SIMULATION METHODS FOR WATERSHED MANAGEMENT

Hydrologic cycle, runoff process

Motivation of hydrological modelling

- What happens at the catchment and in the stream when it rains?
- How does the increased/decreased runoff affect (not only) the landowners and people downstream?

  - maximum probable flood at proposed sites
  - prediction of water production from catchments
  - relationship between surface water and groundwater resources
  - design required reservoir capacity (for irrigation or municipal water supply)

Motivation of hydrological modelling

- How does water actually get into the stream? *
  - Where does water go when it rains?
  - What flowpath does it take?
  - How long does it reside in the catchment?

* (highly recommended Jeff McDonnell's virtual lectures: http://www.cof.orst.edu/cof/fe/watershd/fe537/fe537VL_2008.html)

Hydrological cycle

- Water occurs in different form and at different places (**stocks**)
- It is in a permanent motion from one stock to another (**fluxes**)

The global pattern of fluxes and stocks is called **global hydrological cycle** (**global water cycle**)

Stocks

Overland flow	Surface ponding and flooding	Depression storage	Dew and interception	Streams (rivers, brooks, torrential streams etc.)	Wetlands
Reservoirs and fishponds	Lakes	Seas and oceans	Snowpack	Ice on ground surface	Ice on above-ground objects
Ground ice and permafrost	Ice on/in water	Glaciers	Soil water	Water in unsaturated (vadose) zone	Groundwater (saturated zone)

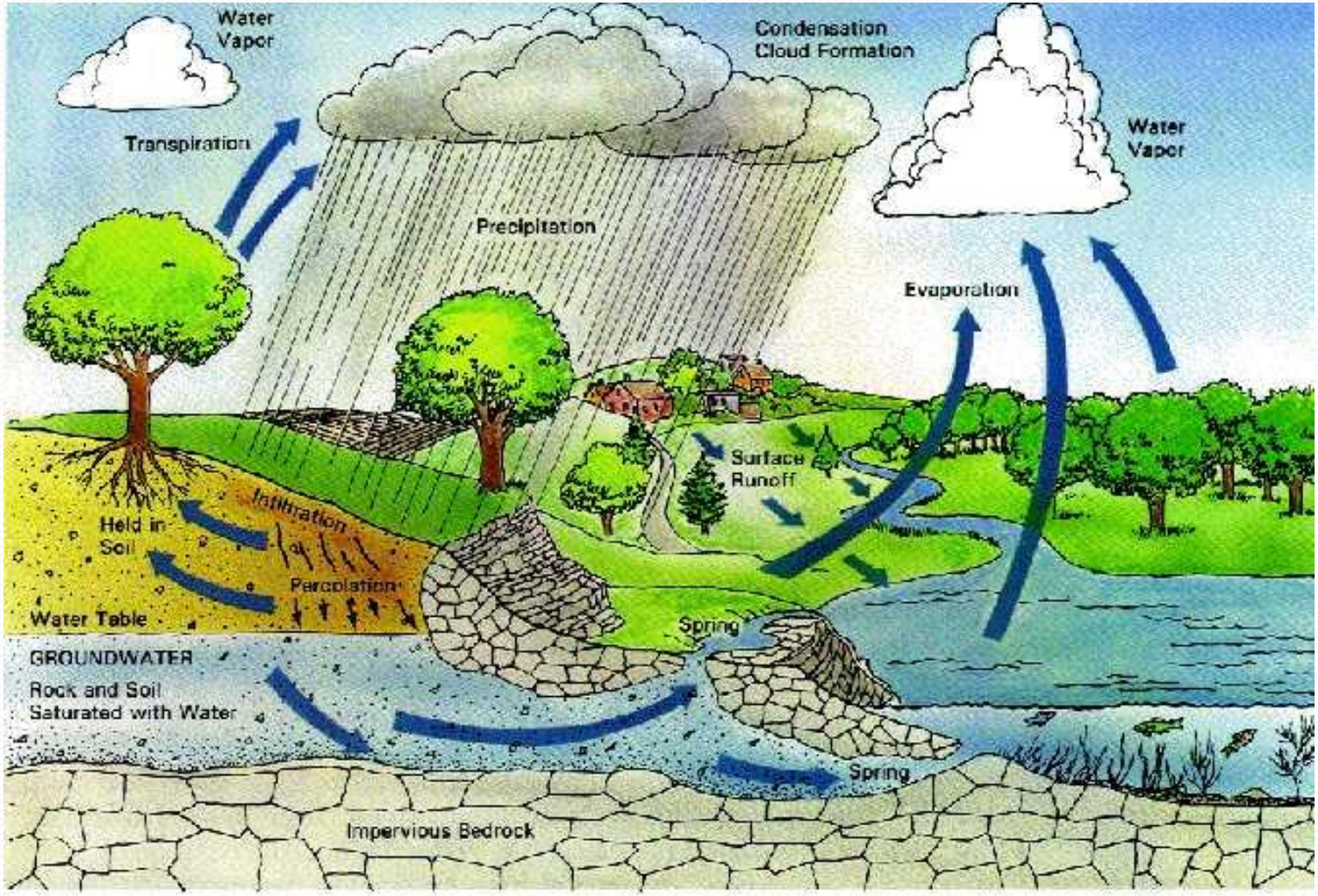
Biosphere	Atmosphere	Man-made systems (water supply,irrigation, sewerage, industry)

Fluxes

Evaporation	Transpiration	Vapour transport in atmosphere	Precipitation (rain, snowfall, hail, hoarfrost etc.)	Interception
Stream runoff consisting of surface runoff (overland flow), interflow, groundwater runoff (baseflow)	Infiltration and preferential flow	Percolation (redistribution, drainage)	Capillary rise	Exfiltration (seepage)
Circulation in lakes/reservoirs	Circulation in seas/oceans	Groundwater circulation	Man-induced water flow (Water supply, Rain drainage and sewerage, Irrigation, Land drainage)	

- Each particular flux in the water cycle scheme represents a **hydrological process**. The processes are often studied separately but interconnection with other processes should be taken into consideration.
- We can roughly distinguish **rapid processes**, **processes with diurnal periodicity** and **medium-slow and slow processes**

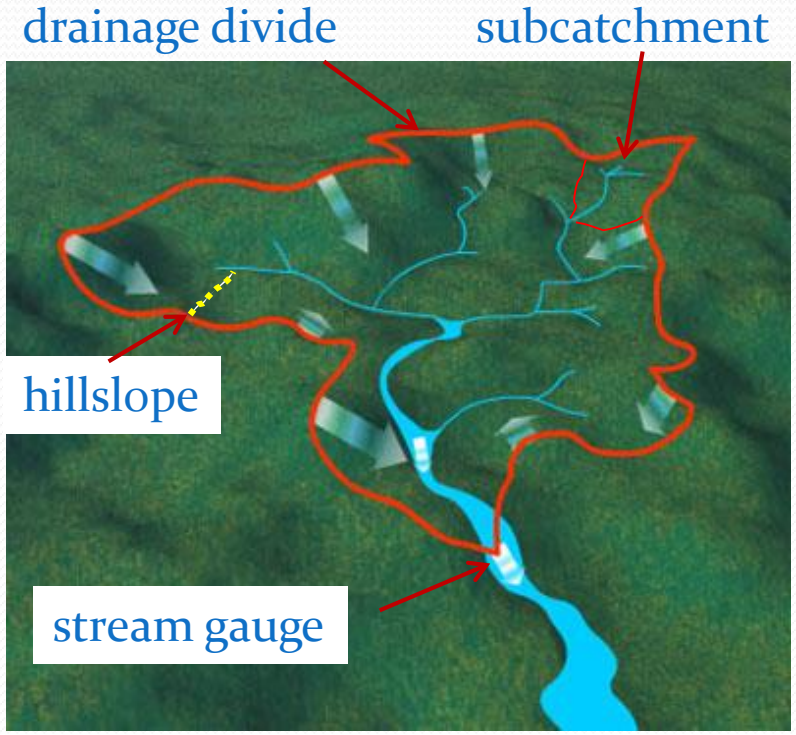
Hydrological cycle



http://www.ldeo.columbia.edu/

Catchment (watershed, drainage basin)

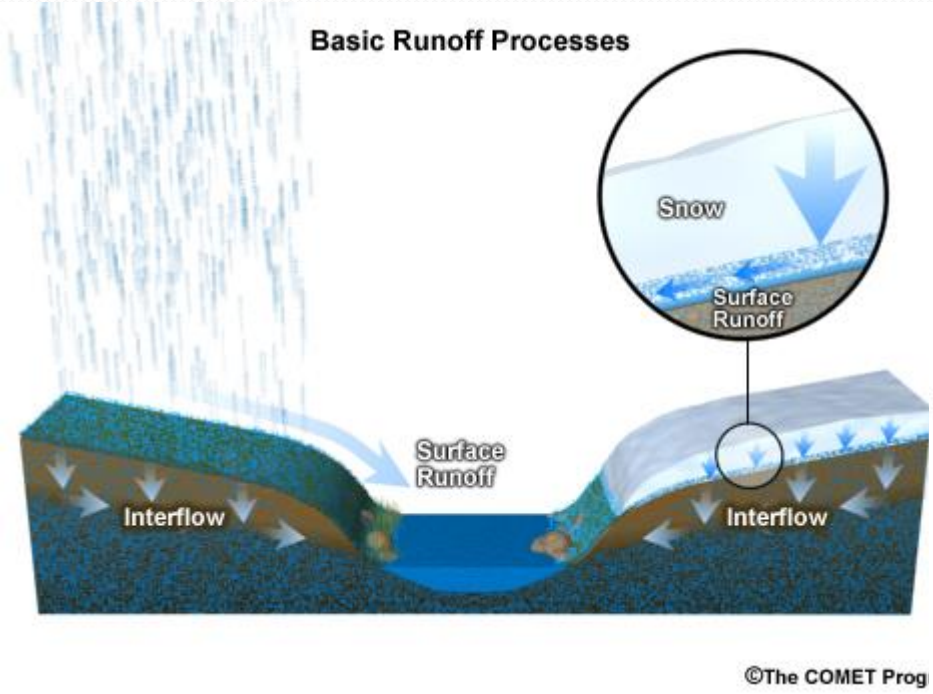
- Appropriate unit for managing natural resources
- Bounded by natural features (mountain ranges, hills) – runoff drains to a common lower point



(www.kidsgeo.com)

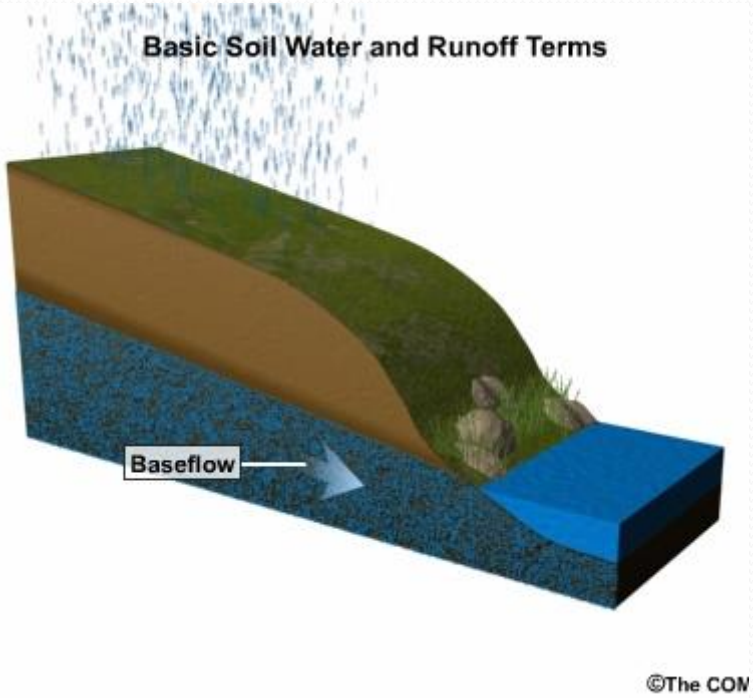
Runoff

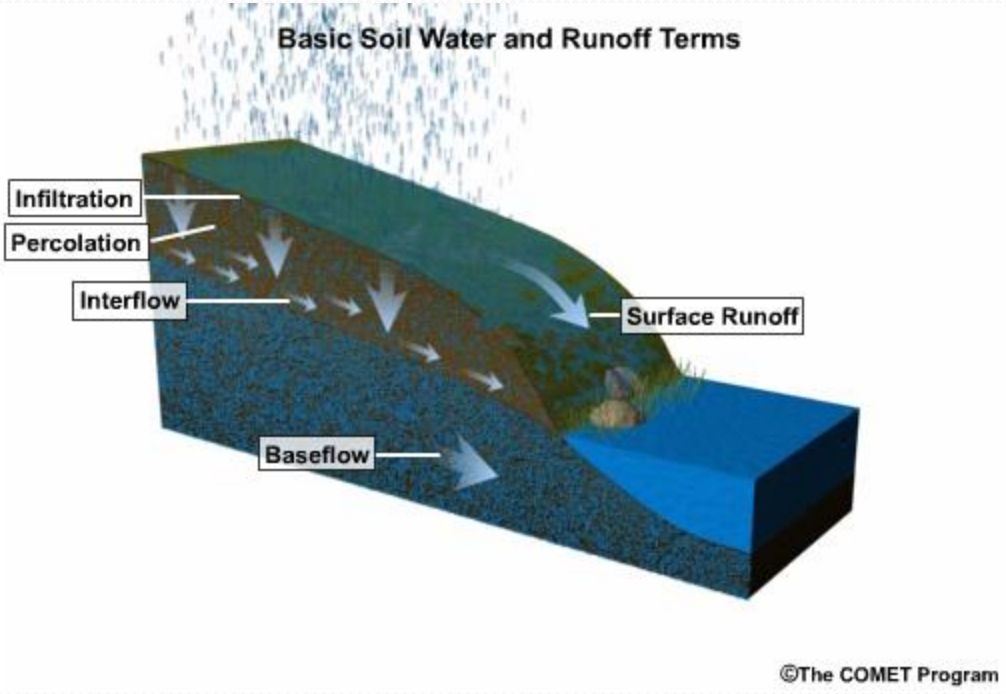
- Infiltration
- Surface runoff
- Subsurface runoff



Runoff terms

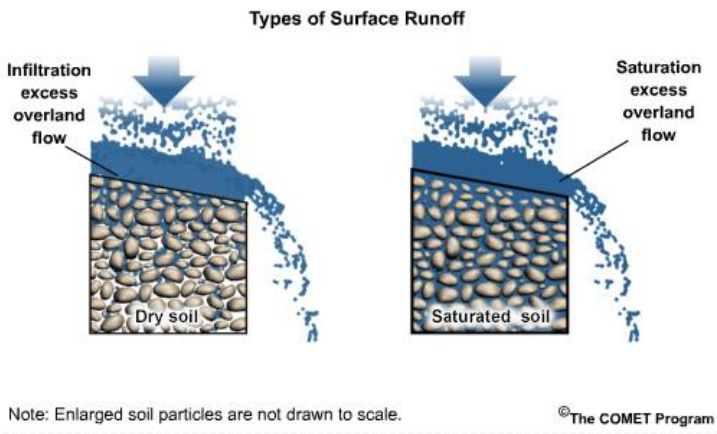
- Infiltration rate x infiltration capacity



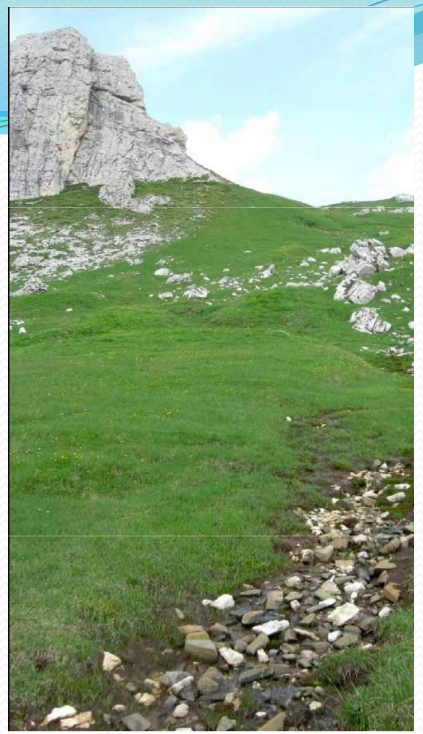


Types of runoff

- Surface runoff
  - Infiltration excess overland flow
  - Saturation excess overland flow

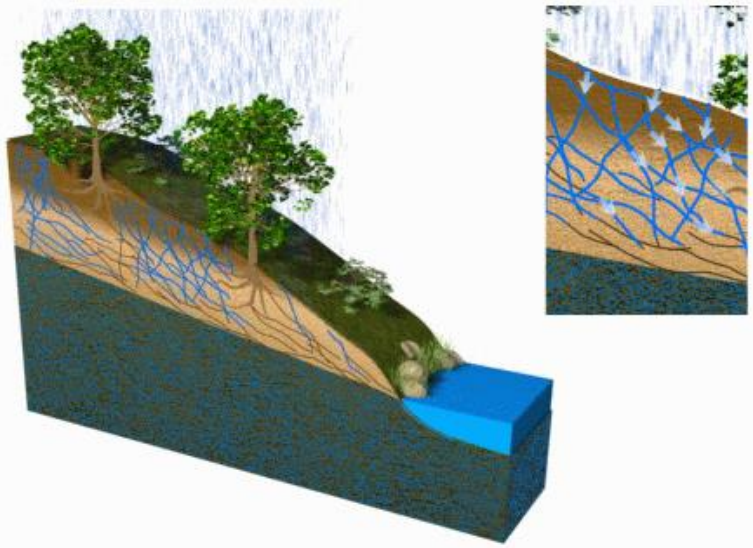


Subsurface runoff

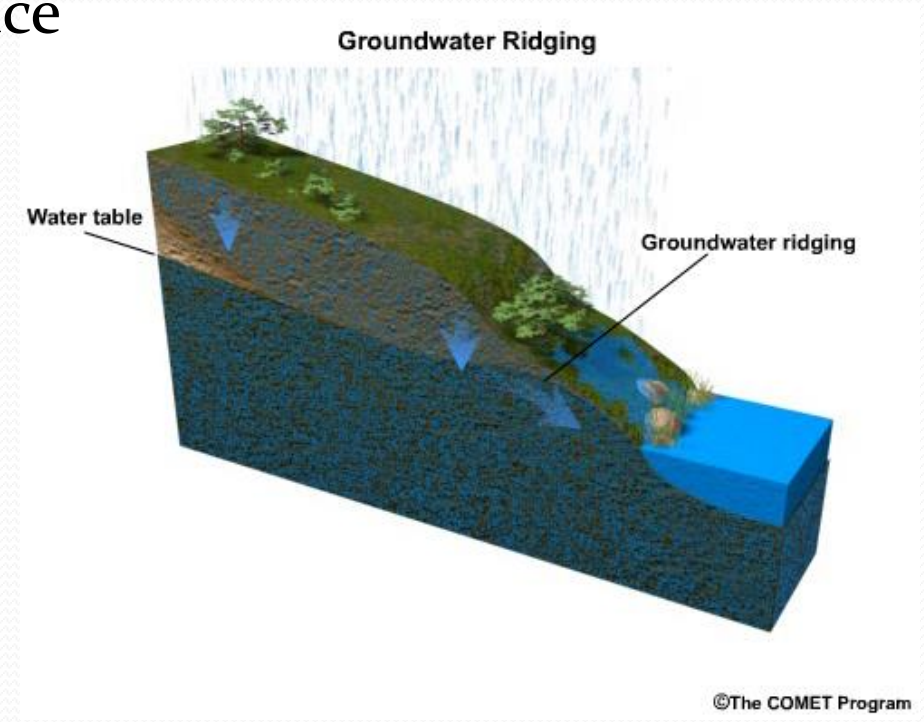


- Interflow
  - rapid subsurface flow toward the stream
  - faster than base flow, slower than surface runoff
  - on steep permeable hillslopes often dominant runoff process
  - in humid areas
- Through macropores network
- Along soil-bedrock interface
- Along impermeable layers

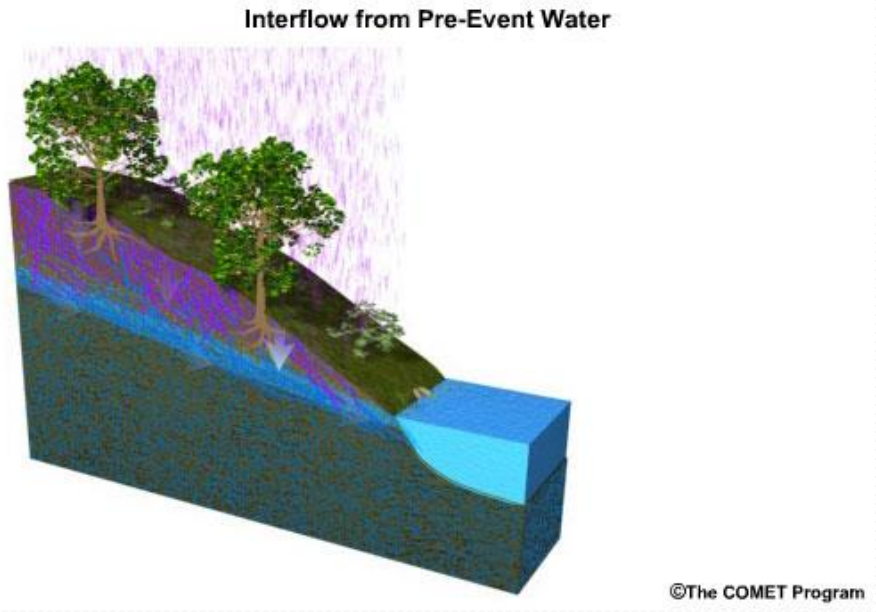
Interflow Through Macropores



- Variably saturated area concept
  - rain falls on saturated surface or streams
  - groundwater rise

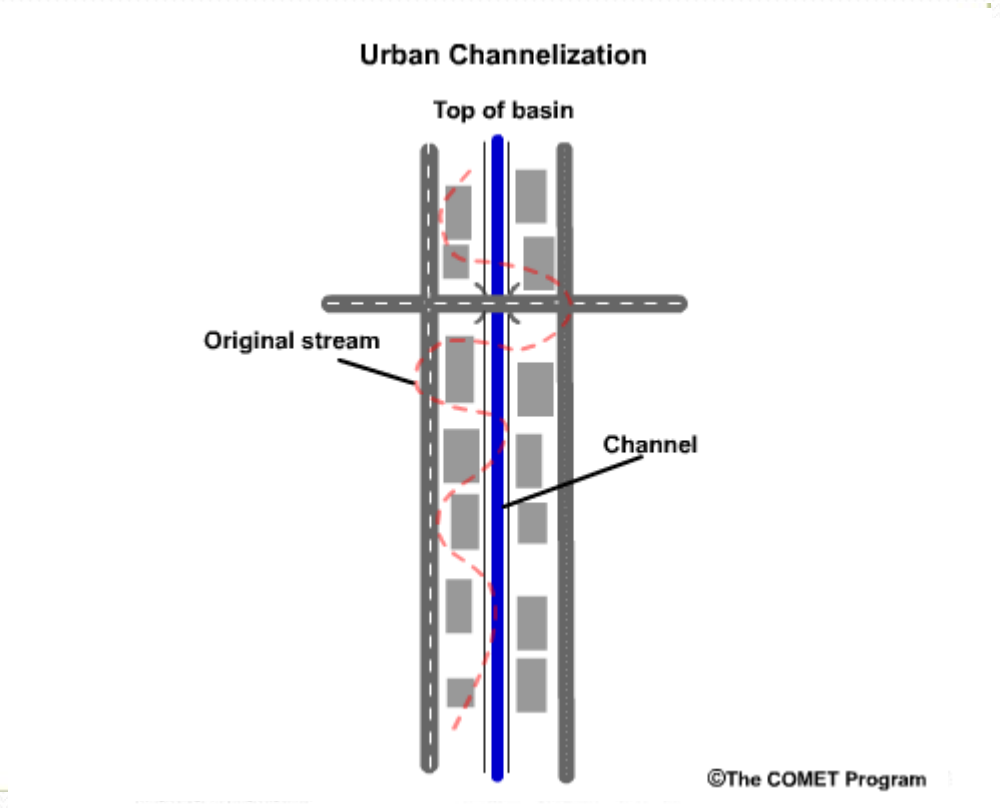


- "Old water" concept – pre-event water
  - old water displaced by new water
  - often dominant in humid areas on hillslopes with preferential pathways



Catchment properties affecting runoff

- Basin shape
- Basin size
- Stream meanders
- Basin slope
- Roughness
- Stream density
- Urbanization



Model inputs into “usuall” distributed model

- topography
- precipitation
- temperature (net radiation, wind velocity, air moisture) – evapotranspiration
- land-use
- soil characteristics

!!! Identify the goals of the simulation and major runoff processes at the catchment before you choose the simulation code !!!

Homework – preparation of presentation

- Start to work on your presentation which should be given at the end of semester
- Used different information resources and cite them in your presentation
- Do not forget to attach the list of references to your presentation (put it at the end of presentation after „thank you for your attention“ slide)