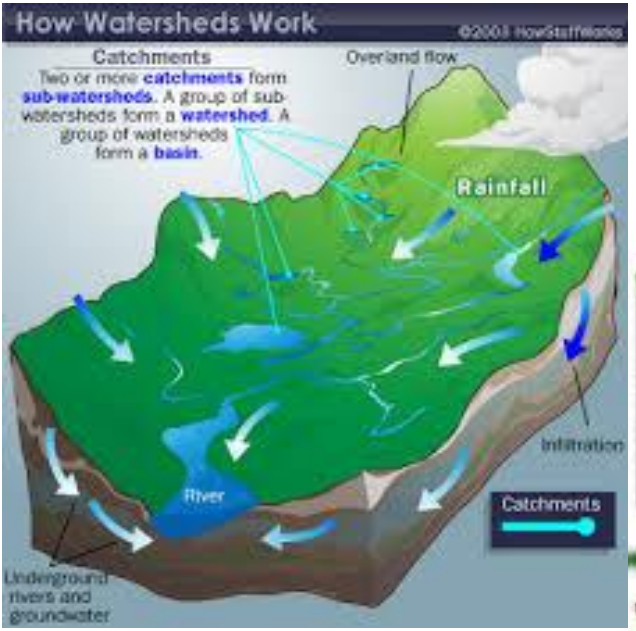
First recommendation: take care of the soil the most important ecological organ

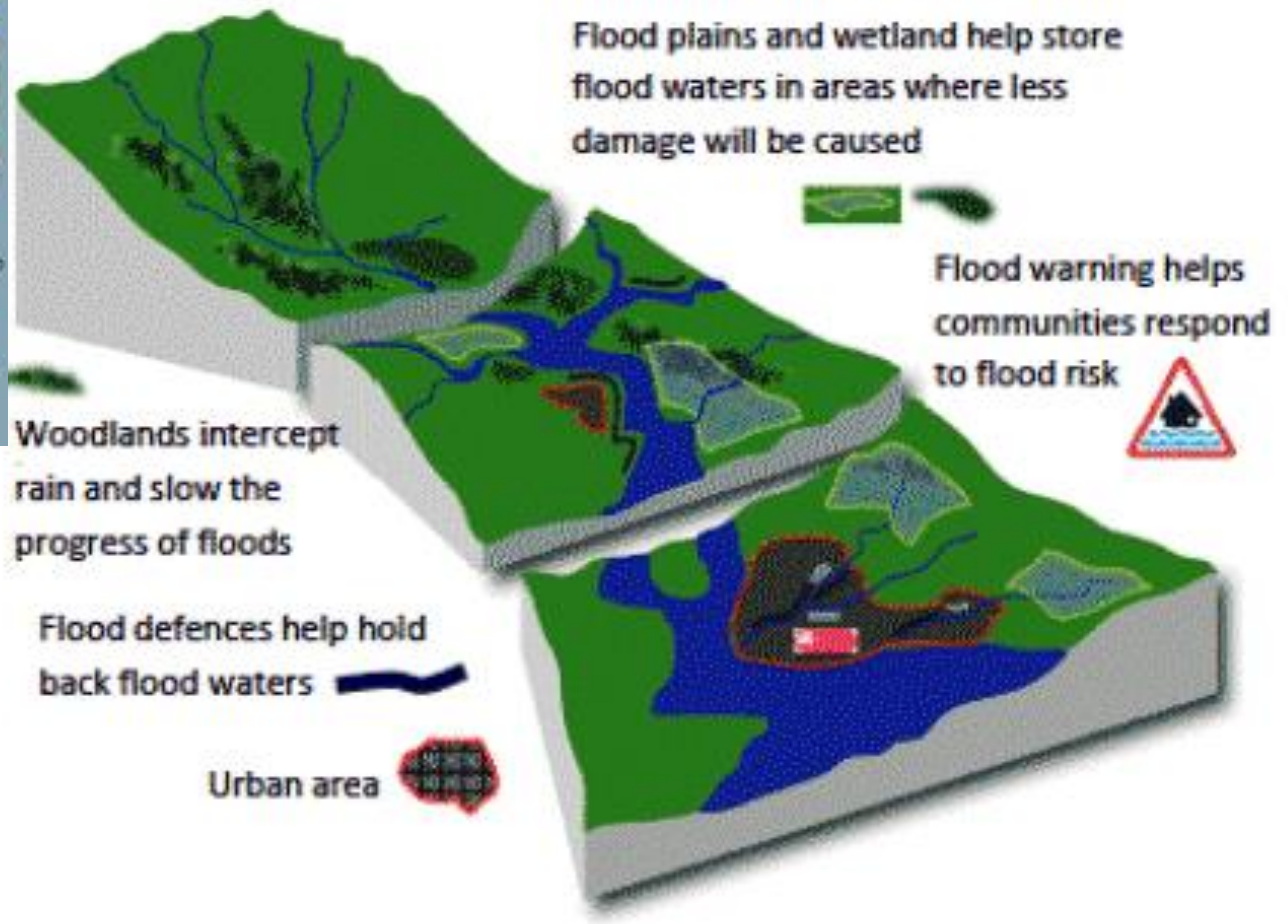
- A natural or a cultivated soil is a mix of mineral elements such as sand, silt and clay as well as organic matter, gases (mainly CO2) and water. **Soils need regular return of a sufficient amount of organic matter to maintain their fertility**.
- It fulfils many different functions, which are all essential for resilient ecosystems. **Healthy unpolluted soils** can
  - absorb large quantities of water and release it when needed by the vegetation;
  - filter the water before storing it underground;
  - close the nutrient cycle by digesting vegetation residues which in turn release chemical elements for growing plants;



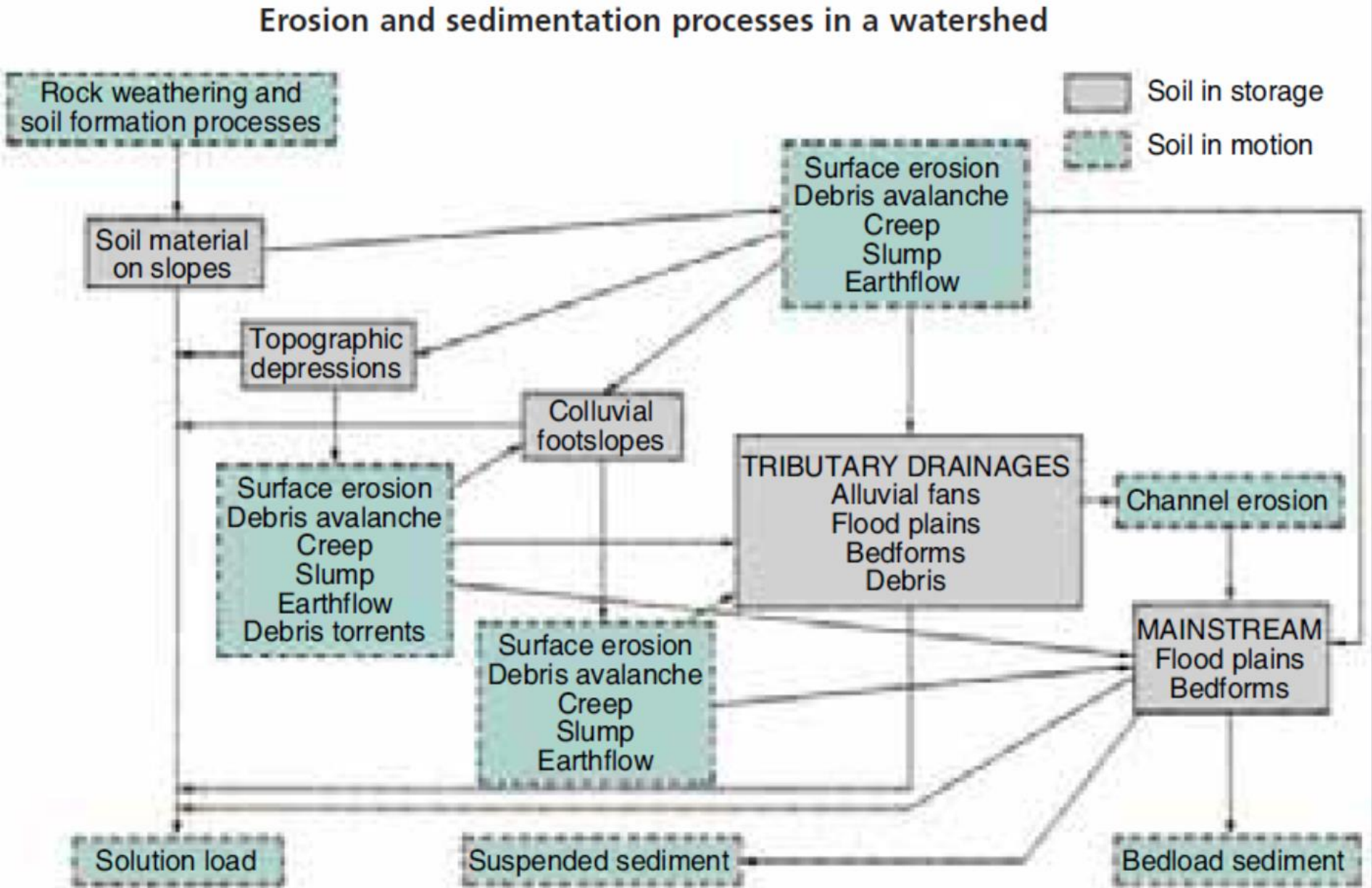
Only healthy soils can fulfil much needed ecological functions

Second recommendation: use the watershed as basic management unit

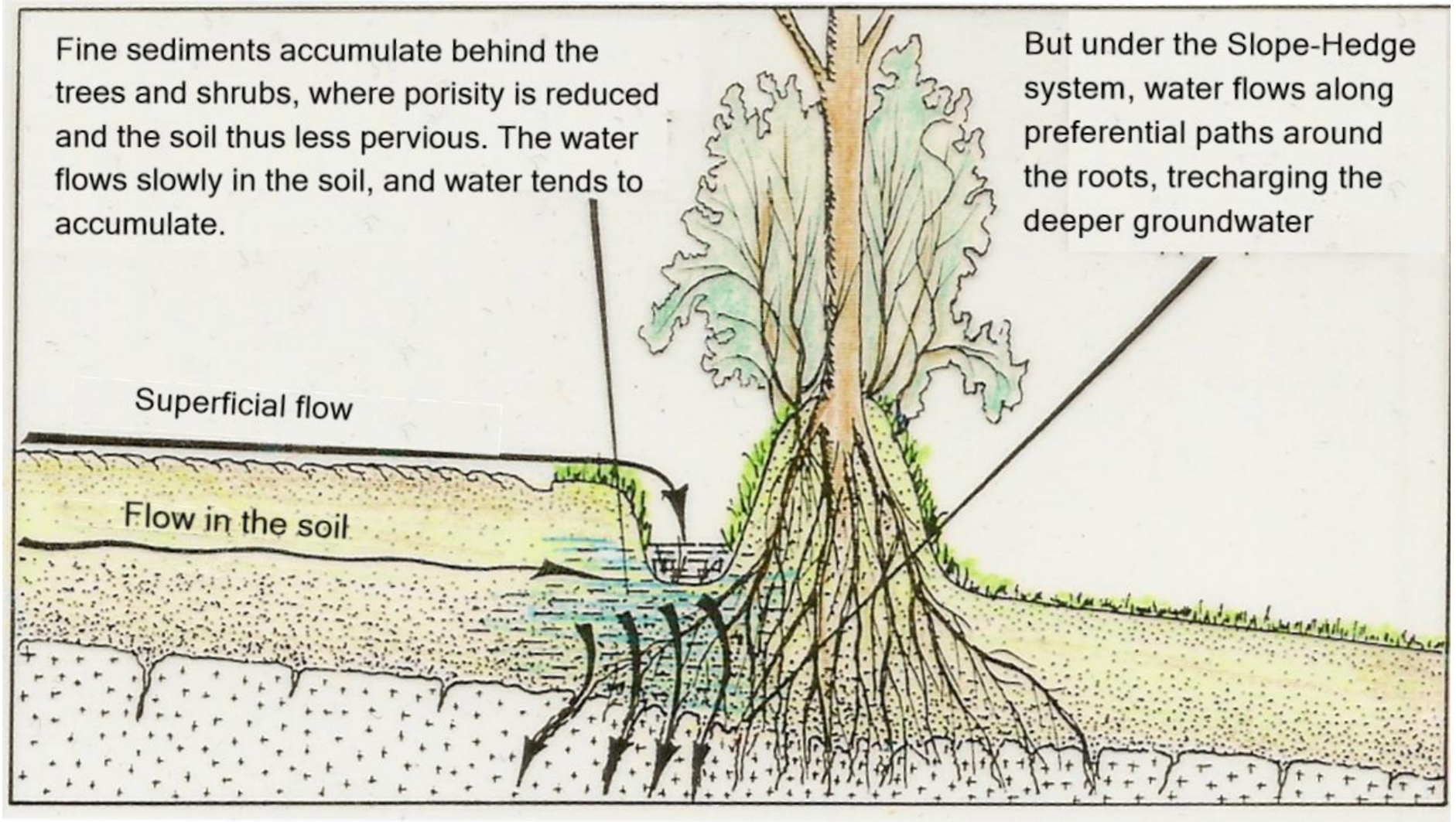




Manage sedimentation at watershed level

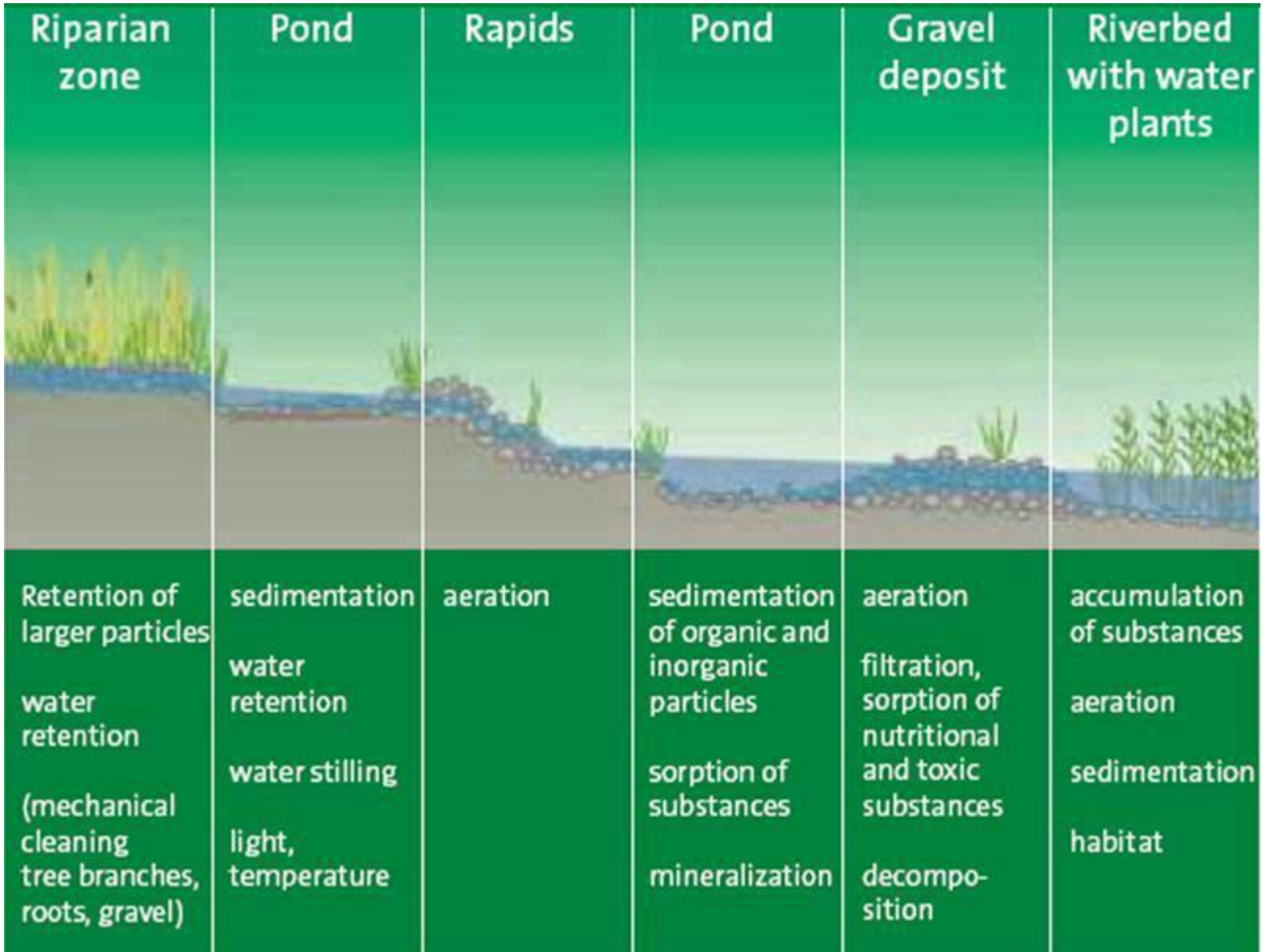


Third recommendation: consider the positive impact of trees, shrubs and hedges



Planting trees should be considered with a watershed perspective, not with a firewood perspective…

Fourth recommendation: use the natural filtration capacity of river banks



Last recommendation: maintain water-related ecosystems to sustain clean water flows in rivers