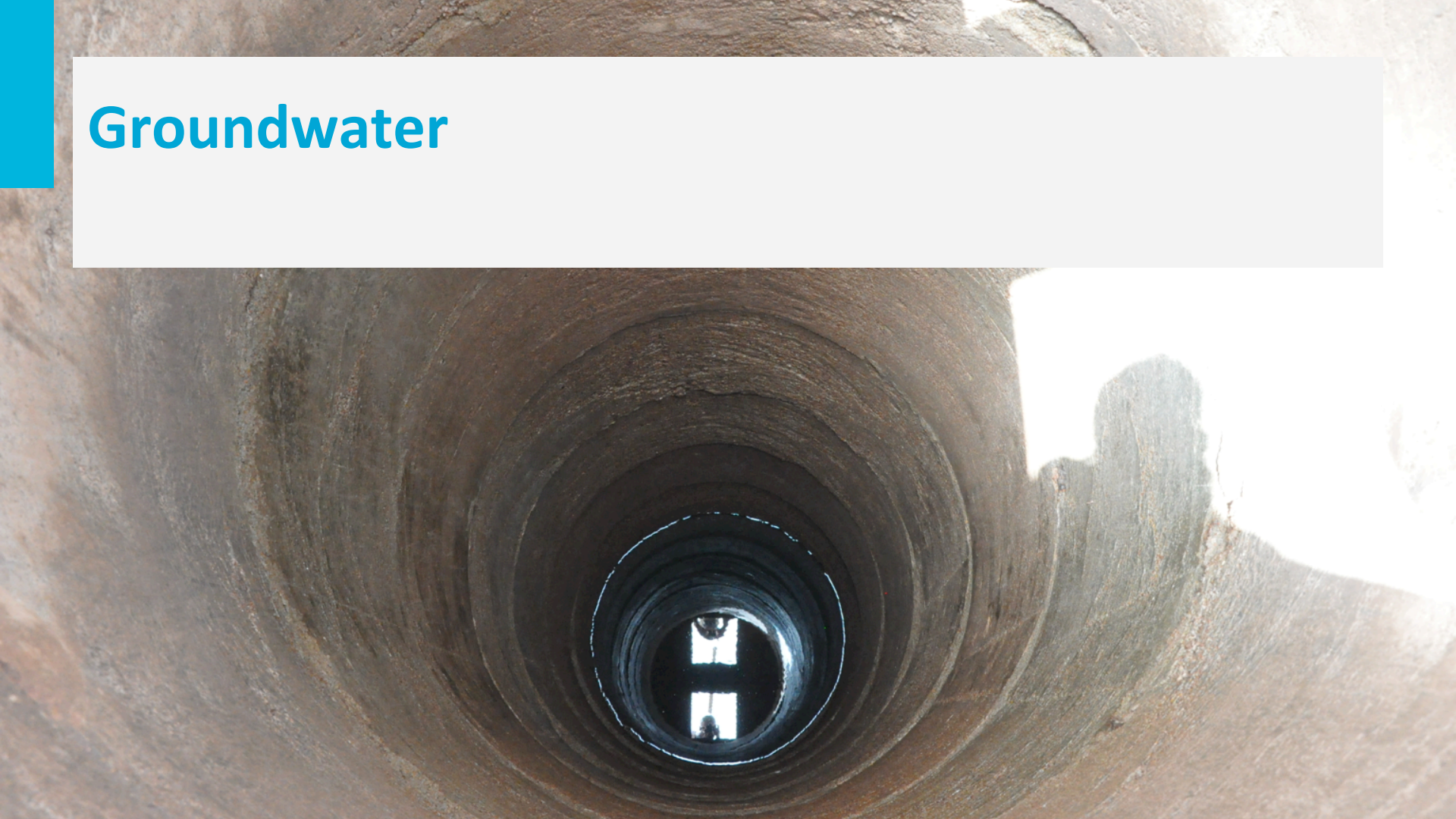
WR-4 Groundwater

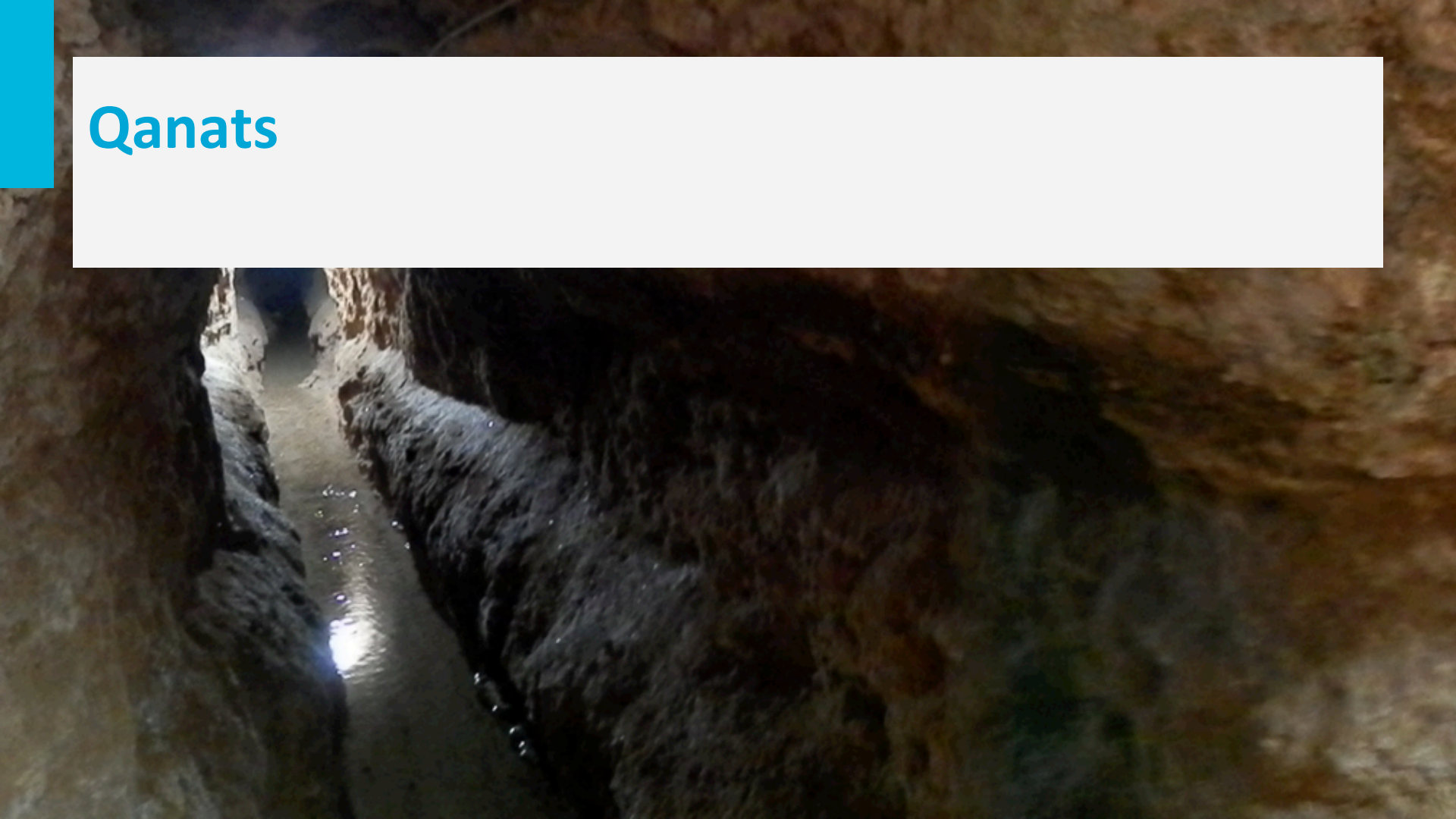
CTB3300WCx: Introduction to Water and Climate

Prof.dr.ir. Nick van de Giesen

Groundwater



Qanats



Flow speeds

1 – 1.5 m/s

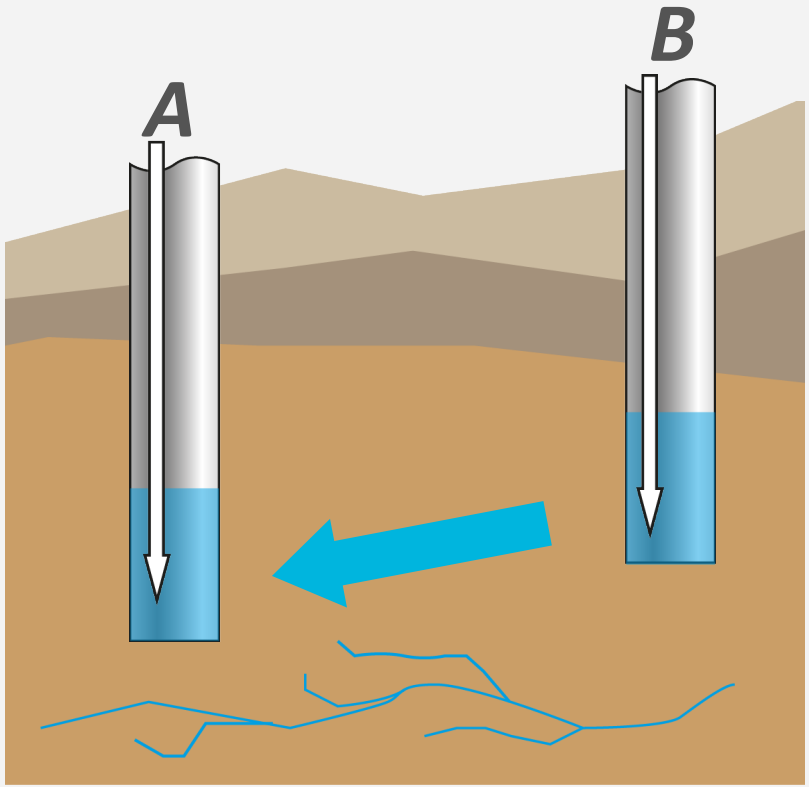
0.075 m/s

0.014 m/s

GROUND WATER

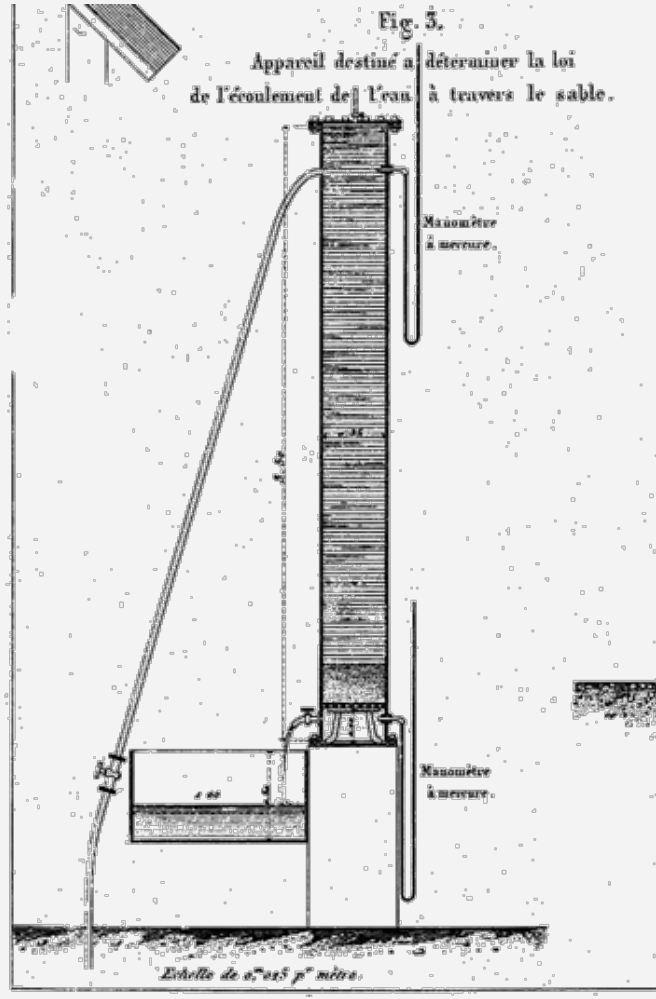
> 0.001 m/s

Difference in watertable depth



- *Aquifers*
- *Piezometers*
- *Water flow*

Henri Darcy

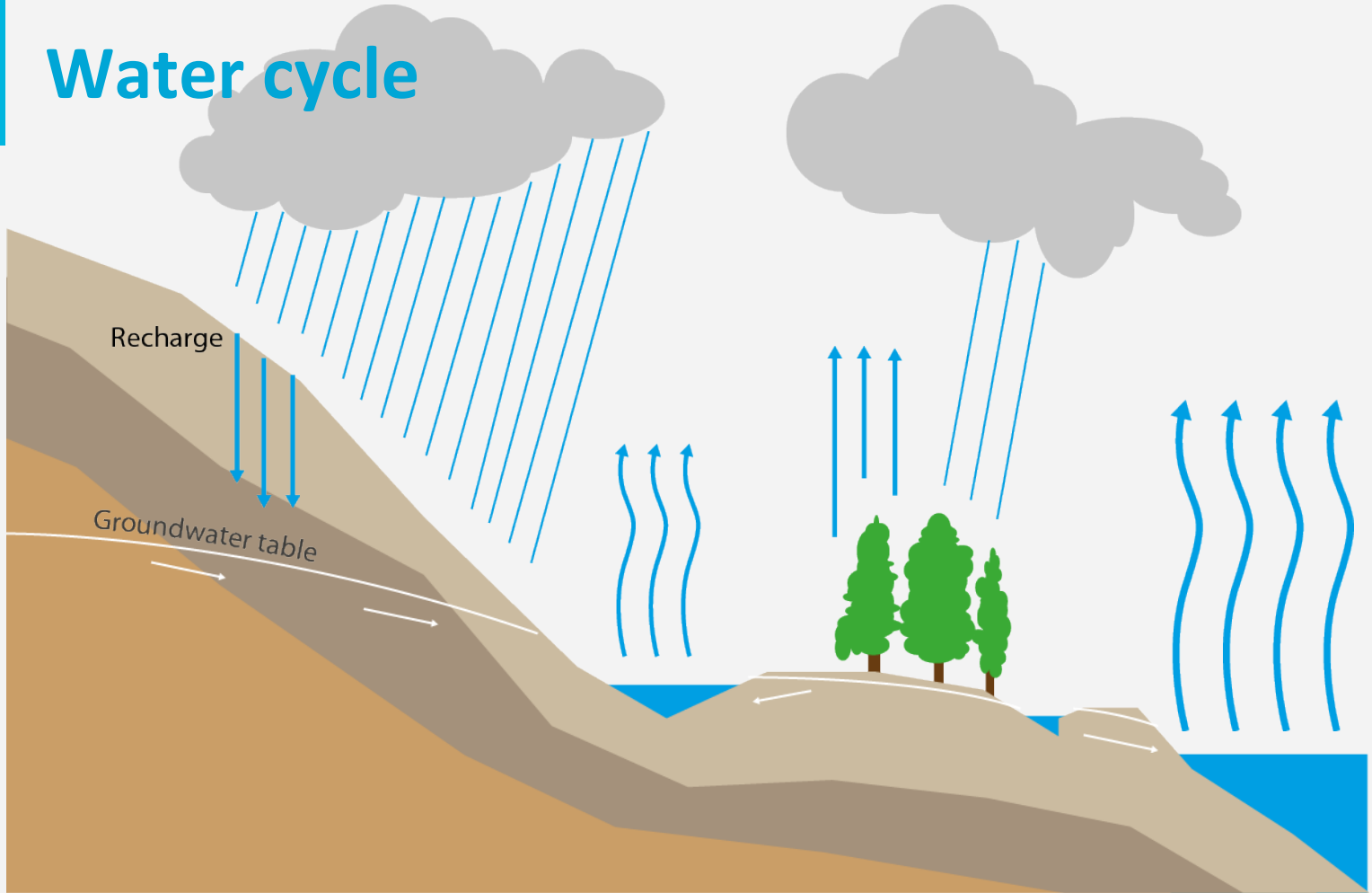


Darcy's Law:

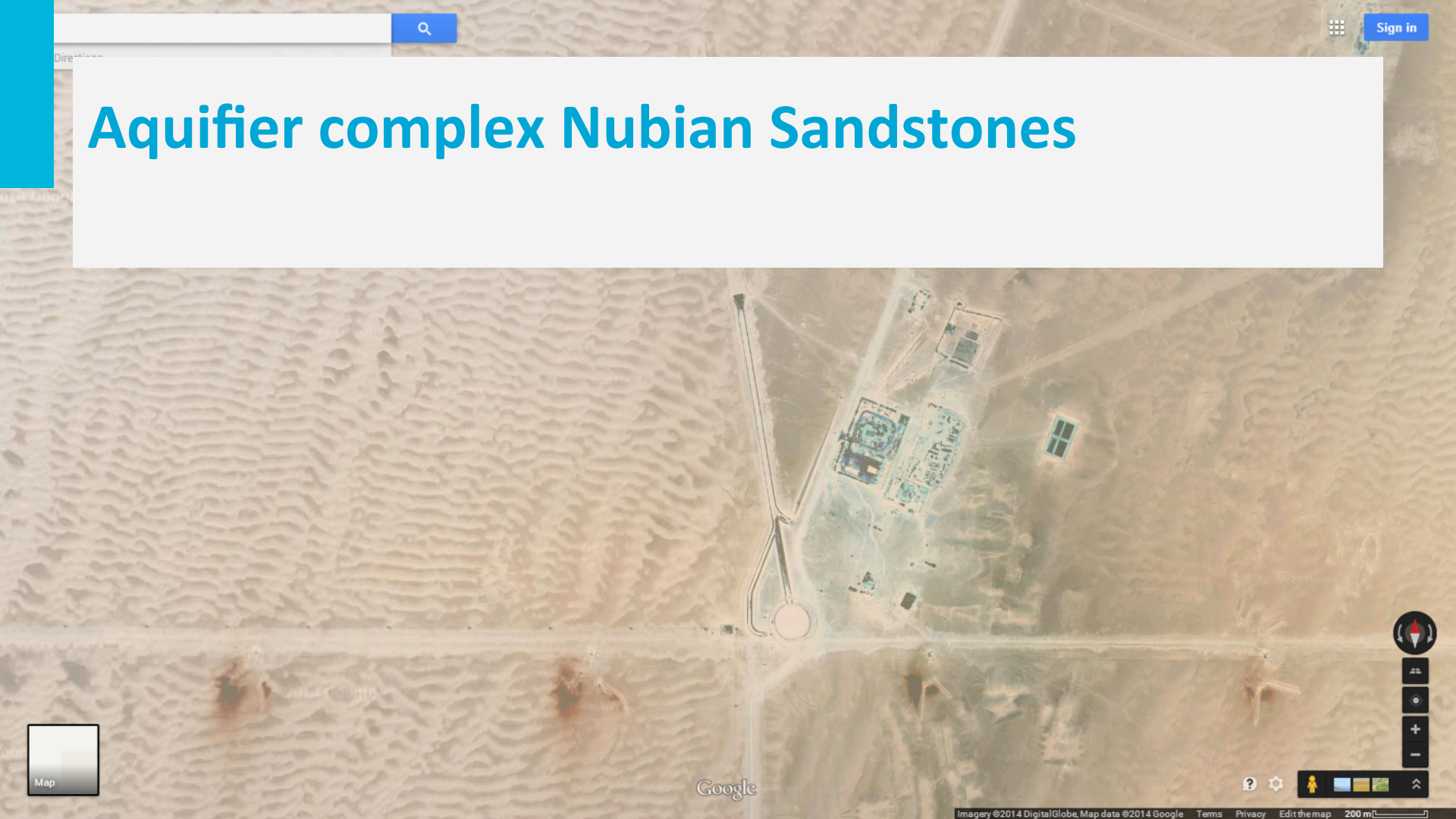
$$Q = A \cdot K \cdot H\downarrow 1 - H\downarrow 2 \ / \Delta x$$

Q = total flow [m^3/s];
A = area [m^2]
K = permeability coefficient of soil [m^3/s]
H1 = water height at point 1
H2 = water height at point 2
Δx = distance between points 1 and 2

Water cycle



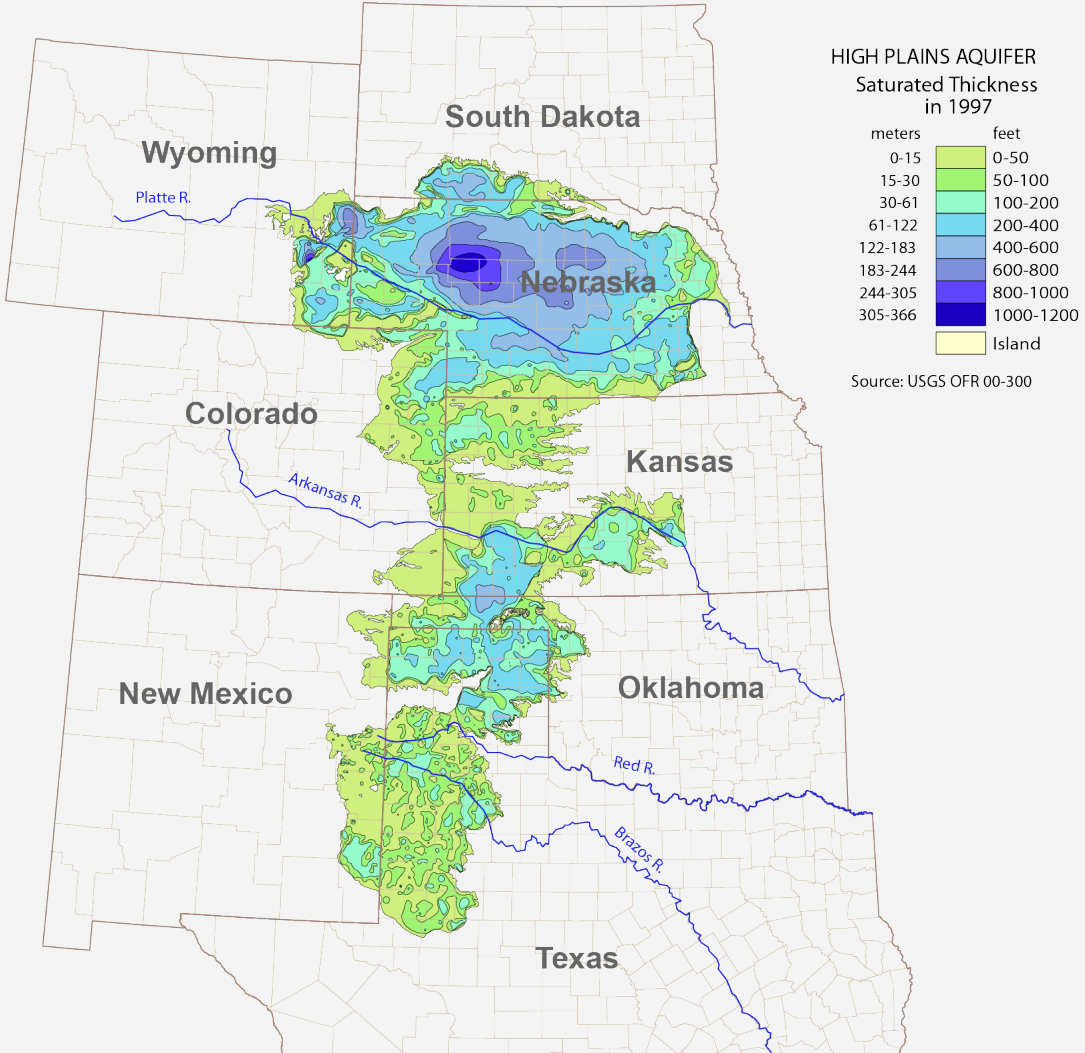
Aquifier complex Nubian Sandstones



Recharge and Extraction

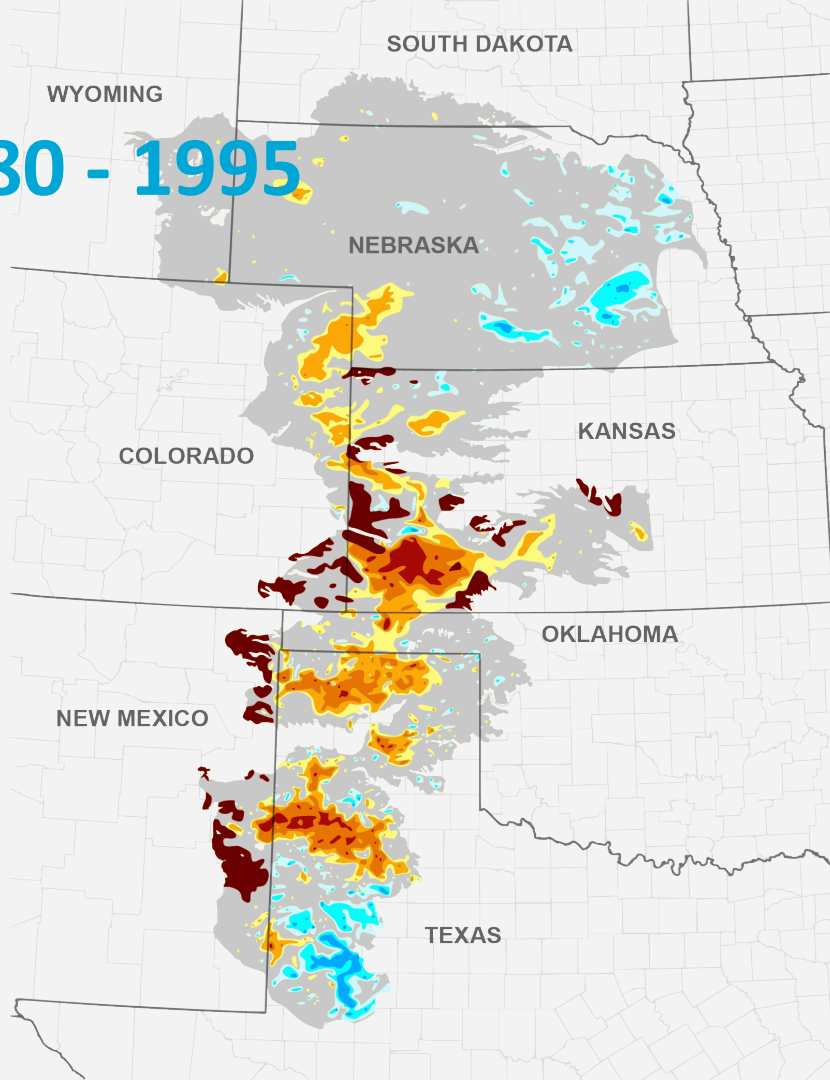
- If *Recharge* < *Extraction*;
  - *The groundwater table falls*
  - *Not sustainable*

Ogallala aquifer



Changes in the Ogallala, 1980 - 1995

- Today: 26 km^3/yr
  - *30% more than the flow of the Colorado river*
  - *= 55 mm/yr*
- Recharge << Extraction



Groundwater Depletion

Groundwater depletion in the regions of the U.S.A., Europe, China and India and the Middle East

For the year 2000:
($mm \cdot a^{-1}$;
clockwise from top-left).

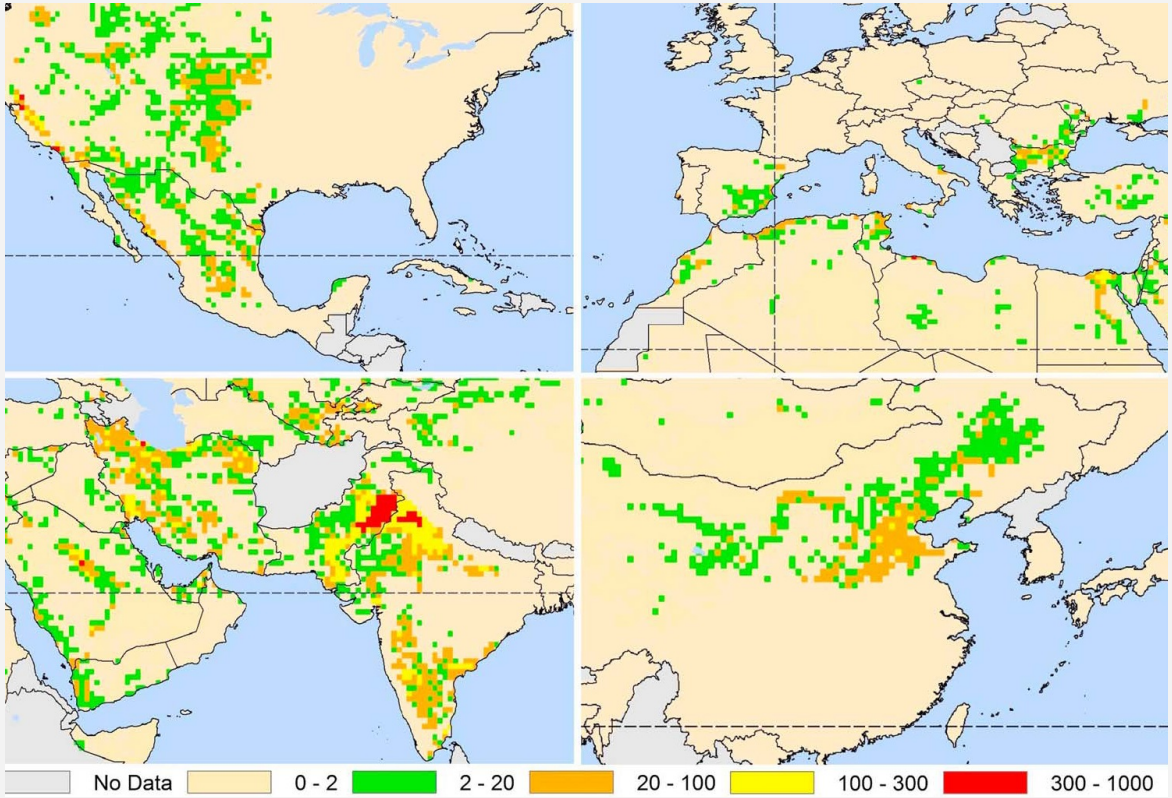
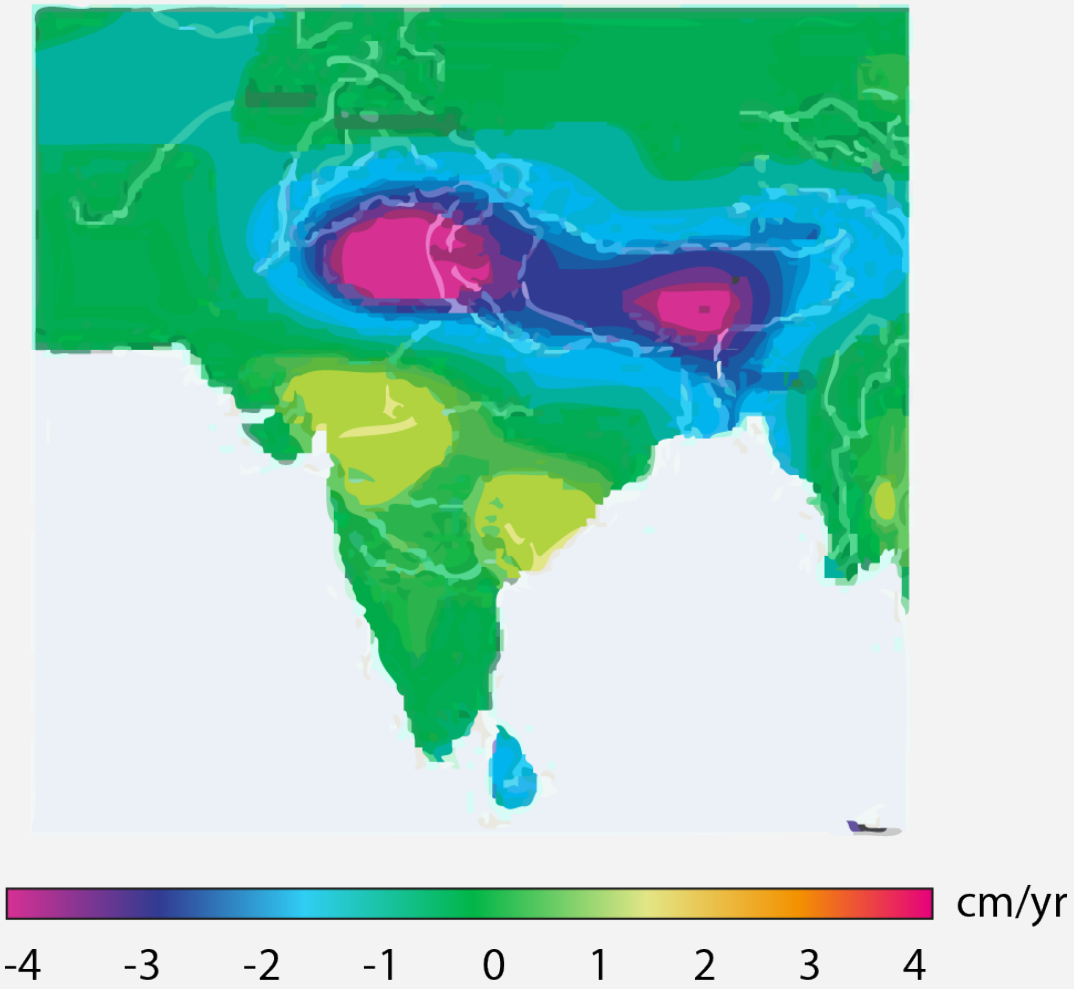


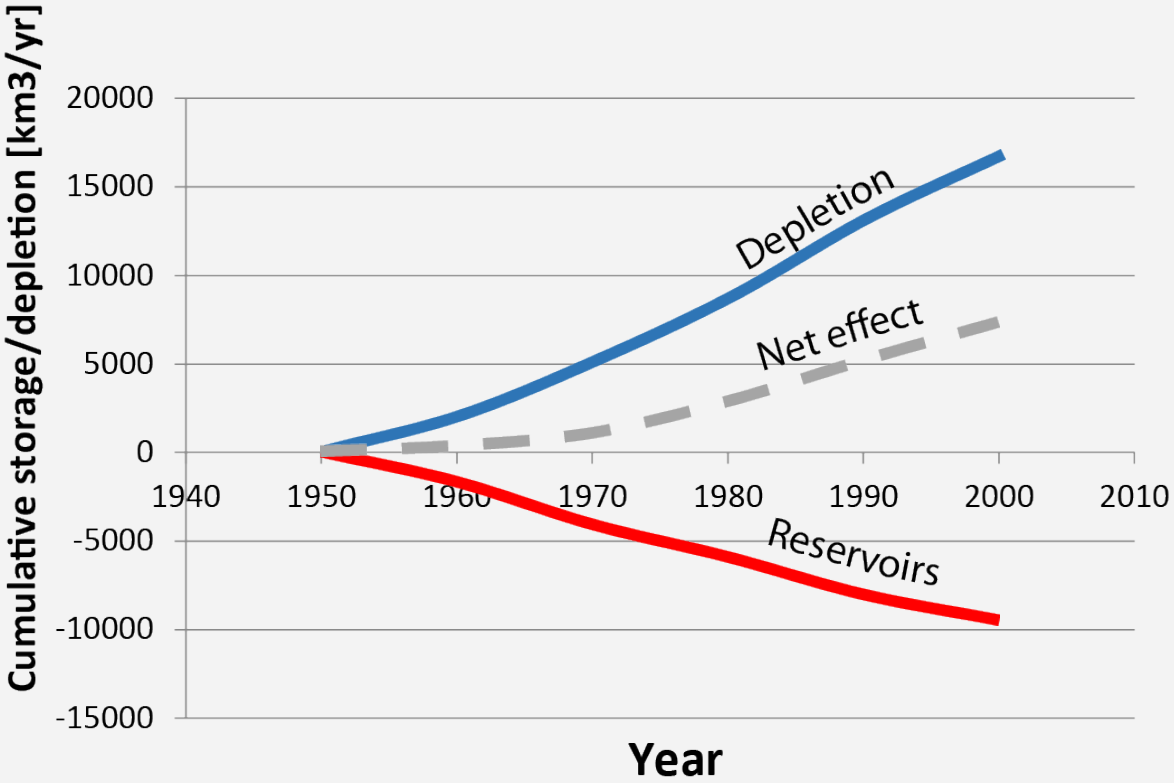
Image from GRACE

(left) Rate of change of terrestrial water storage, in cm/yr of water thickness, determined from GRACE gravity solutions.

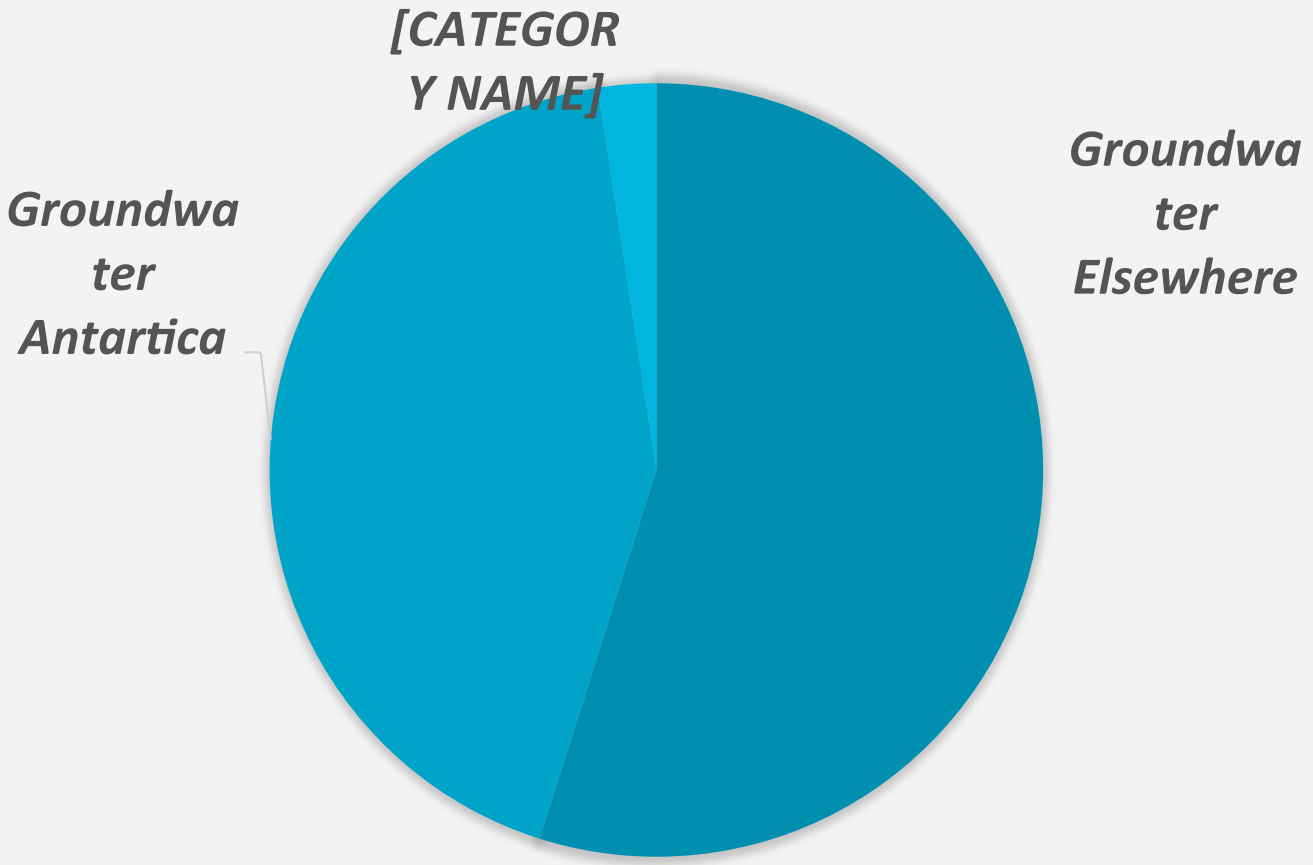


Reservoirs

Graph Reservoirs



Fresh water


[CATEGOR
Y NAME]
Groundwa
ter
Antartica
Groundwa
ter
Elsewhere

Groundwater

CTB3300WCx: Introduction to Water and Climate

Prof.dr.ir. Nick van de Giesen