FASTER

Farmers' Adaptation and Sustainability in Tunisia through Excellence in Research

2nd FASTER SPECIALIZED TRAINING

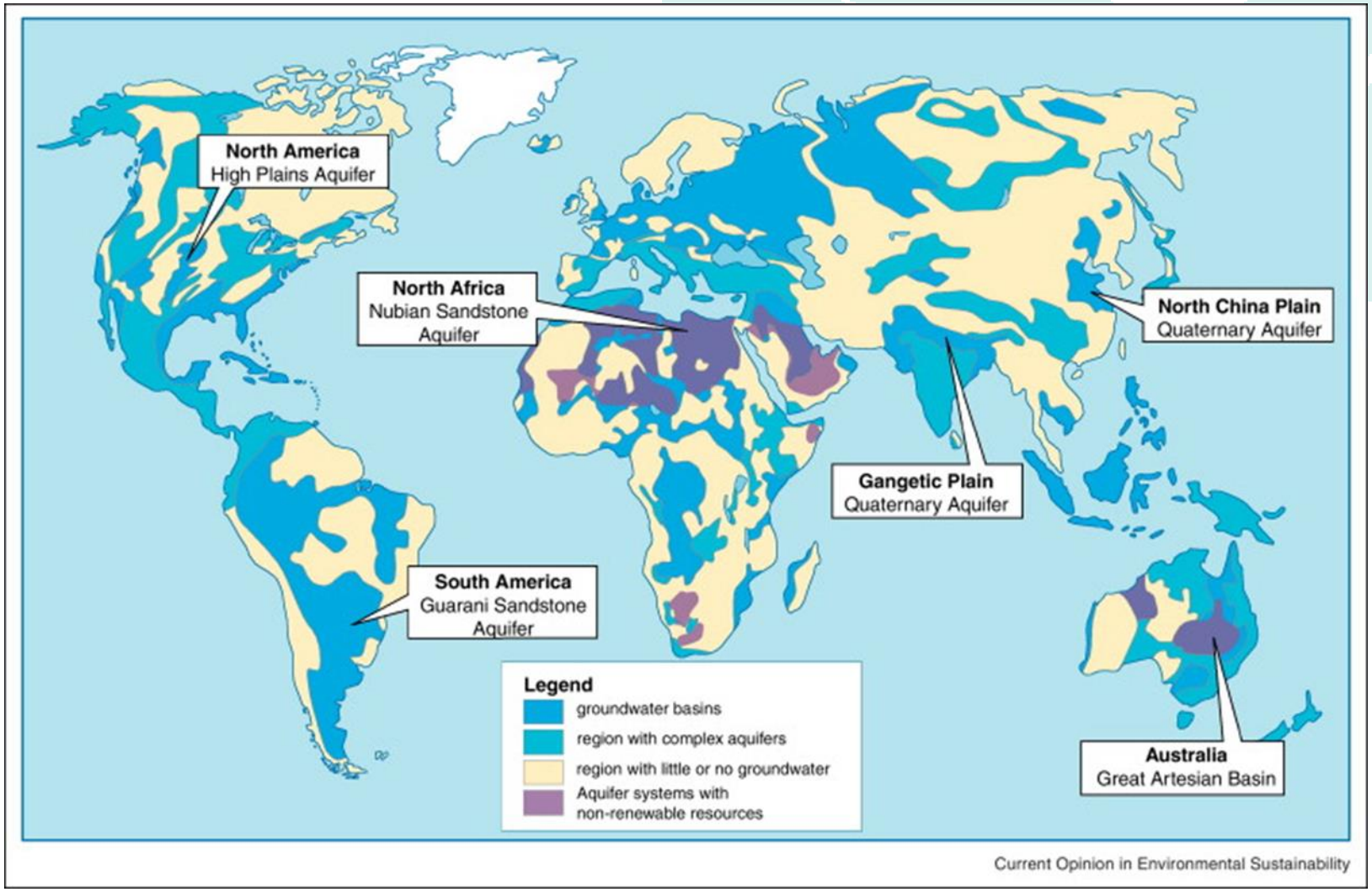
on Climate change effects on water & land management in the Mediterranean

22-26 March 2021 (ONLINE)

AGENDA

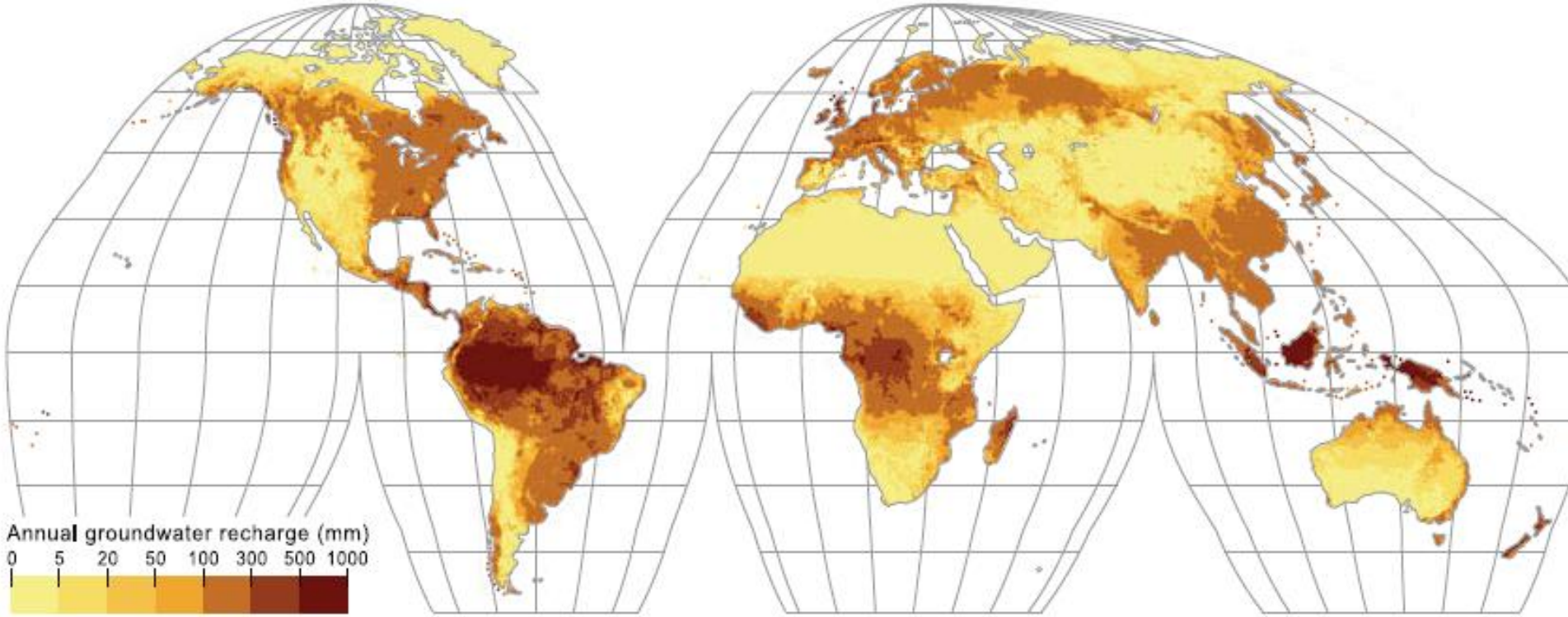
Groundwater observations and simulations

World's largest aquifers with vast storage reserves in part of palaeo-groundwater



Source: Foster et al. (2013)

Groundwater recharge



Source: Jones (2011)

Groundwater worldwide

Global groundwater use represents:

30% of the world's used freshwater supply,

36% of potable water supply,

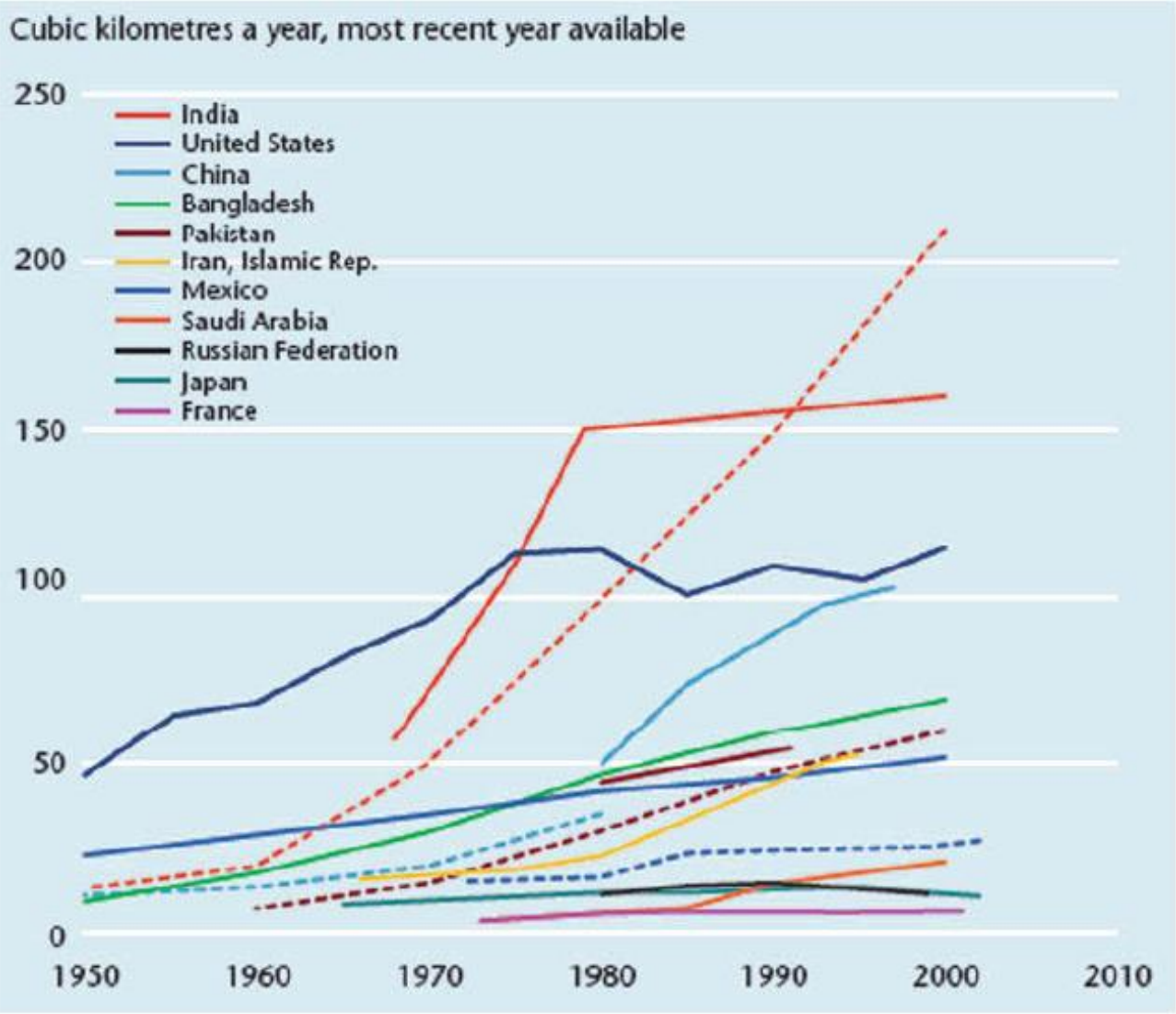
42% of water for irrigated agriculture,

and 24% of direct industrial water supply

World groundwater volume: ~4-300 000 000 km^3 (50% saline?)

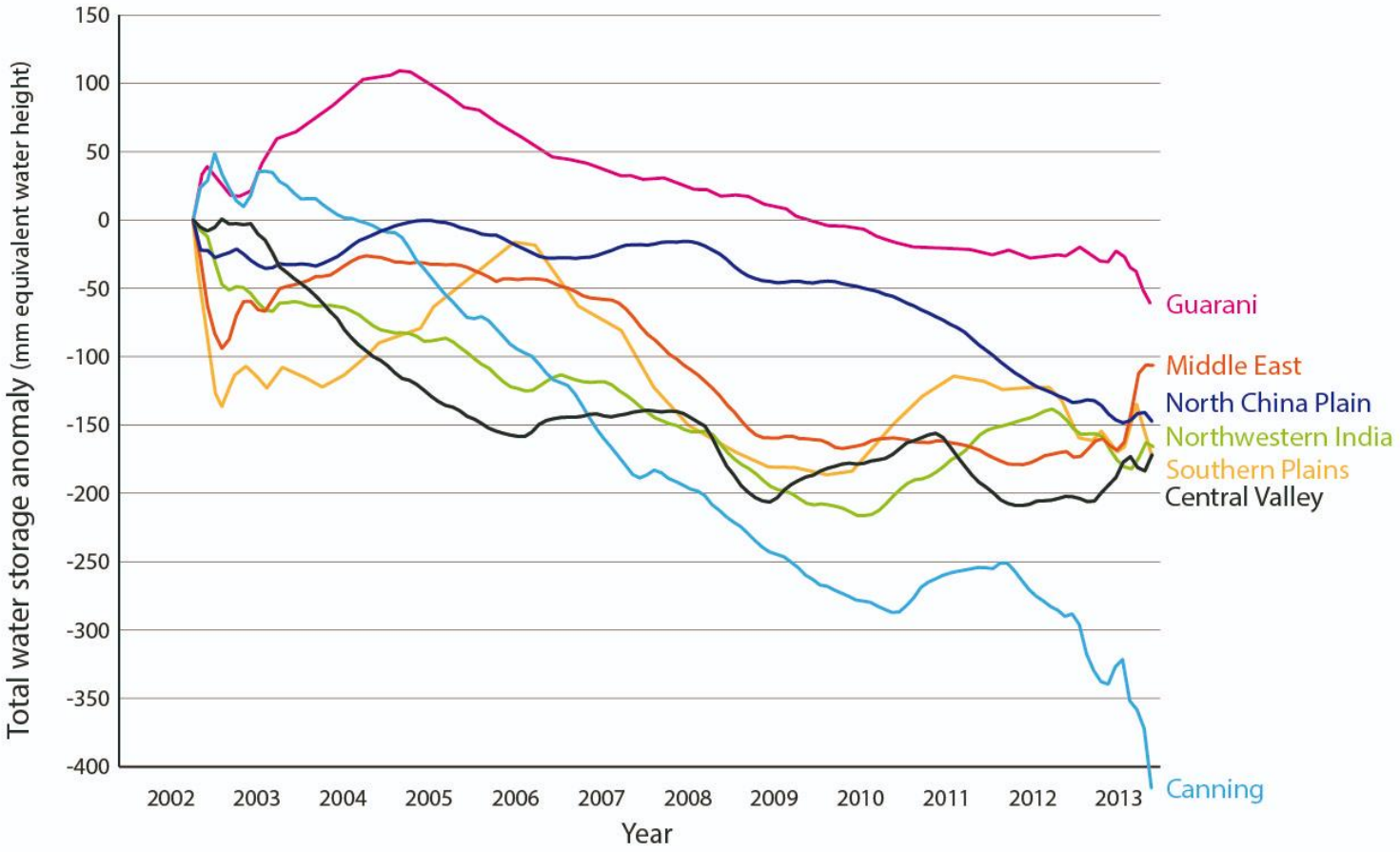
world annual river flow: 40 000 km^3

Increasing groundwater use



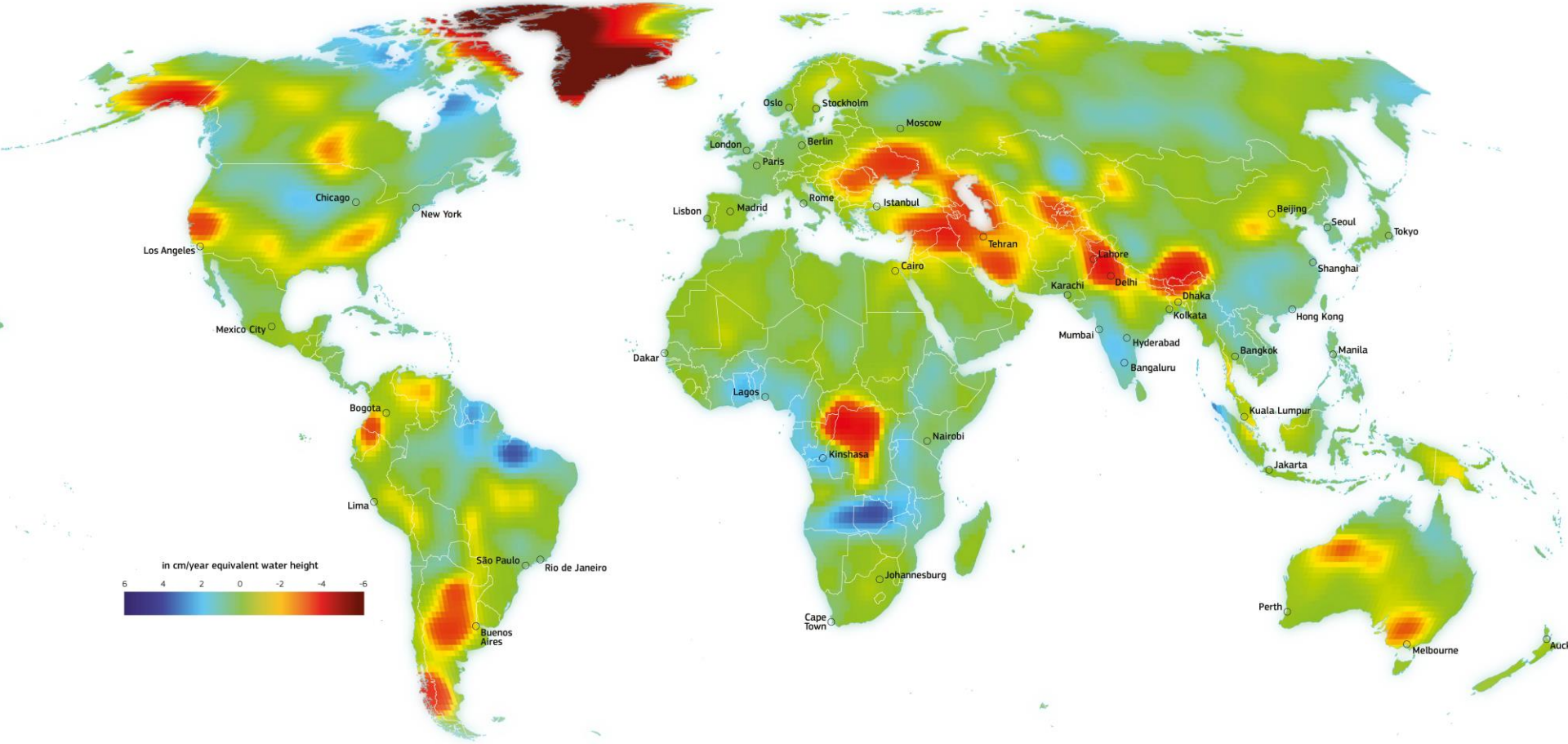
Source: Margat, (2008)

Groundwater drawdown



Source: T. Reager, NASA Jet Propulsion Laboratory, California Institute of Technology

Groundwater change 2003-2013 (NASA-GRACE)



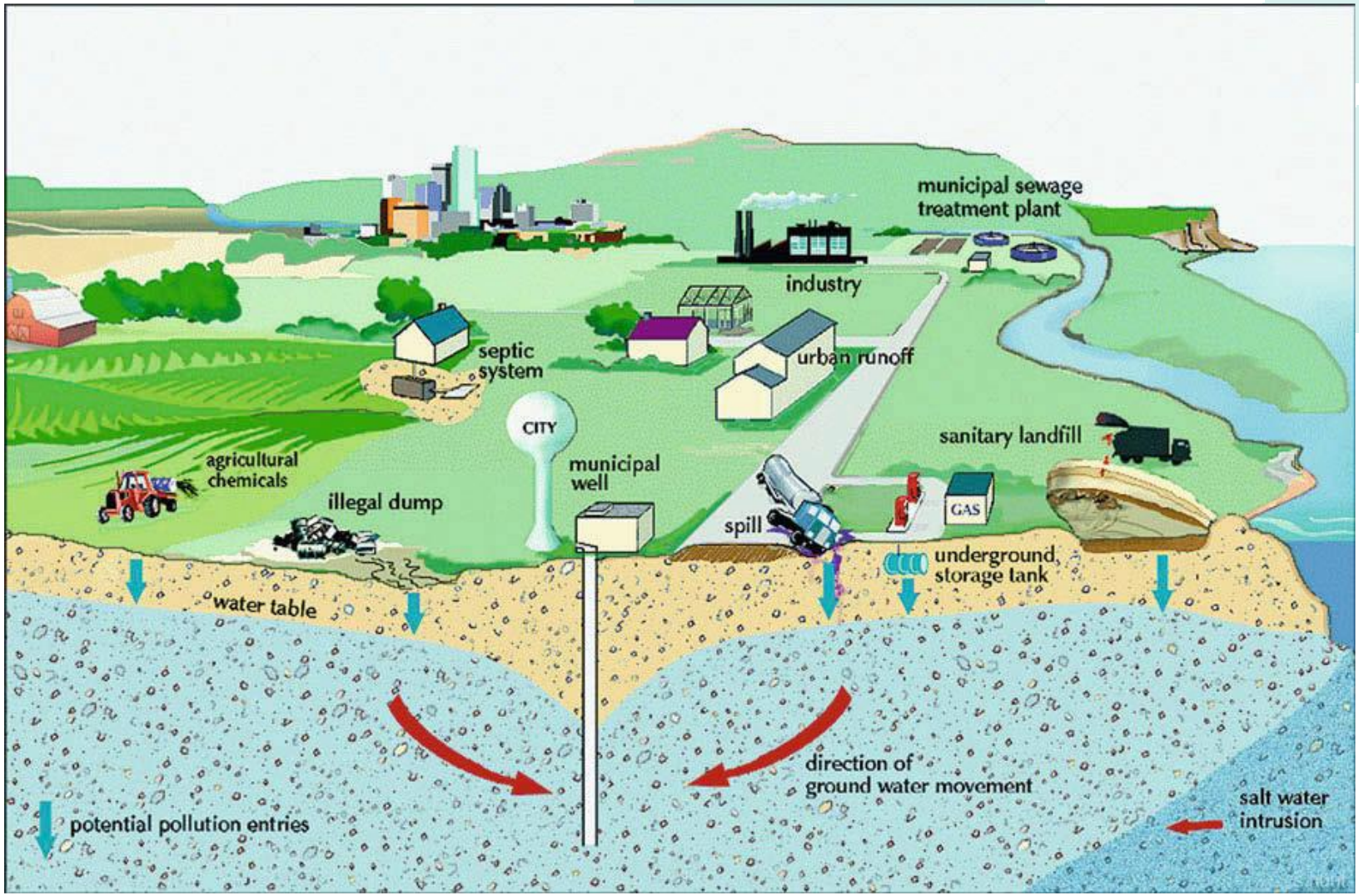
Source: Chen et al. (2016)

Groundwater quality

- Often high salinity (e.g., NaCl) in arid regions, in deep aquifers, near saltbearing rock formations or in coastal aquifers fed by rainfall with considerable chloride content.
- Sometimes excessive hardness in carbonate formations or high sulphate content in gypsiferous formations.
- Often high iron and manganese concentrations in basement aquifers and in other formations rich in organic matter or other sources of carbon dioxide.
- Often significant acidity in crystalline rocks.
- Significant fluoride levels in some sedimentary rocks (phosphates) or crystalline rocks (e.g. in India).
- Significant arsenic content, in particular in some Quaternary sedimentary formations (e.g. in Bangladesh).
- Naturally occurring bacteria.
- High nitrate contents in urban and agricultural areas.

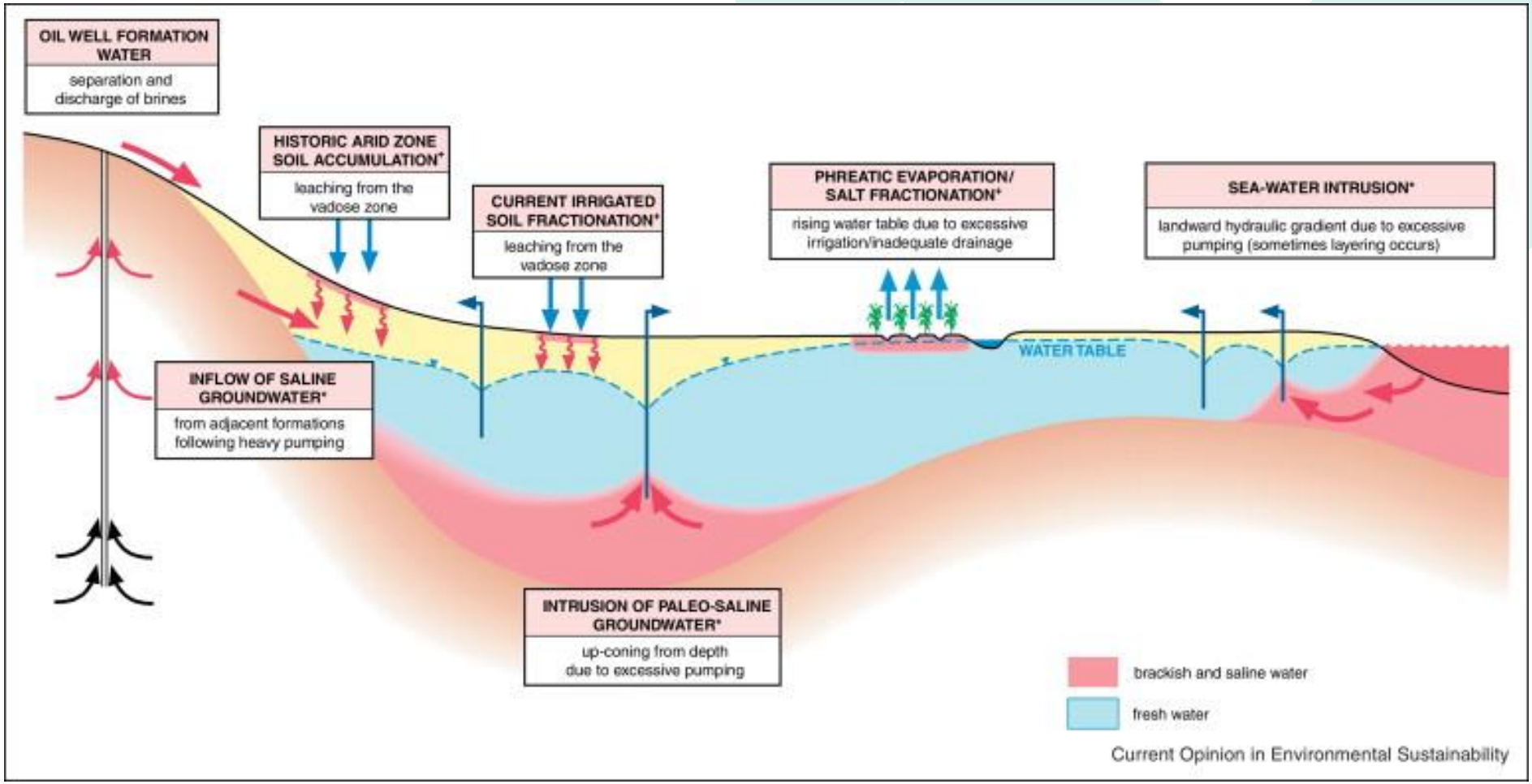
Source: Margat and van der Gun (2013)

Groundwater pollution sources



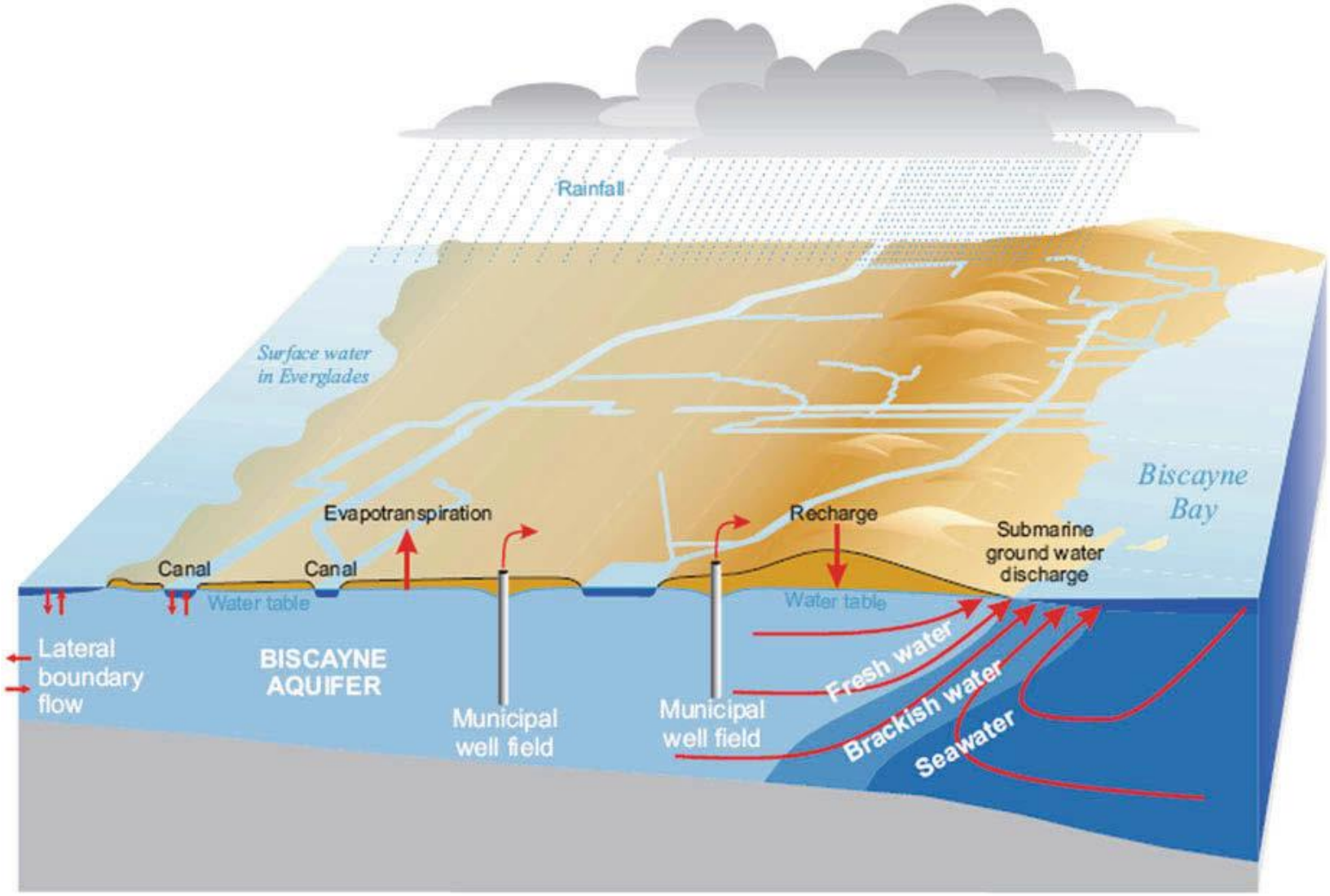
Source: Zaporozec and Miller (2000)

Processes in groundwater salinity



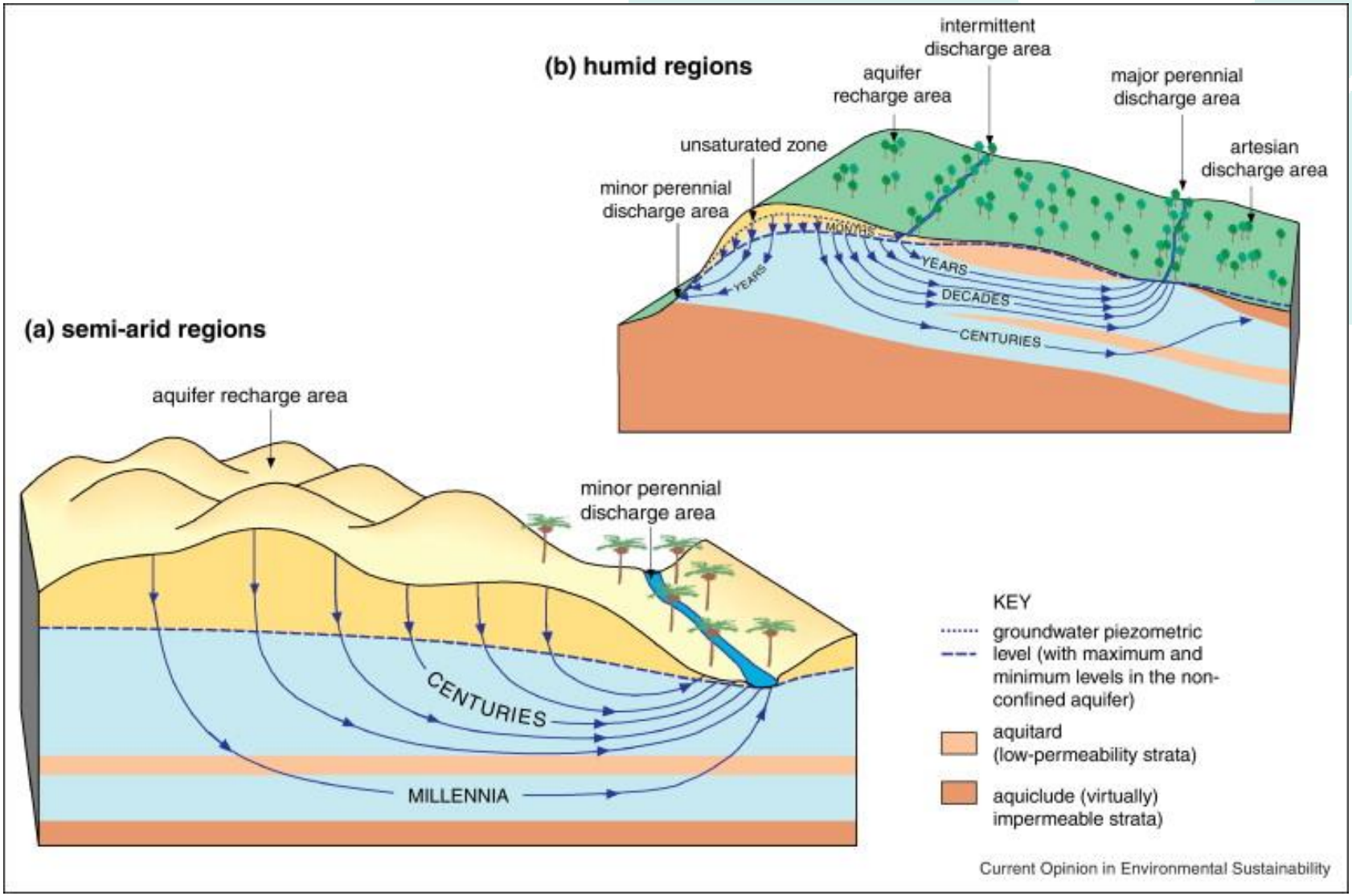
Source: Foster et al. (2013)

Saltwater intrusion



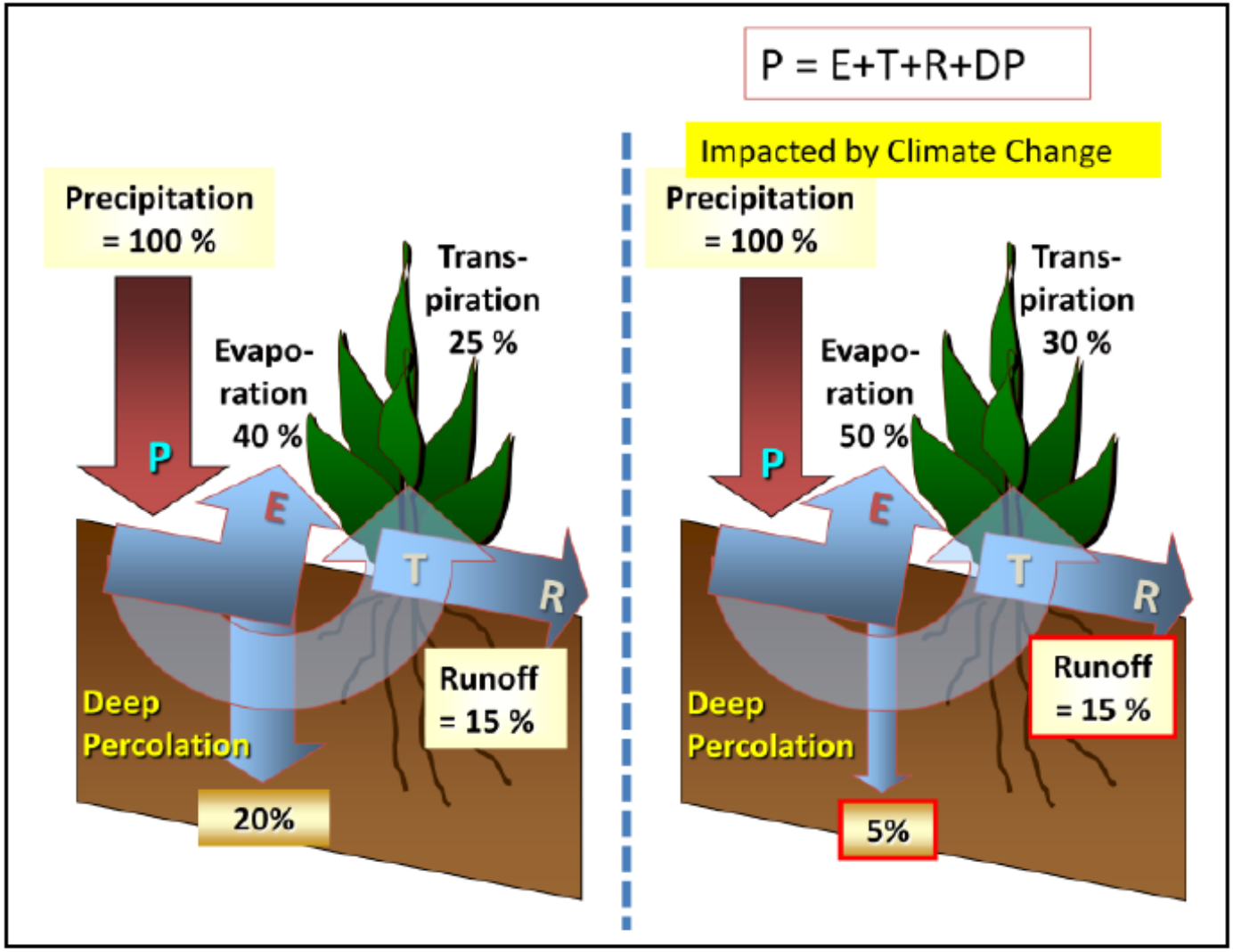
Source: Langevin (2003)

Arid vs. humid groundwater



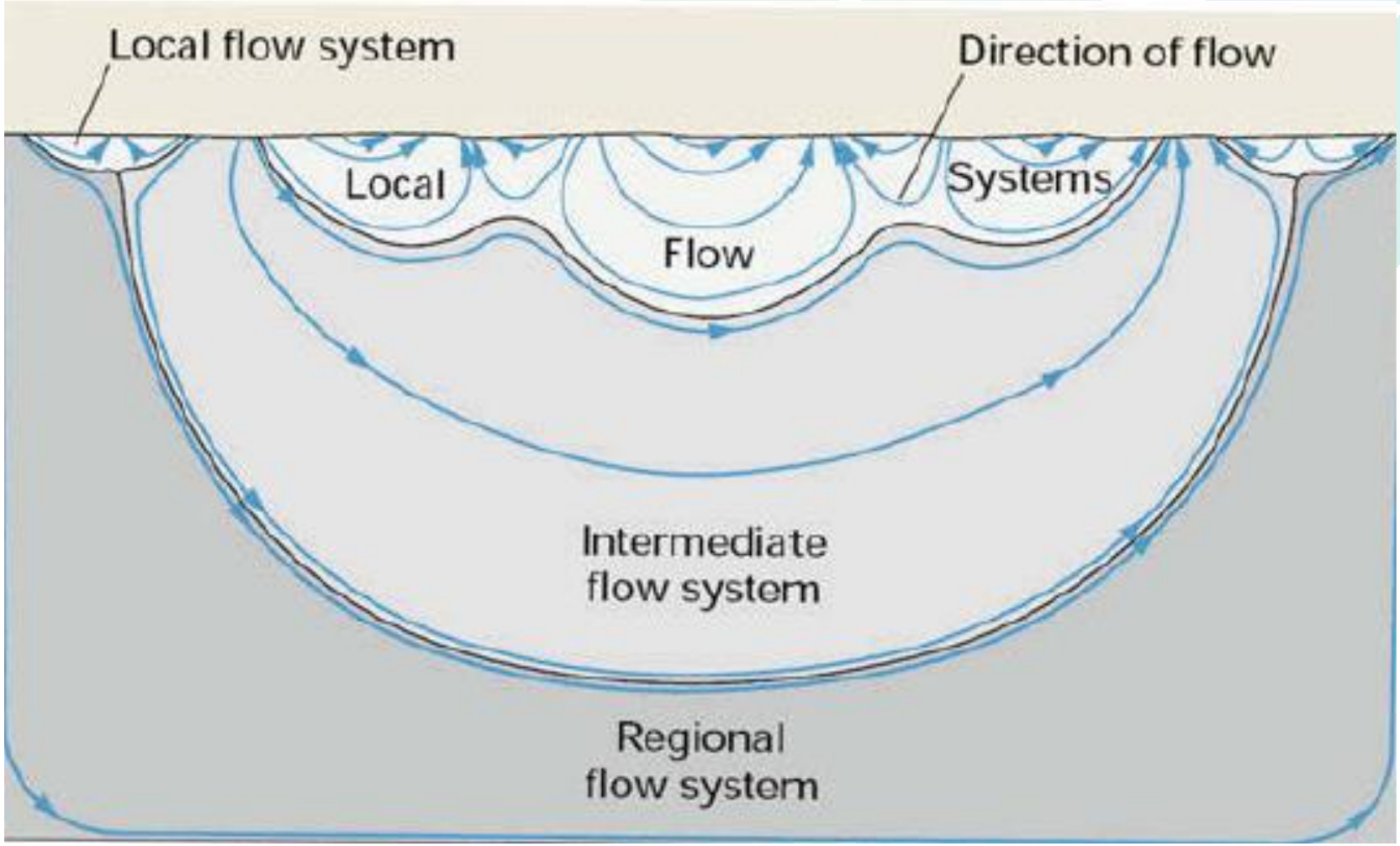
Source: Foster et al. (2013)

Changing water balance in warmer climate



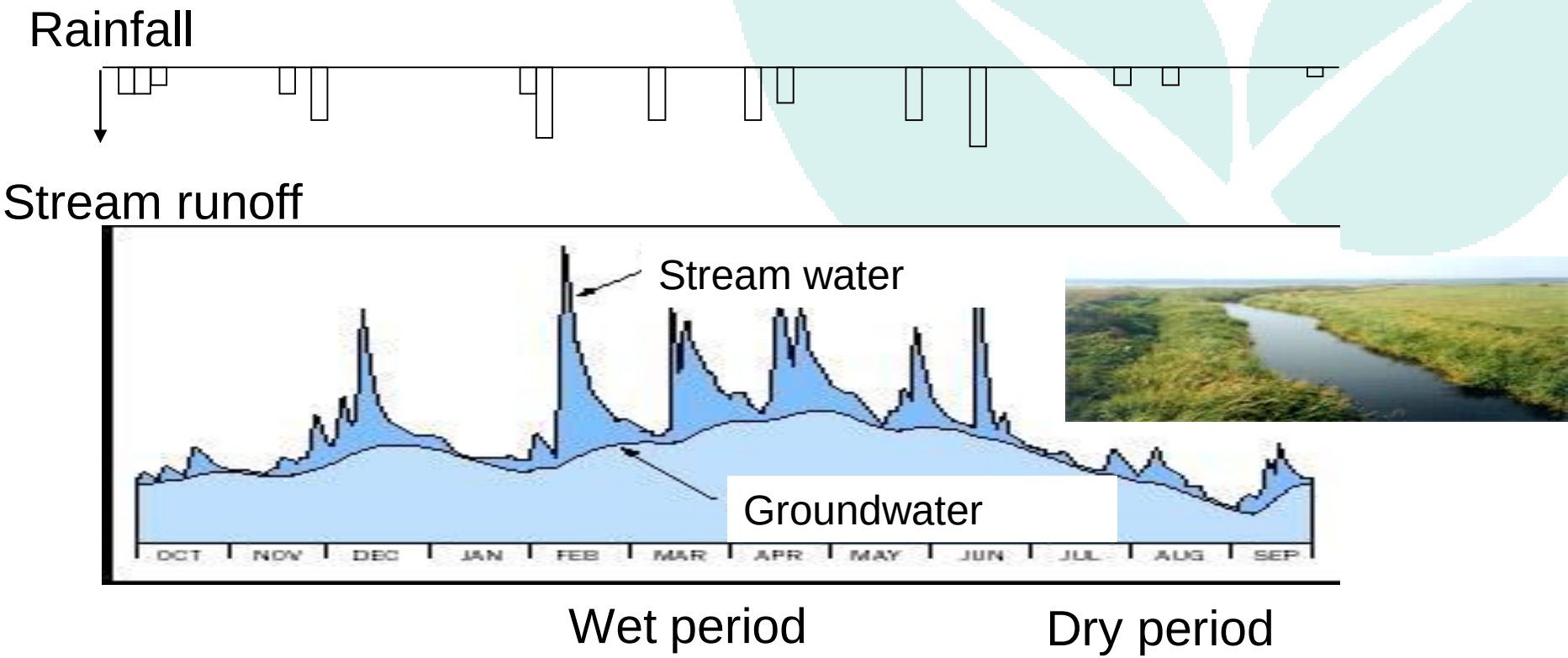
Source: Jnad and Prinz (2013)

Groundwater scales



Source: Jones (2011)

Renewable water resources

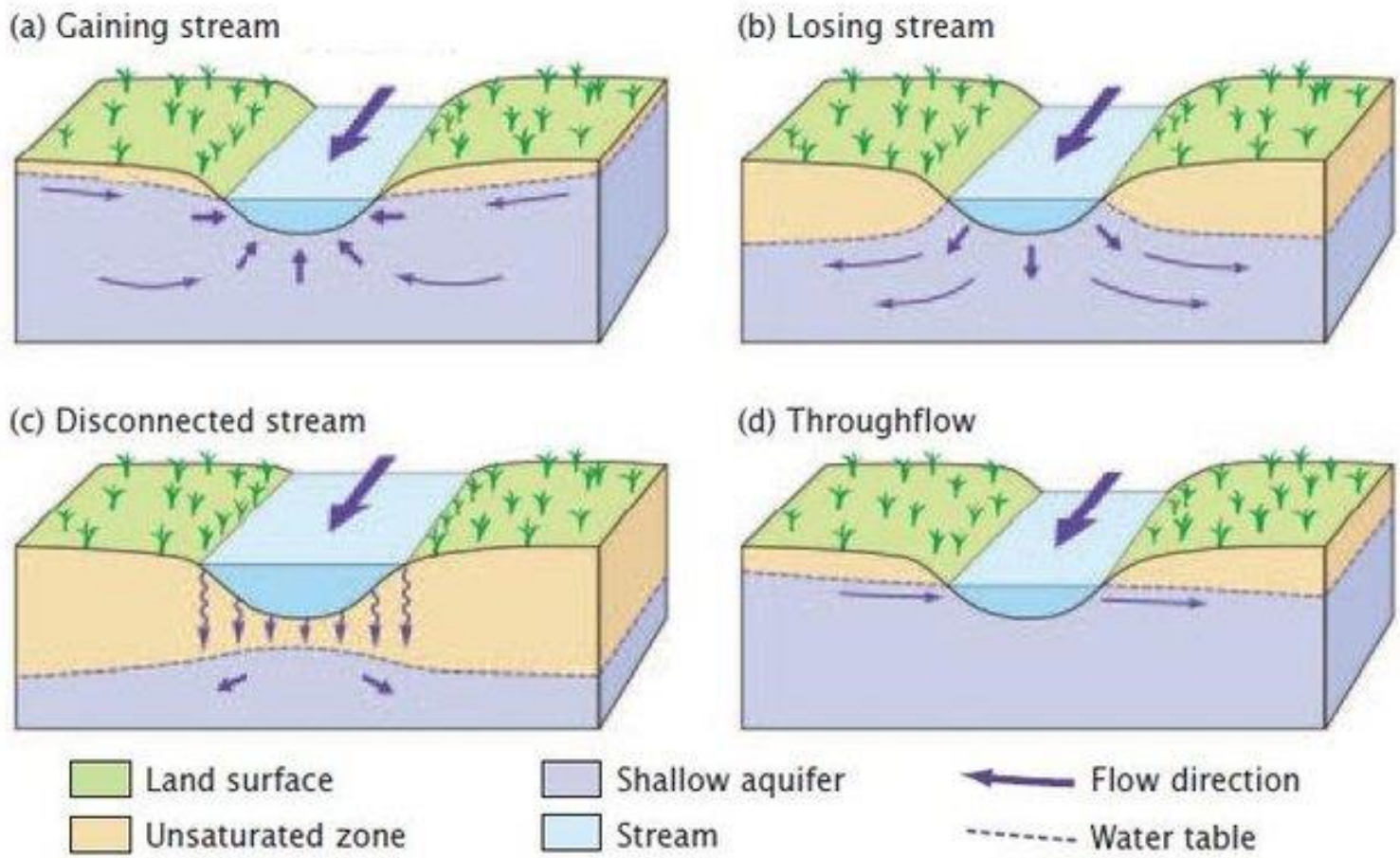


From: http://www.waterencyclopedia.com/St-Ts/Stream-Hydrology.html

Baseflow from groundwater

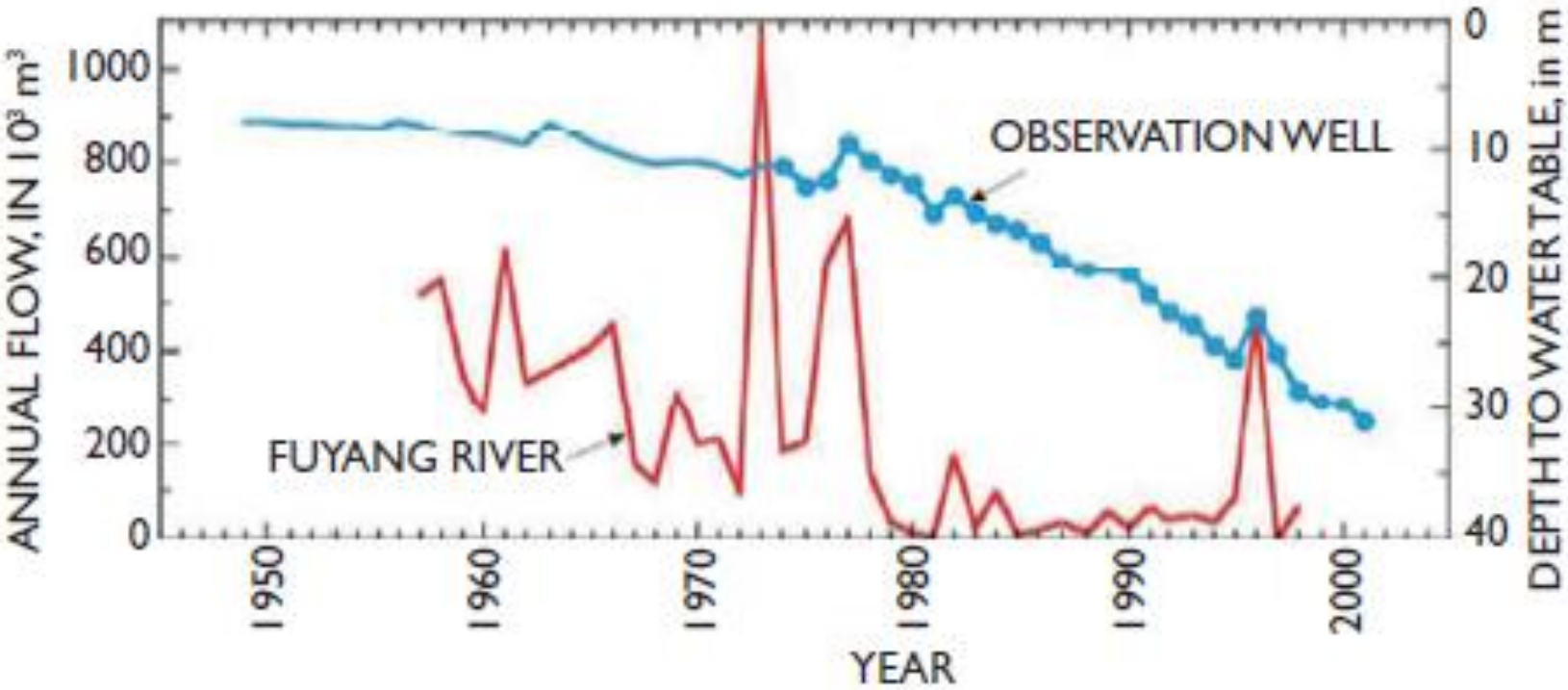
Source: Margat and van der Gun (2013)

Surface-groundwater interactions



Source: USGS

Groundwater affects surface flow

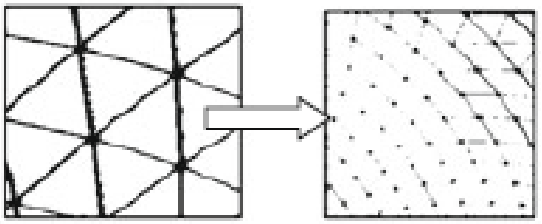


Source: Margat and van der Gun (2013)

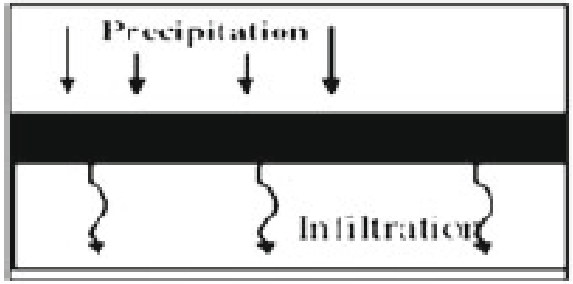
Climate change prediction for groundwater

Global Climate Change Model Outcomes

Downscaling Model



Infiltration/Recharge Model



Localised Aquifer Model

Source: Jones (2011)

Deposit porosity

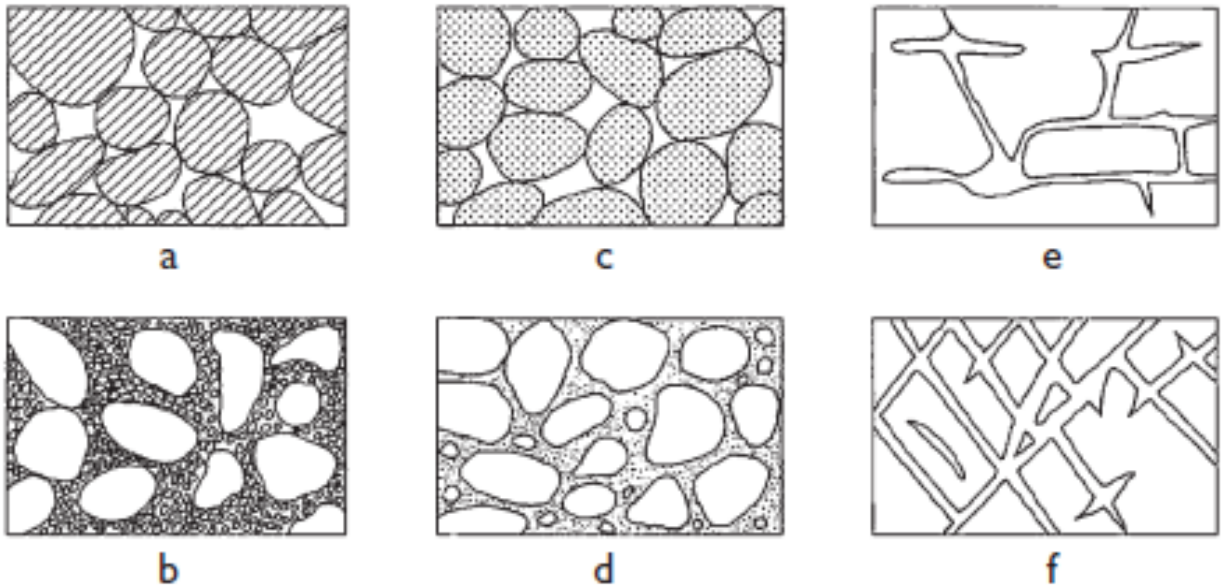
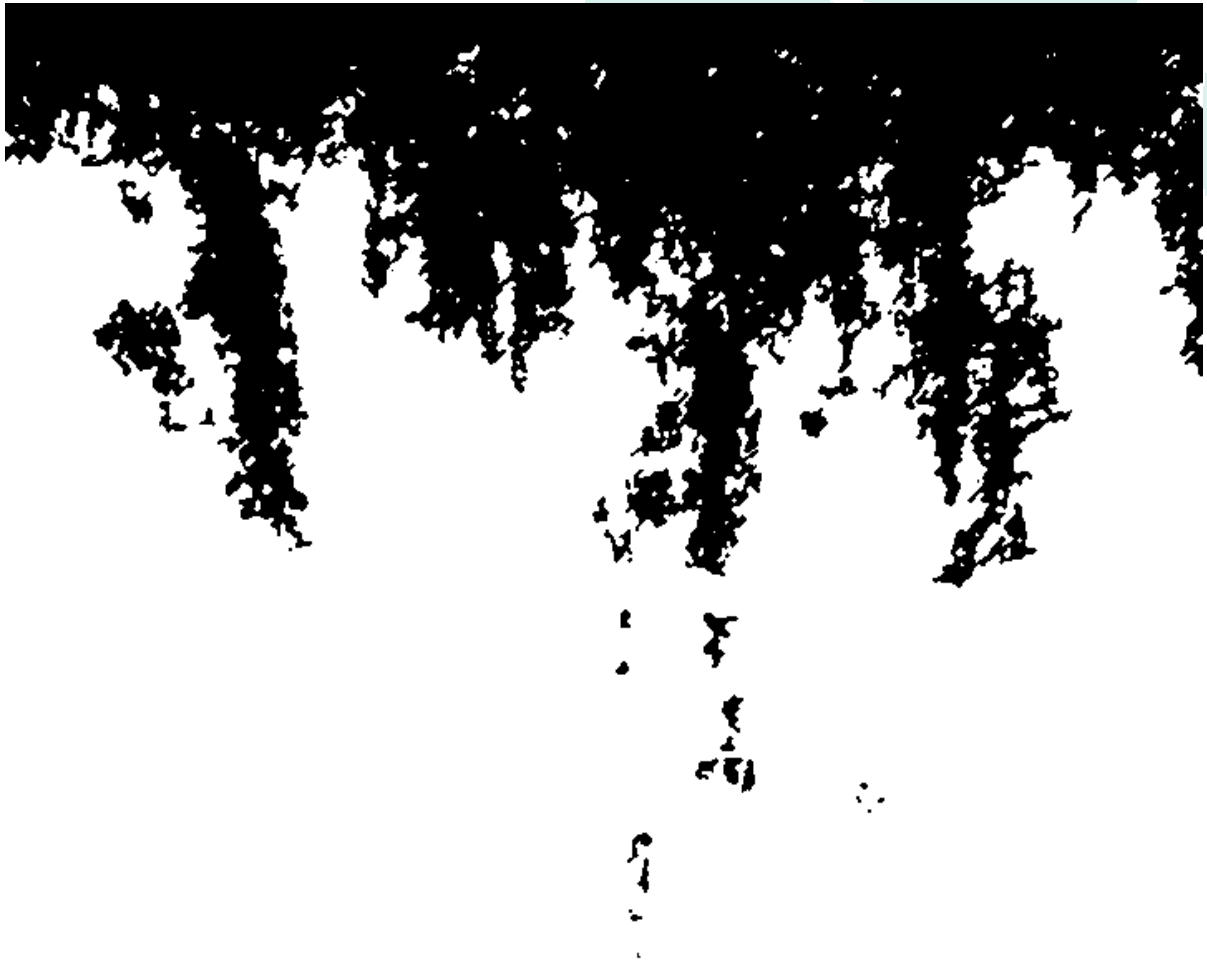


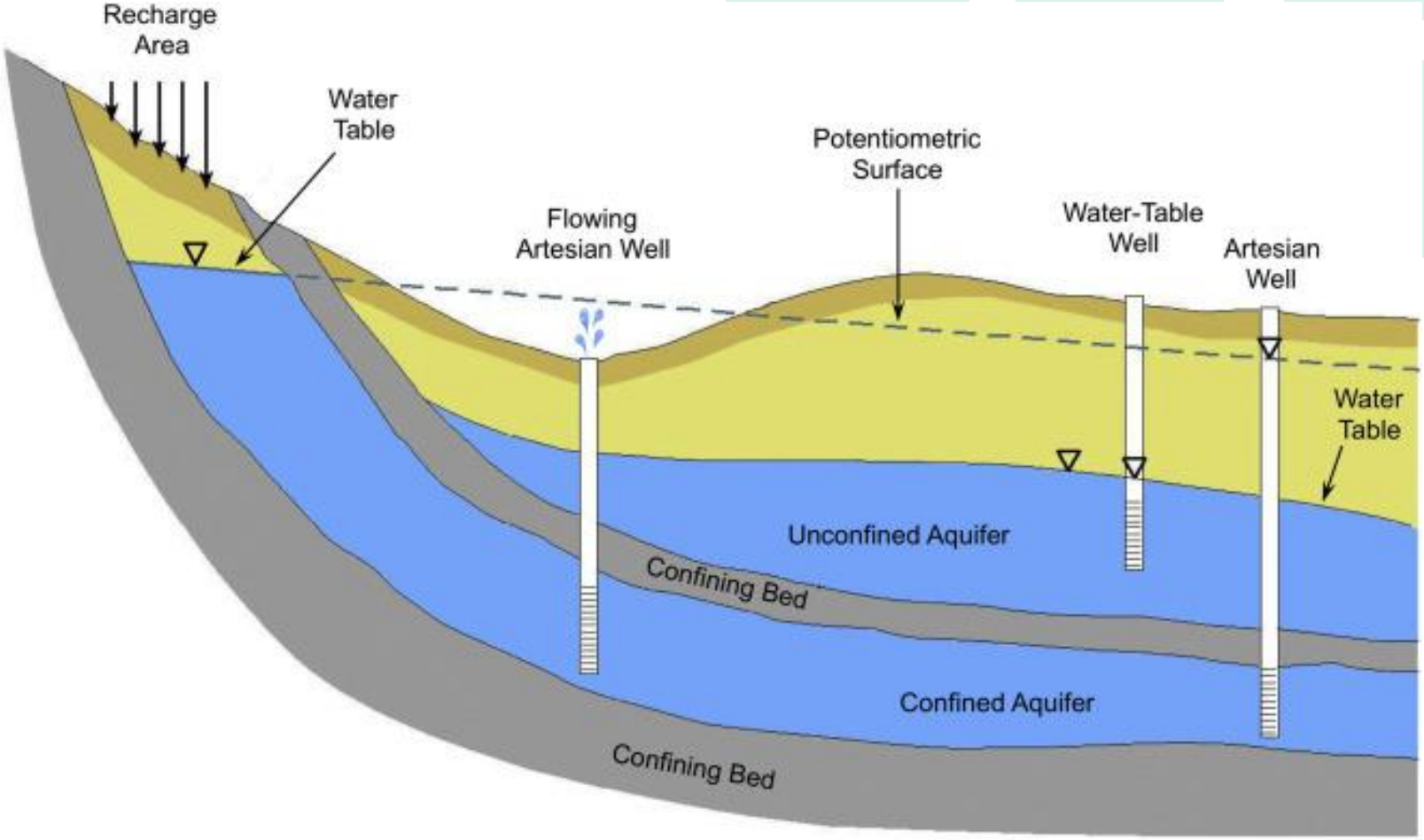
Figure 3.1 Different types of rock interstices, relevant for storage and movement of groundwater. [*Source*: After Meinzer (1923)].

(a) Well-sorted sedimentary deposit having high porosity;
(b) poorly sorted sedimentary deposit having low porosity;
(c) well-sorted sedimentary deposit consisting of pebbles that are themselves porous, so that the deposit as a whole has very high porosity;
(d) well-sorted sedimentary deposit whose porosity has been diminished by the deposition of mineral matter in the interstices;
(e) rock rendered porous by solution; and
(f) rock rendered porous by fracturing.

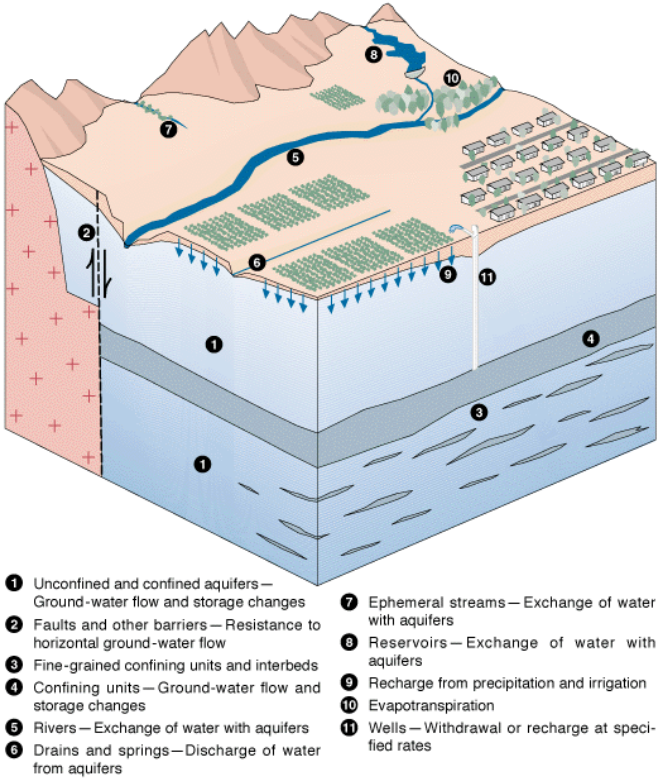
Infiltrating irrigation water



Groundwater level observations



Simulation models

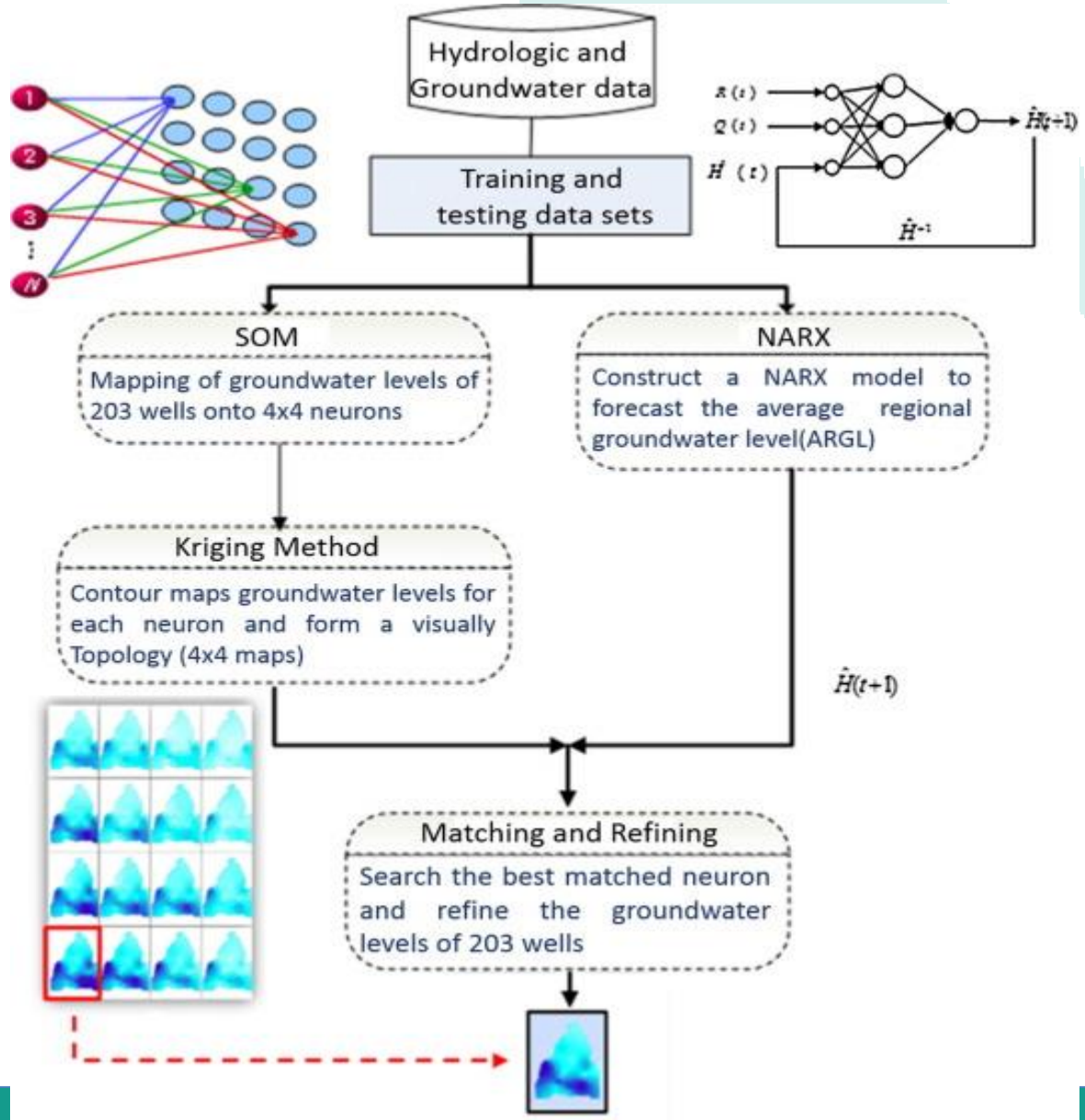


- Conceptual, numerical, analytical, mathematical, black box, etc.
- Water balances
- 1D flow
- MODFLOW

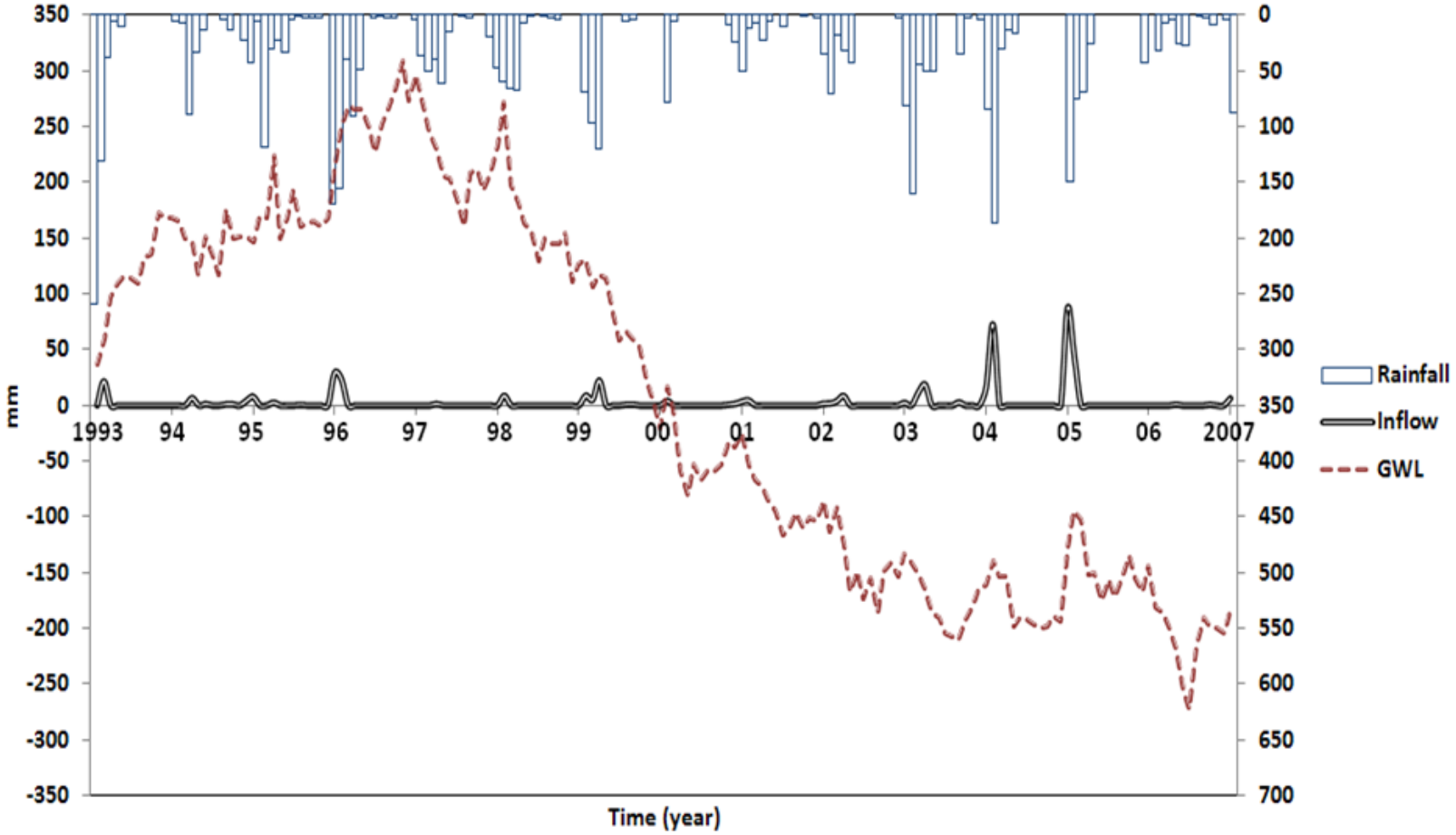
All models require reliable field data and a higher degree of information on rock types and geological structures than is often readily available. Few rocks are uniform. Water is likely to drain faster through joints and faults in the rocks than through the porous mass of rock. Such discontinuities invalidate the normal assumption of homogeneous porosity commonly made in computer models

Source: Margat and van der Gun (2013)

Neural network and SOM models

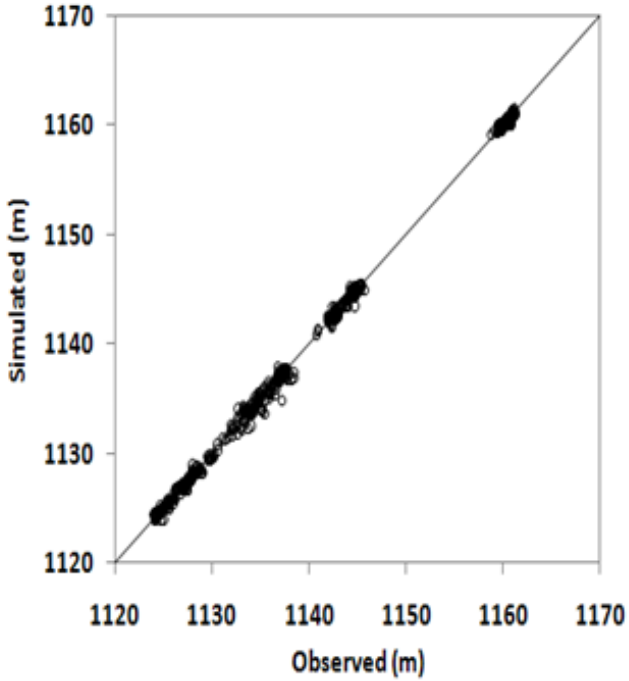


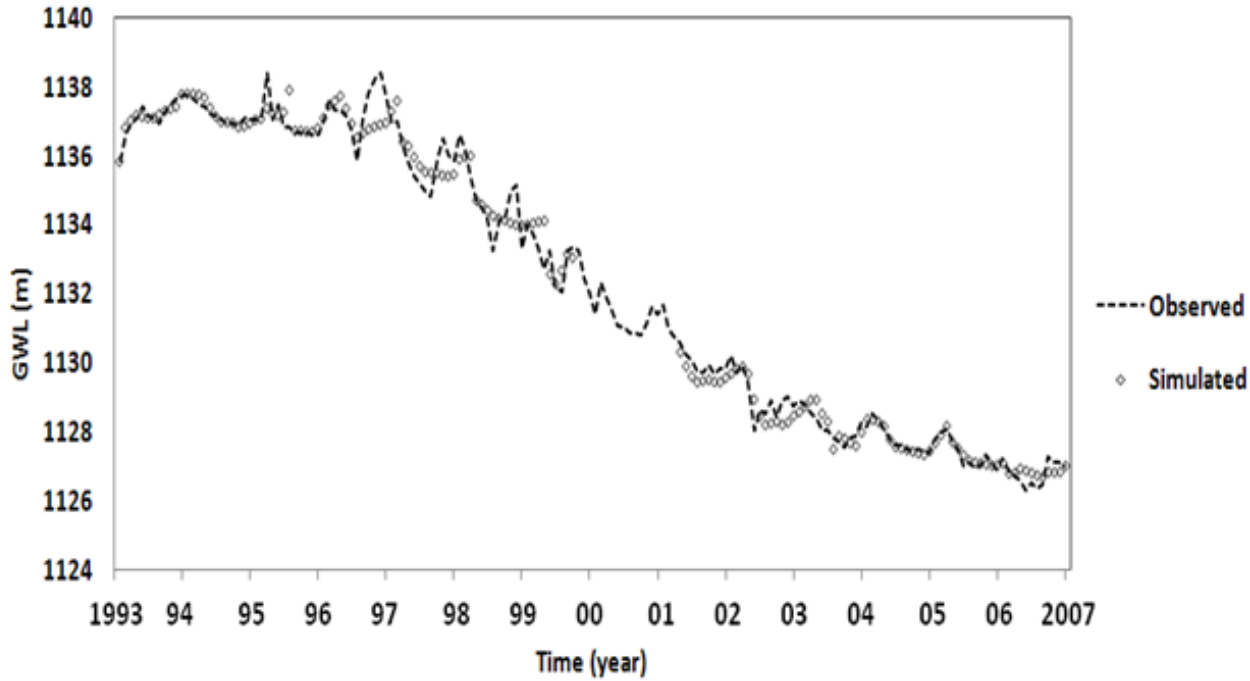
Groundwater level



Source: Hashemi (2013)

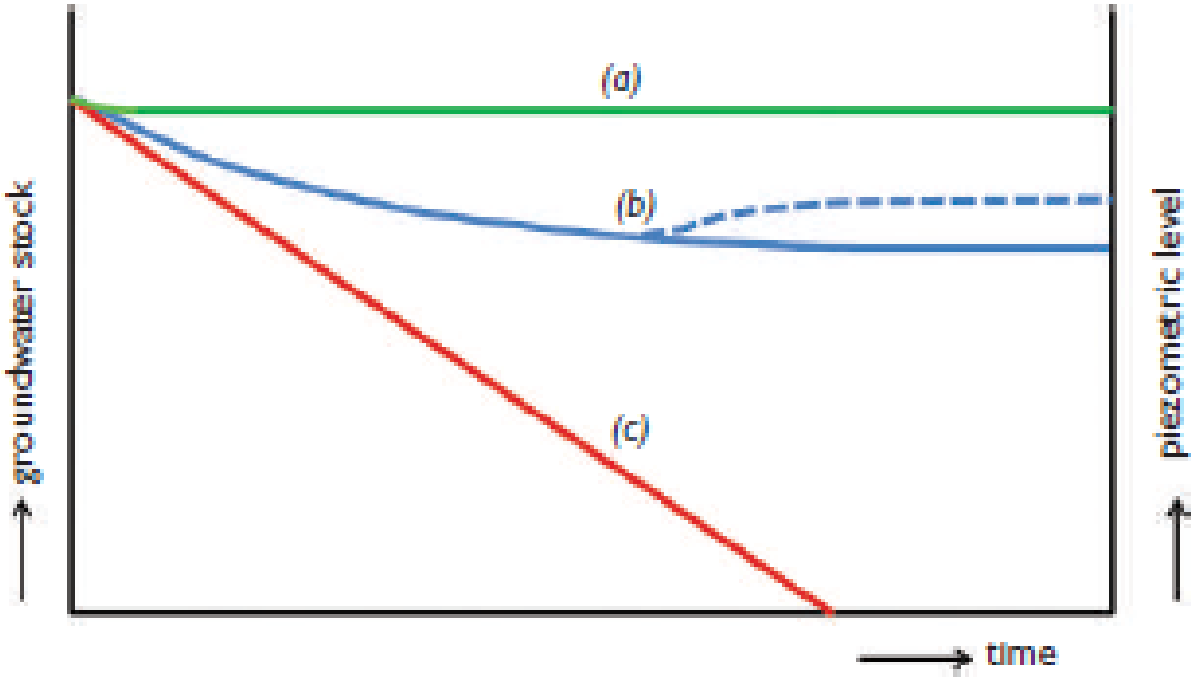
Steady state modeling





Source: Hashemi (2013)

Sustainability of groundwater use



(a) Sustainable yield strategy

(b) Mixed strategy

(c) Mining strategy

Source: Margat and van der Gun (2013)

Climate change adaptation

Supply side	Demand side
Increase storage capacity by building reservoirs and dams	Improve water-use efficiency by recycling water
Desalinate seawater Expand rainwater storage	Reduce water demand for irrigation by changing the cropping calendar, crop mix, irrigation method and area planted
Remove invasive non-native vegetation from riparian areas	Promote traditional practices for sustainable water use
Prospect and extract groundwater	Expand use of water markets to reallocate water to highly valued uses
Develop new wells and deepen existing wells Maintain well condition and performance	Expand use of economic incentives including metering and pricing to encourage water conservation
Develop aquifer storage and recovery systems	Introduce drip-feed irrigation technology
Develop conjunctive use of surface water and groundwater resources	License groundwater abstractions
Develop surface water storage reservoirs filled by wet season pumping from surface water and groundwater Develop artificial recharge schemes using treated wastewater discharges Develop riverbank filtration schemes with vertical and inclined bankside wells Develop groundwater management plans that manipulate groundwater storage, e.g. resting coastal wells during times of low groundwater levels Develop groundwater protection strategies to avoid loss of groundwater resources from surface contamination Manage soils to avoid land degradation to maintain and enhance groundwater recharge	Meter and price groundwater abstractions

Source: IPCC (2008)

References

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Questions for discussion

- Can you give examples groundwater projects in Tunisia?
- Do you see?
- Other examples of adaptation and mitigation to climate change?

Tasks to do

- Work in small groups of 5-6 members.
- Select a basin or area.
- Describe using text and figures.
- Summarize the above in 2-3 A4 pages per group and send to: ronny.berndtsson@tvrl.lth.se at latest 29th March.

That´s all for now!

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