Water in humanitarian operations

From Emergency supply to Integrated Water Resource Management

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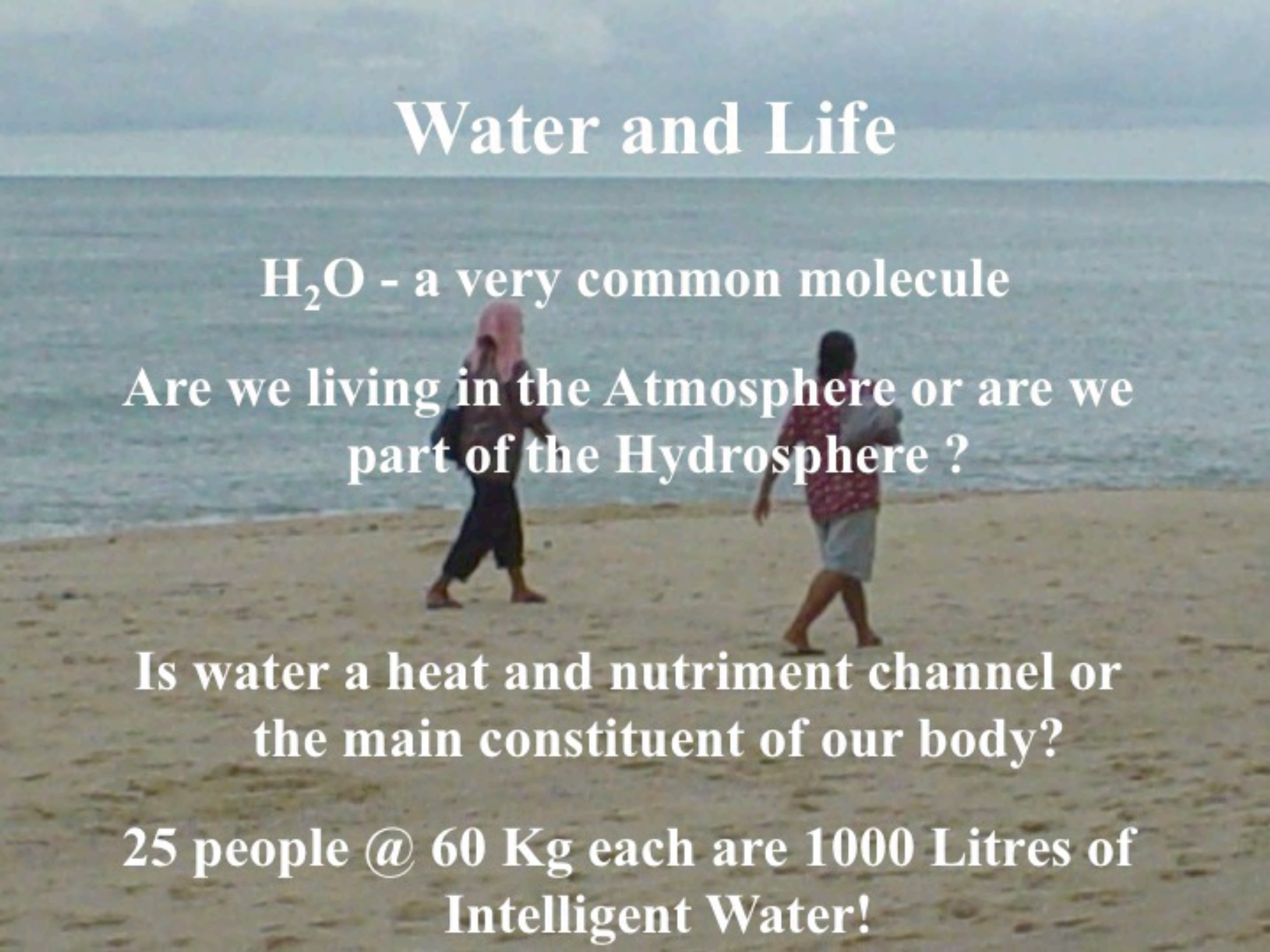
Swiss Humanitarian Aid

Water and Life



H_2O - a very common molecule

Are we living in the Atmosphere or are we part of the Hydrosphere ?

Is water a heat and nutriment channel or the main constituent of our body?

25 people @ 60 Kg each are 1000 Litres of Intelligent Water!

Major stocks of Water

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%	

Some definitions (1)

- **Vapour, liquid, Ice**, or White water
- **Surface water,** chemical composition OK, bacteriologically suspect
- **Groundwater** represents an important part of freshwater resources on Earth. Two main types of groundwater - **active and fossil** chemical composition suspect, bacteriologically OK

Some definitions (2)

- **Blue water** is made of stream flow or groundwater that can be exploited
- **Green water** is the water in the soil on which crop and tree growth depends.
- There is often a competition between Blue water and Green water users, as heavy reforestation programs may result in water remaining trapped as Green water

Some definitions (3)

Grey water is water slightly contaminated by usually hardly harmful components such as grease, soap, oil and anthropogenic aerosols which pollutes water used for washing household items or for personal hygiene.

Brown water is water contaminated by faecal matter of human or animal origin, which is quite dangerous for human health as it contains numerous strains of very active bacteria, microbes and viruses.

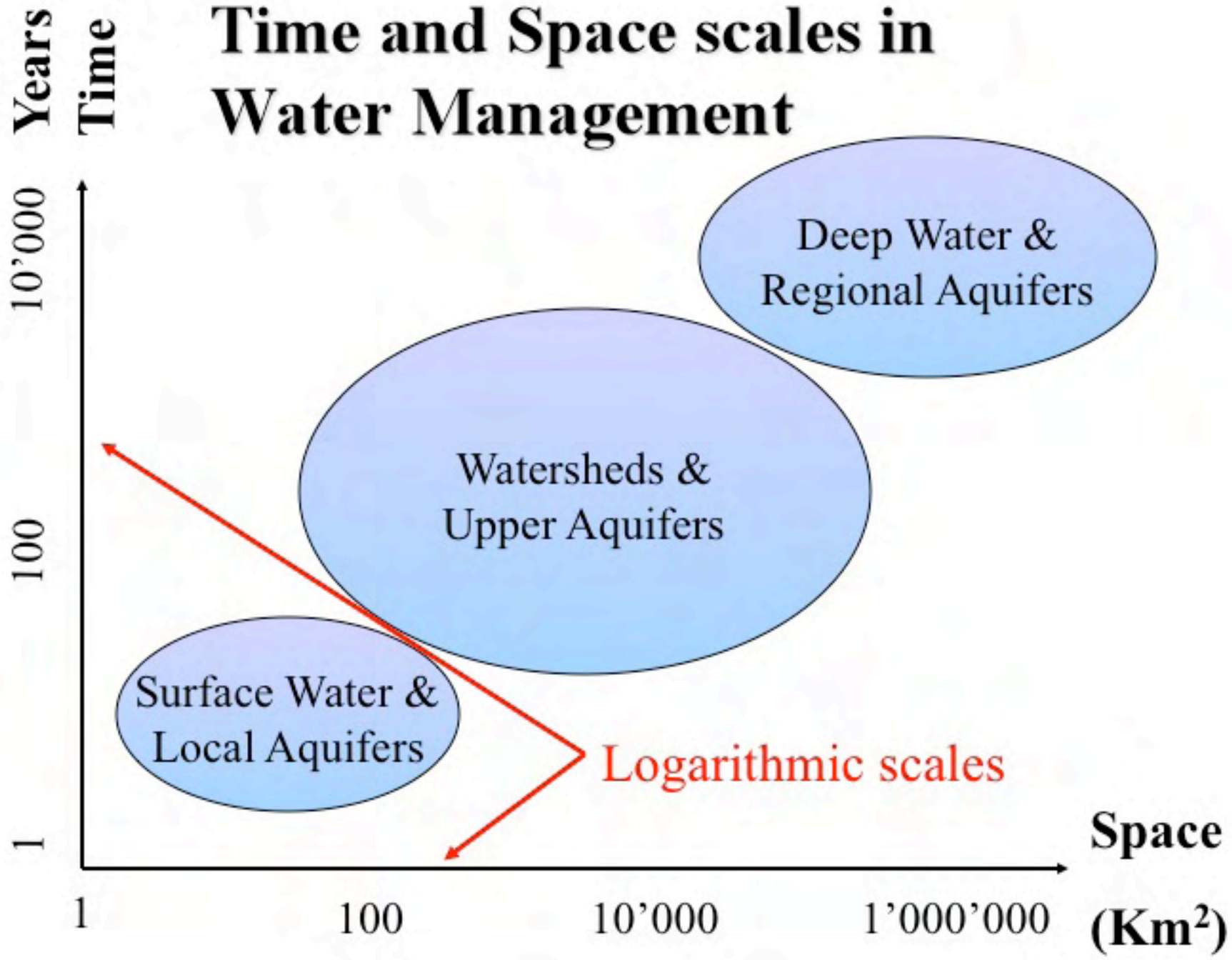
Some definitions (4)

Drainage water is made of rainwater evacuated by different systems of gullies and canals.

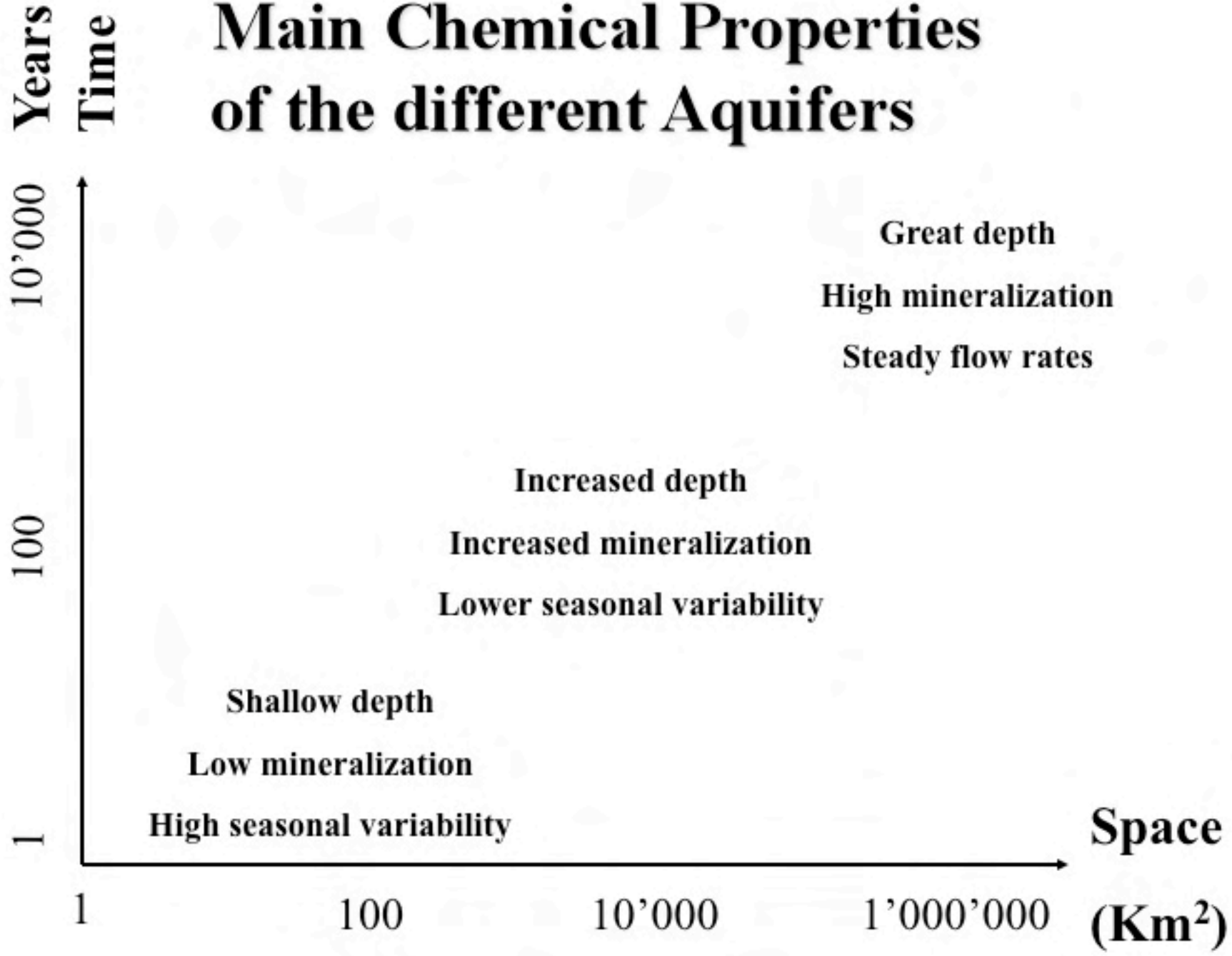
Wastewater is a combination of brown, grey, drainage water in different proportions. The two main problems related to this mixing of different water are

- **dilution** of highly toxic contaminants, which will request treatment of very large amounts of water and
- **combination** of different chemical bodies, that may result in almost impossible treatment.

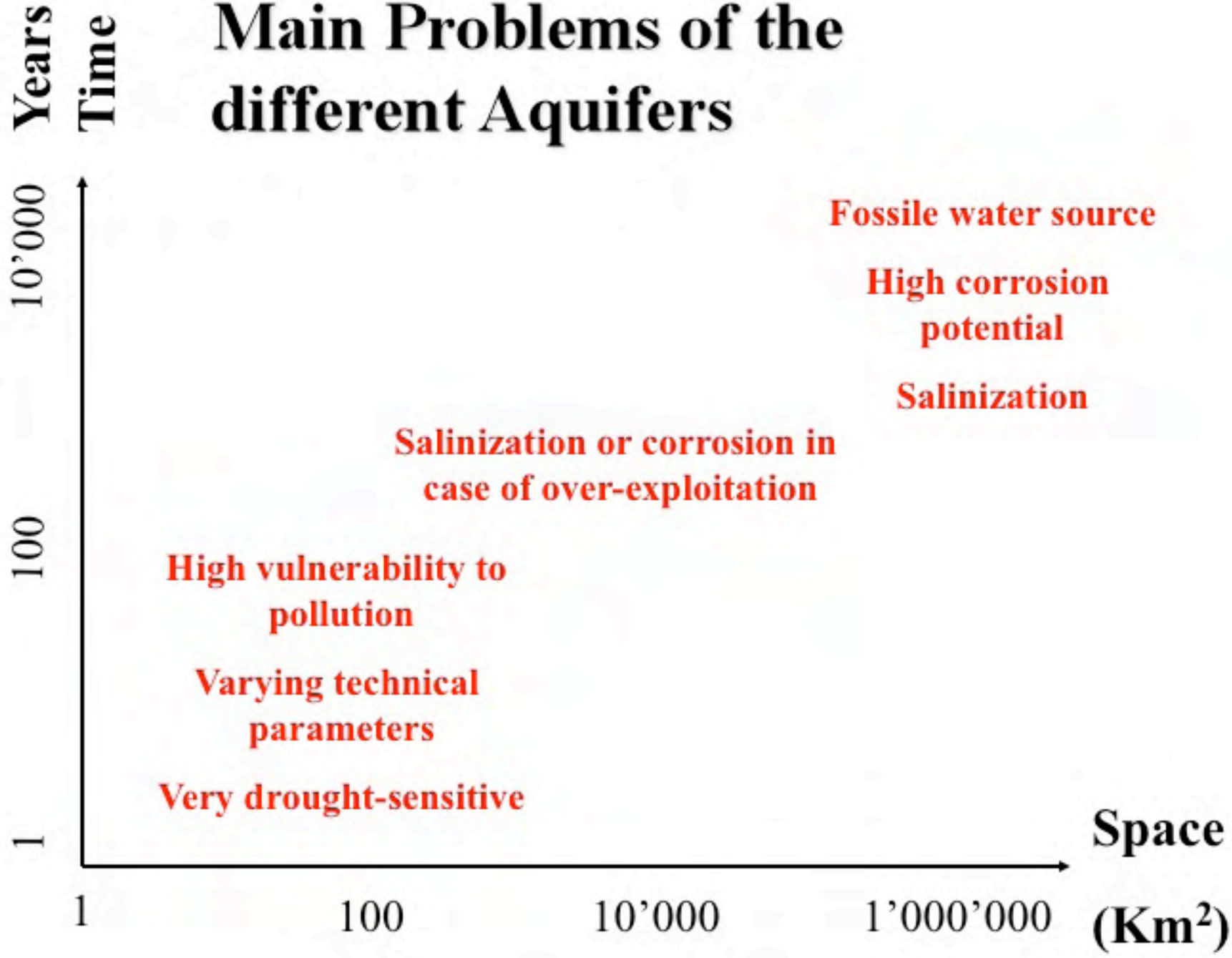
Time and Space scales in Water Management



Main Chemical Properties of the different Aquifers



Main Problems of the different Aquifers



Daily Water Consumption

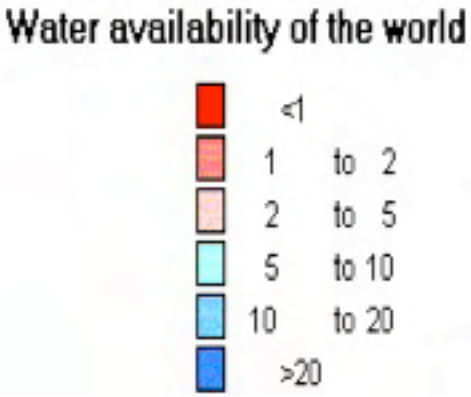
- Africa Average 59.1
- Europe Average 198.6
- North America Average 394.4
- South America Average 311.9
- Asia Average 256.4
- **World Average 227.2**

Switzerland 131.2 Canada 950.7 Haiti

Legend for the maps

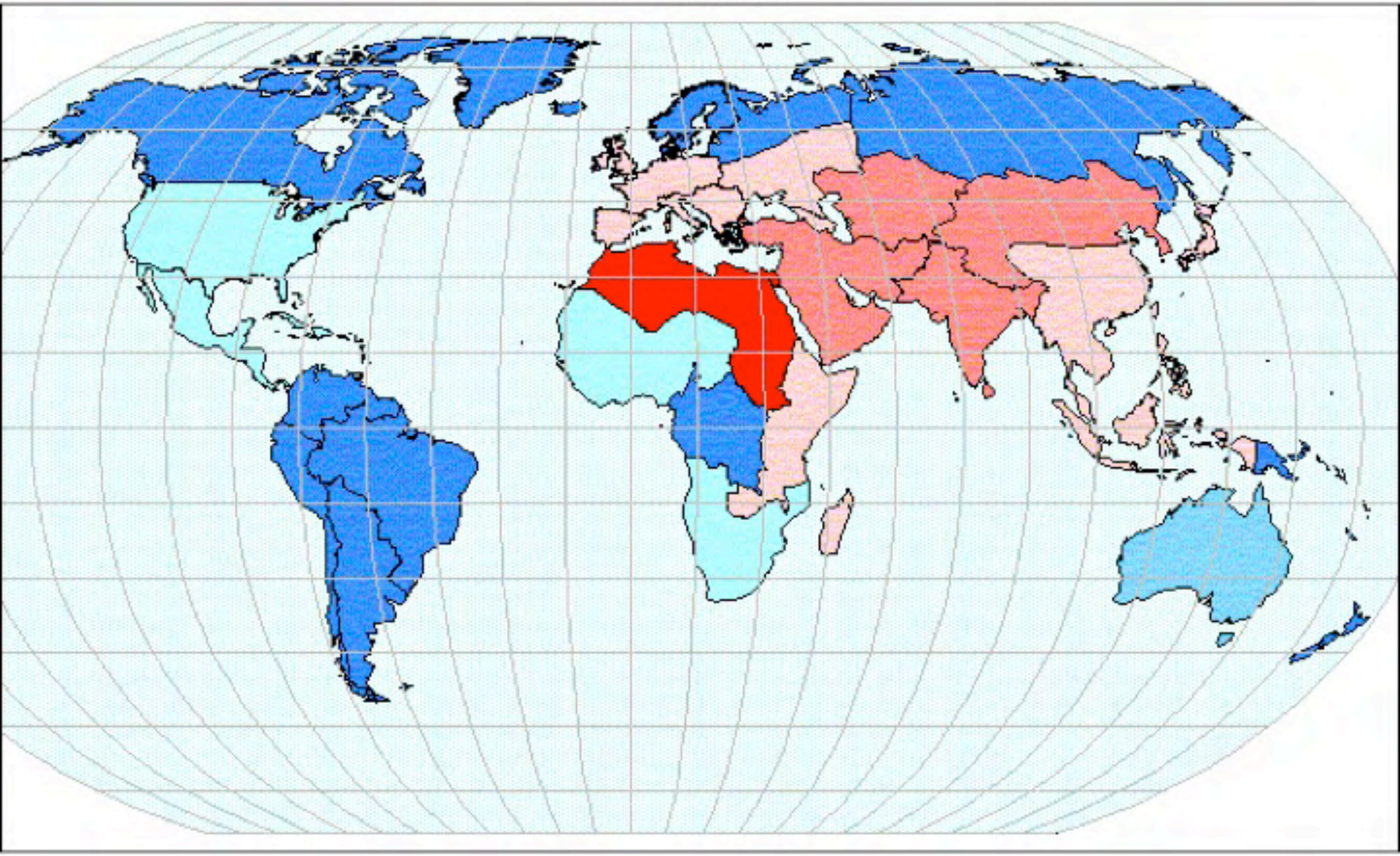
- The following maps illustrate the evolution of water availability from 1980 to today and its forecasted evolution until 2025.

- The color in each country shows the water availability per capita per year. When a country is displayed in pink or red, water shortage is considered as serious.

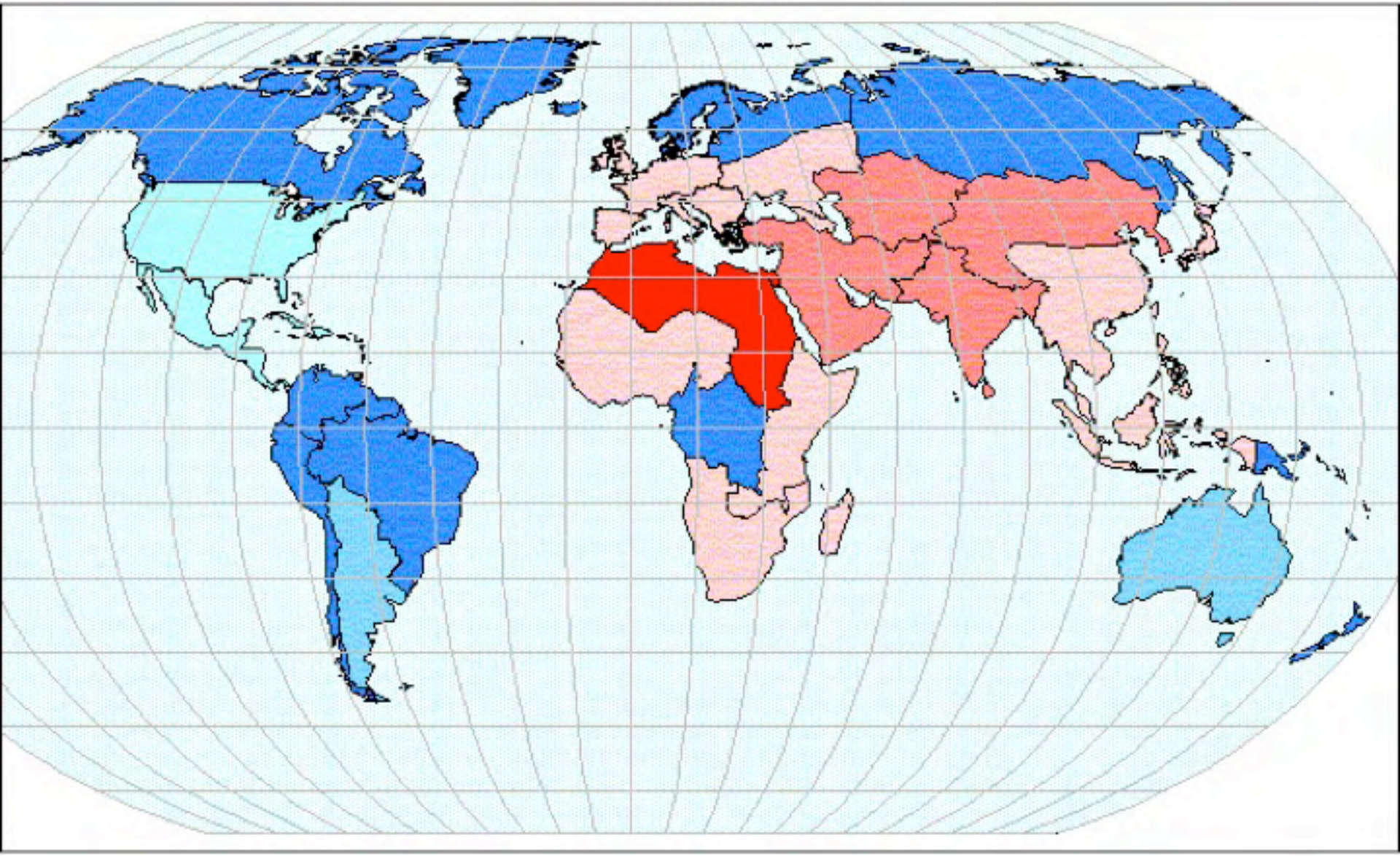


Water availability is expressed in thousands of cubic meters of water per capita per year

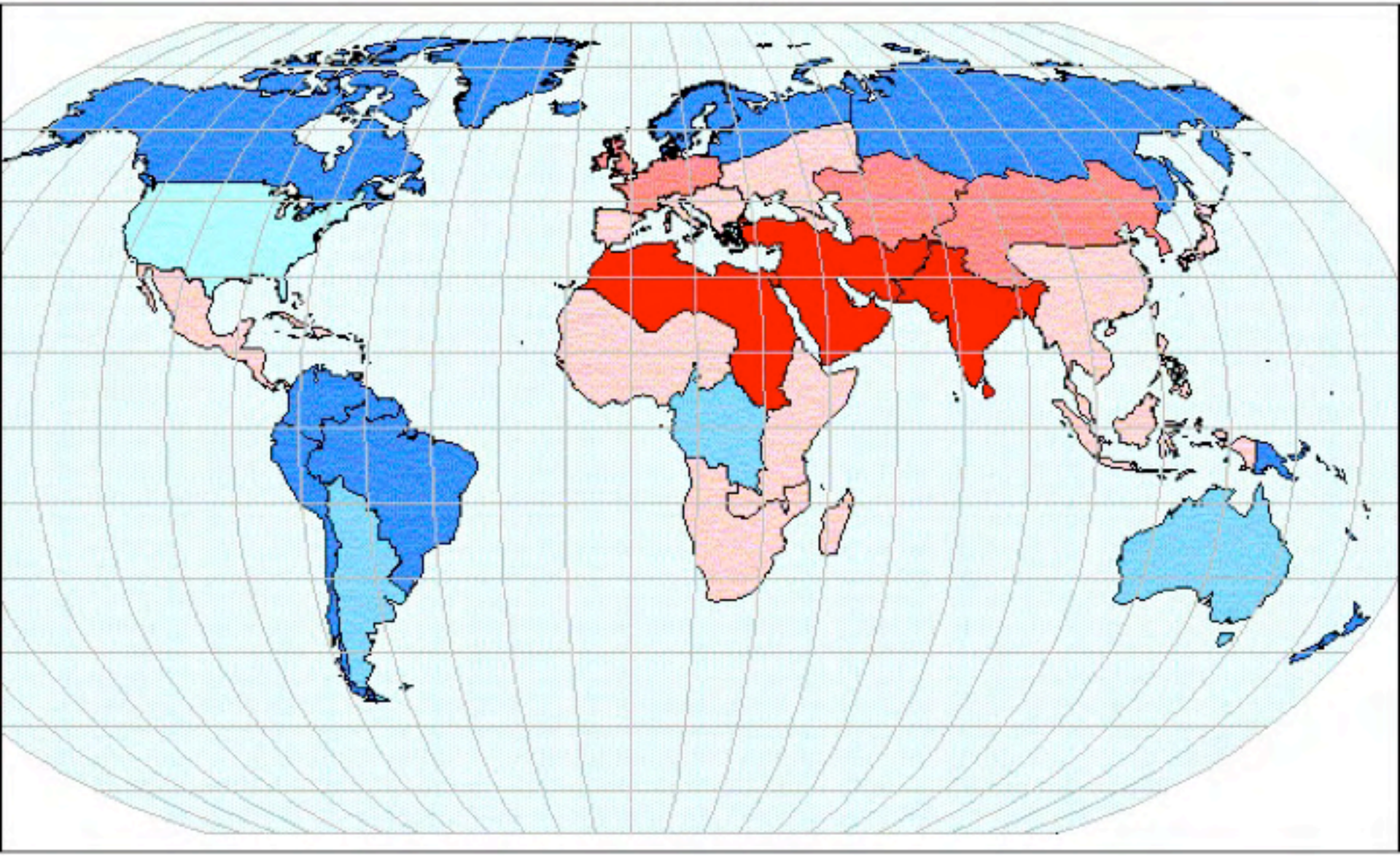
2005



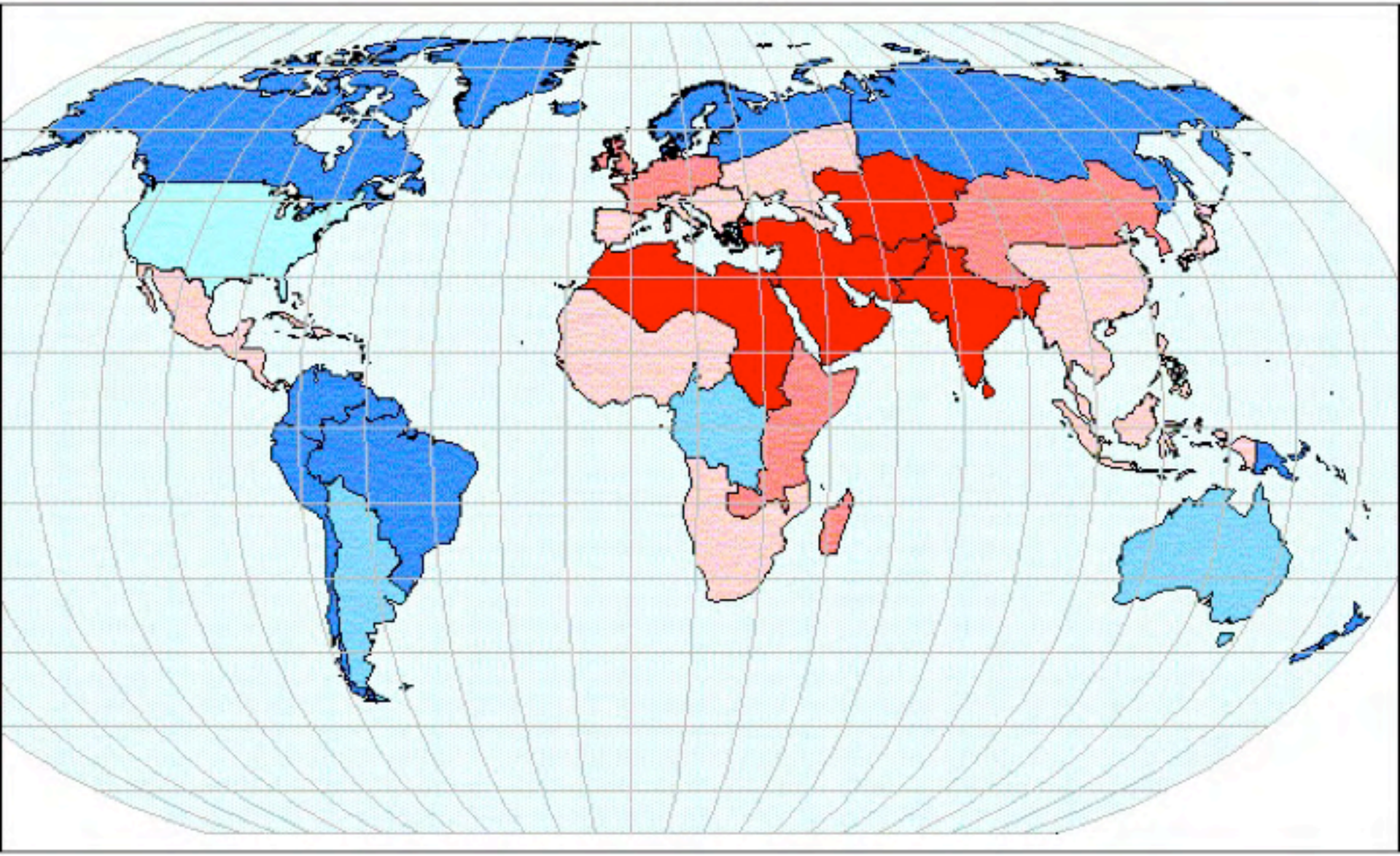
2010

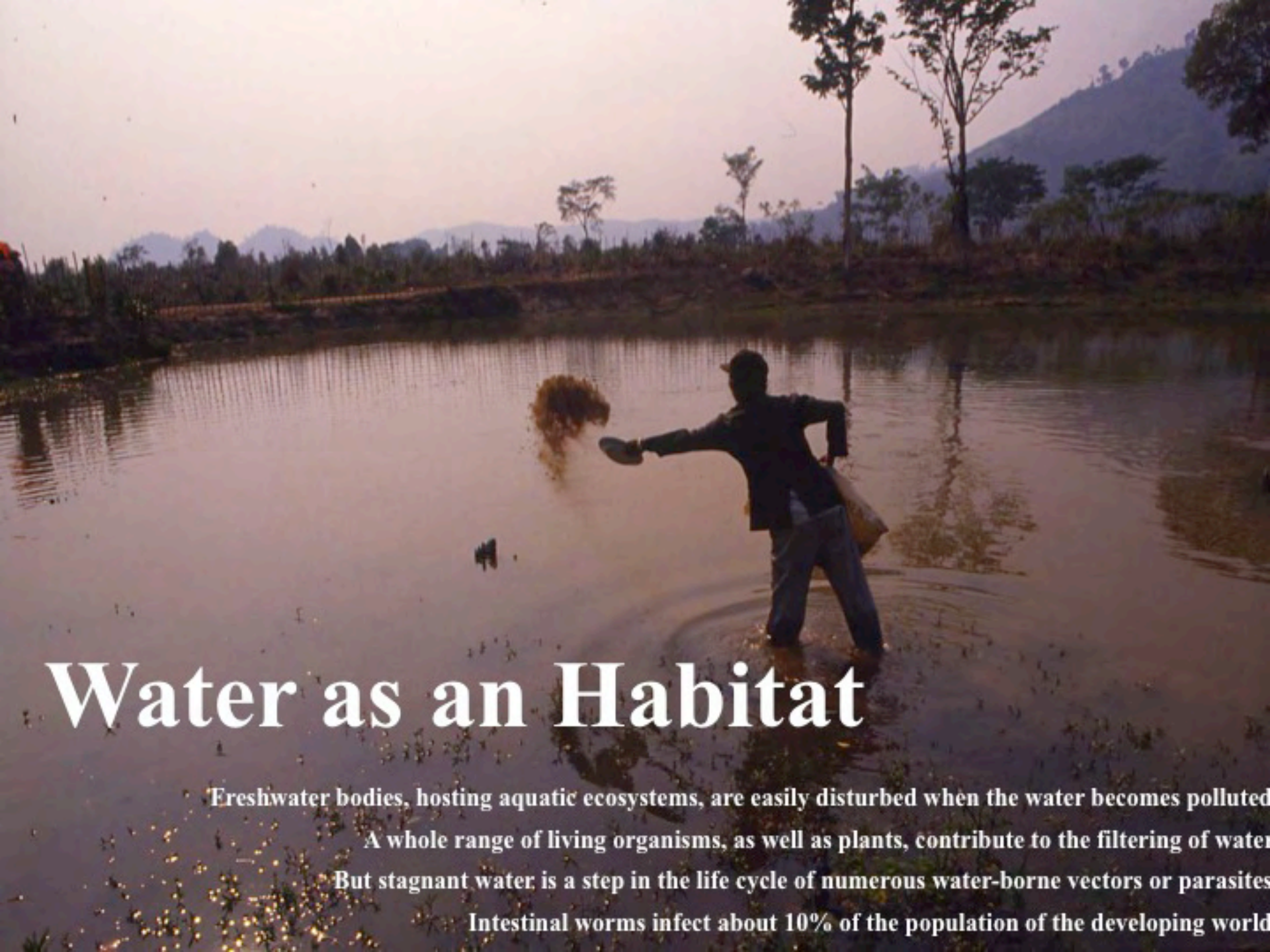


2020



2025





Water as an Habitat

Freshwater bodies, hosting aquatic ecosystems, are easily disturbed when the water becomes polluted

A whole range of living organisms, as well as plants, contribute to the filtering of water

But stagnant water is a step in the life cycle of numerous water-borne vectors or parasites

Intestinal worms infect about 10% of the population of the developing world

The Production function

Water is an important production factor.

When there is water, gardening, shelter, development of handicraft workshops and small factories are possible.

It contributes to improved social life and leisure, which can be linked with education and personal development.

The Carrier function

Water carries dissolved and suspended material picked-up by the mobile water
along its course through atmosphere, landscape and water sources
This function plays a central role in erosion and sedimentation of loose material
Of particular concern are the tropical soils, where more than 1200 mm of rain falls every year, as deforestation and changes in underground flows can result in the formation of lateritic crusts that can't be rehabilitated.

The Health function

Health status reflects the fundamental importance of safe drinking water as a basic pre-condition for socio-economic development.

Safe drinking water means acceptable chemical properties (low salinity, absence of toxic pollutants), and absence of bacteriological contamination

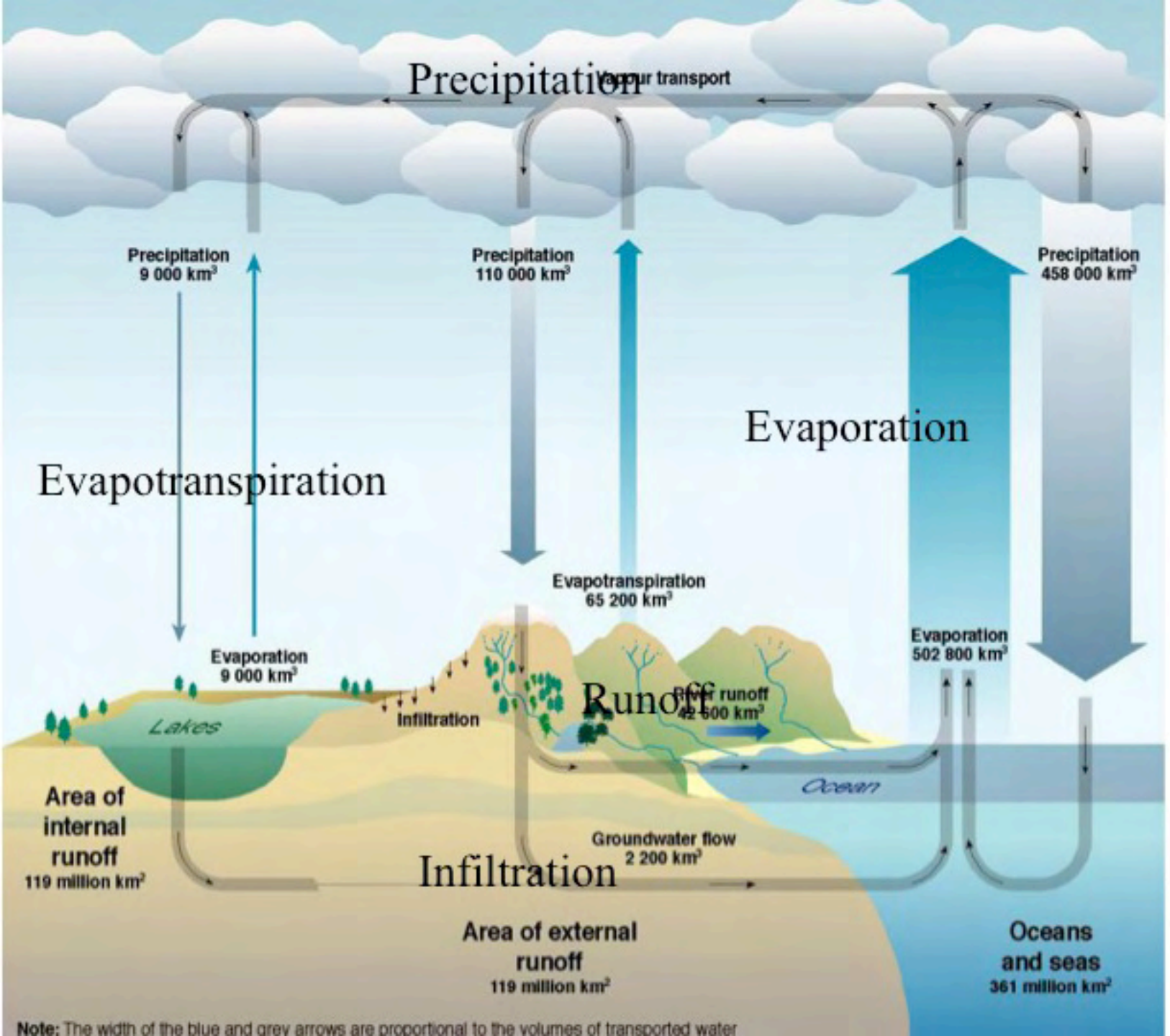
Approximately 4 billion cases of diarrhoea each year cause 2.2 million deaths, mostly among children under five, which is equal to 13 Jumbo jets crashing per day...

Find the water

- To find water, find data first
- Climatic constraints - dry or wet area
- Presence of surface water
- Remote sensing
- Hydrogeological investigations
- Geophysical survey - needs calibration based on existing surveys/databases

More water is better than the best water

- Often, in emergency operation, it is better to increase the water amount than its quality
- If you have a doubt, chlorinate the water
- Underground water is better than surface water - if you can have access to it
- The closer the water source is, the safer the water supply will be



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

Pro memoriam

- $P = E + EPT + R + I + \Delta S$, where
- P = precipitation
- E = Evaporation
- EPT = Evapotranspiration
- R = Runoff
- I = Infiltration
- And ΔS the variation of groundwater stock

When do disaster occur?

- When P is too low -> drought
- When P is too high -> floods
- When R is too high -> erosion, landslides
- When P and I are high -> landslides
- When EPT too low -> stagnant water -> outbreak of water borne disease
- When groundwater is decreasing and E and EPT too high, drying of land will end in severe drought

GIS Data structure

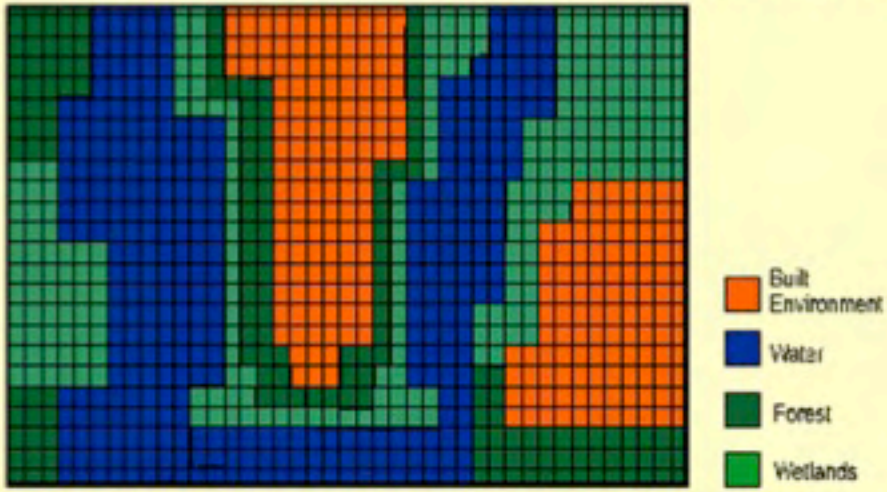
There are two fundamental type of data:

raster (composed of pixels) and

vector (composed of paths).

Raster data originate from RS and scanned maps, while Vector data are processed from a variety of sources

The Raster View of the World



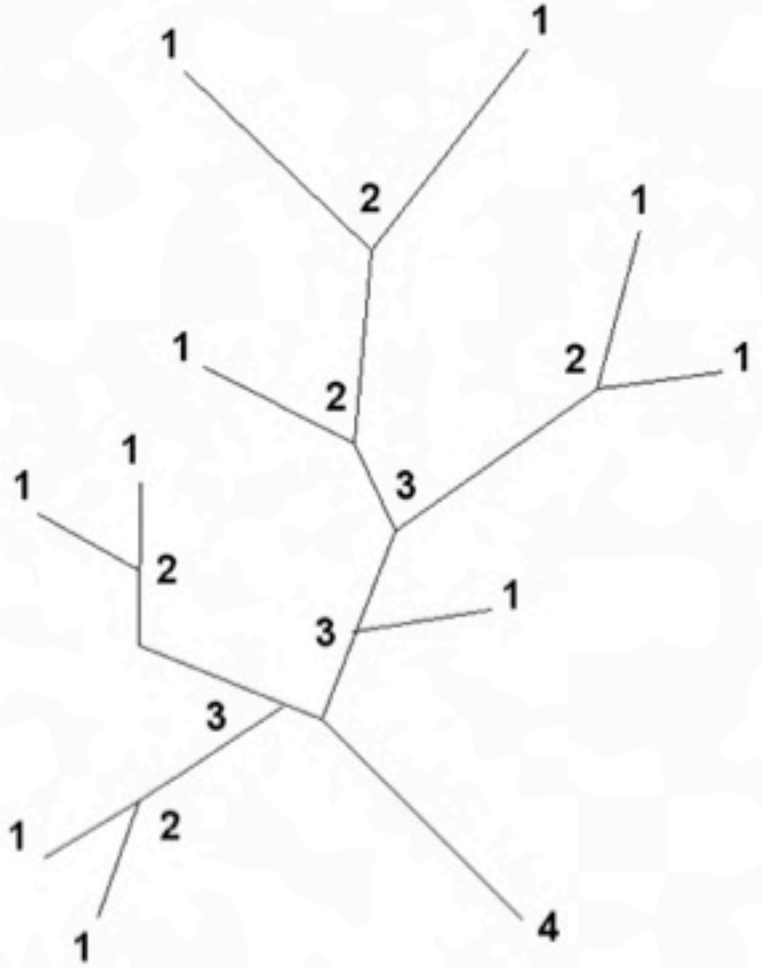
The Vector View of the World

Watersheds and rivers - raster

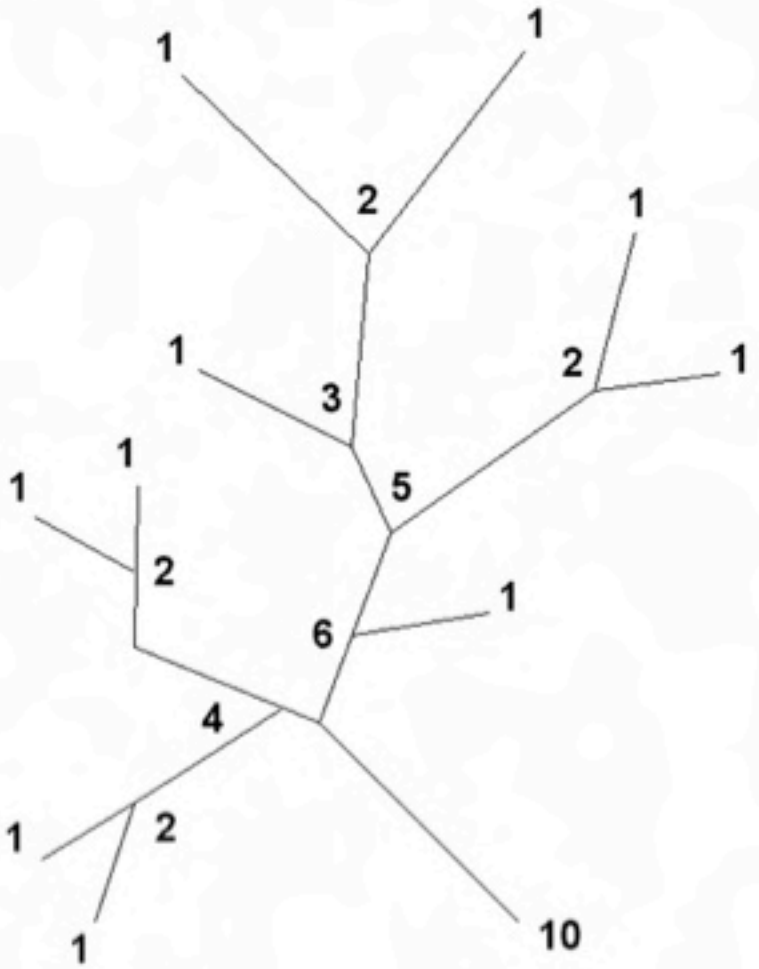
- With a DEM, it is also possible to extract on an automated basis the watersheds, the sub-basins, the network and to order it according to Strahler of Shreve ordering system
- The first example is the automatic treatment of a network in raster mode

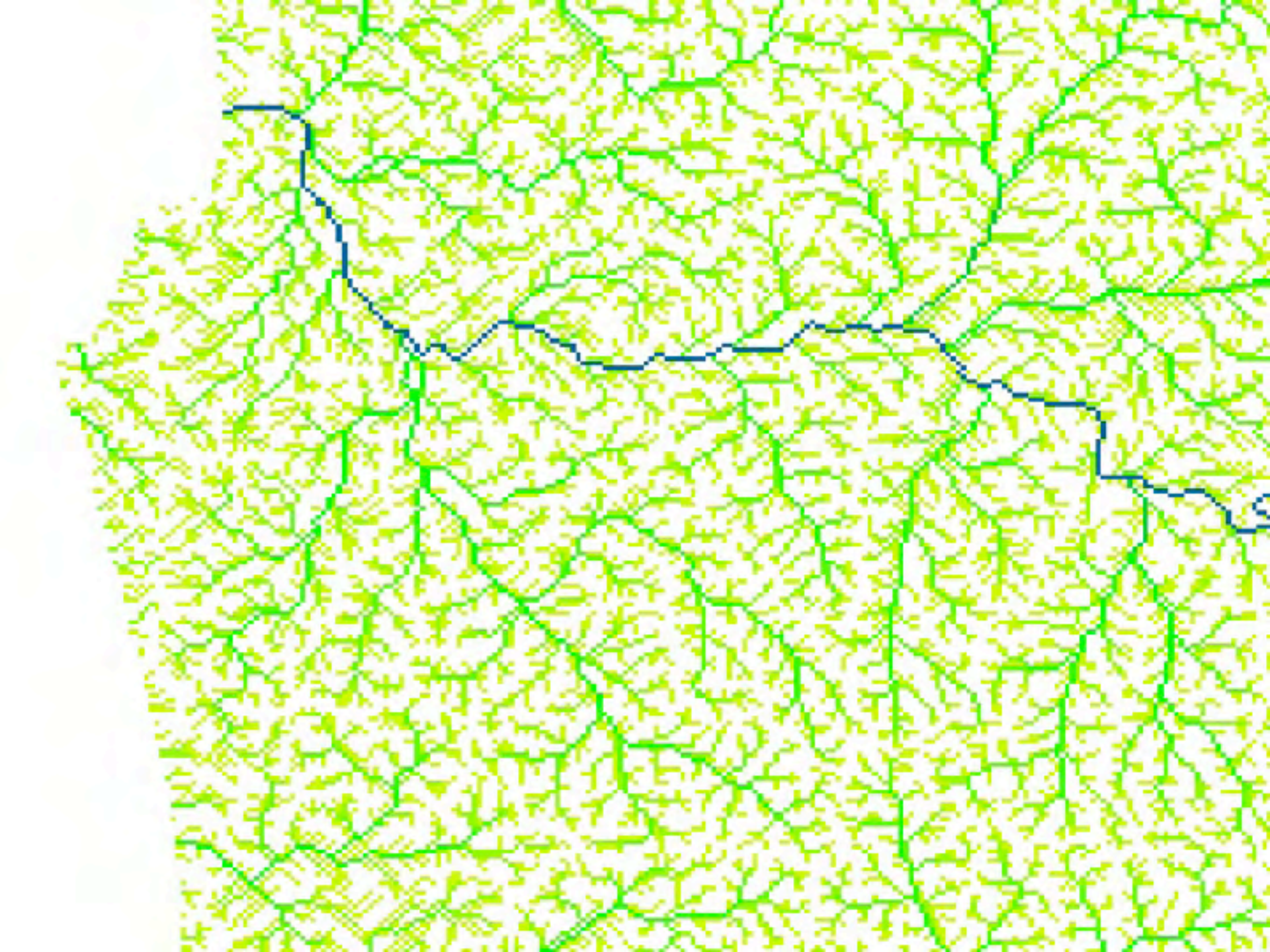
Ordering networks

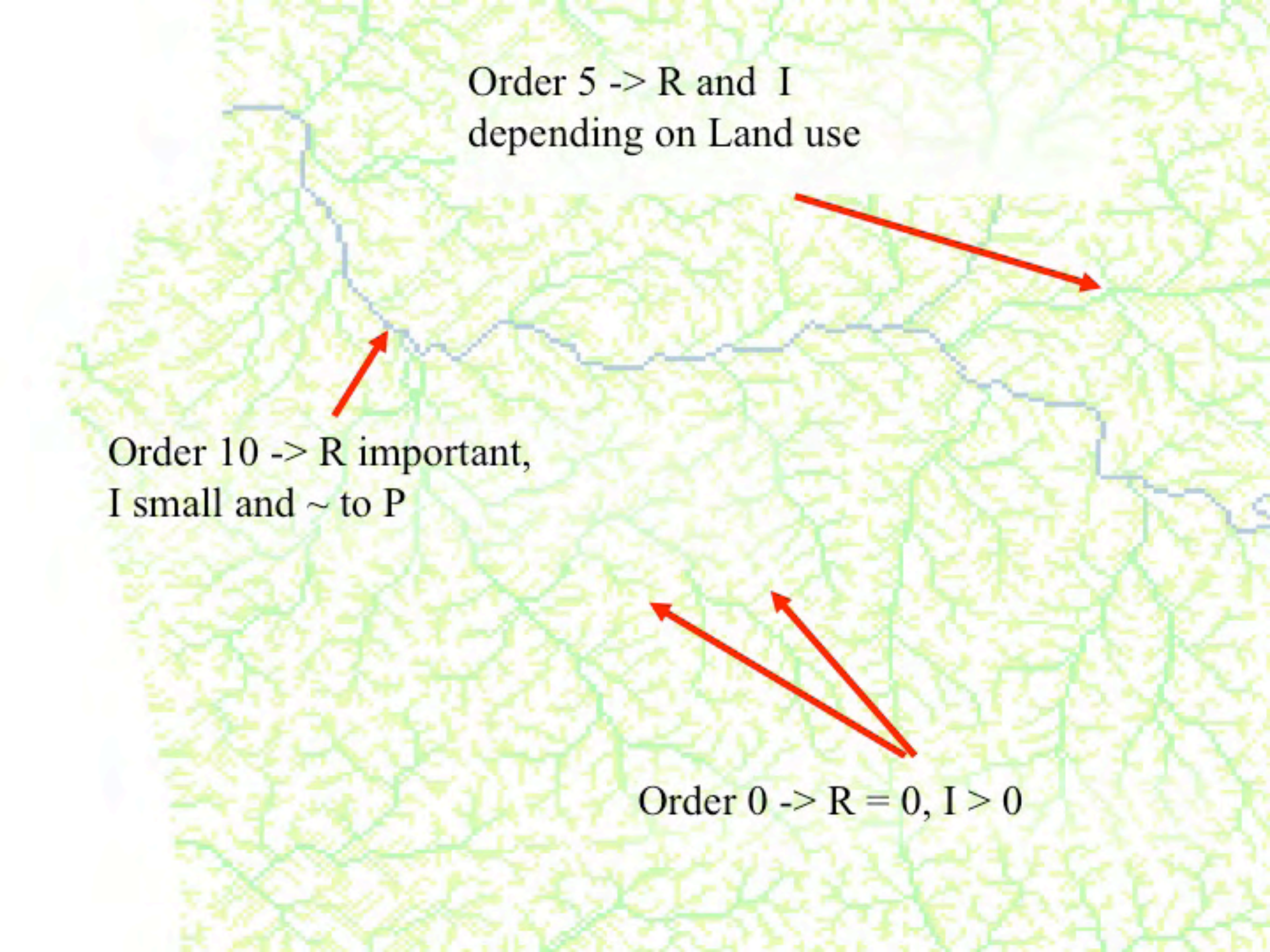
Strahler Index



Shreve Index



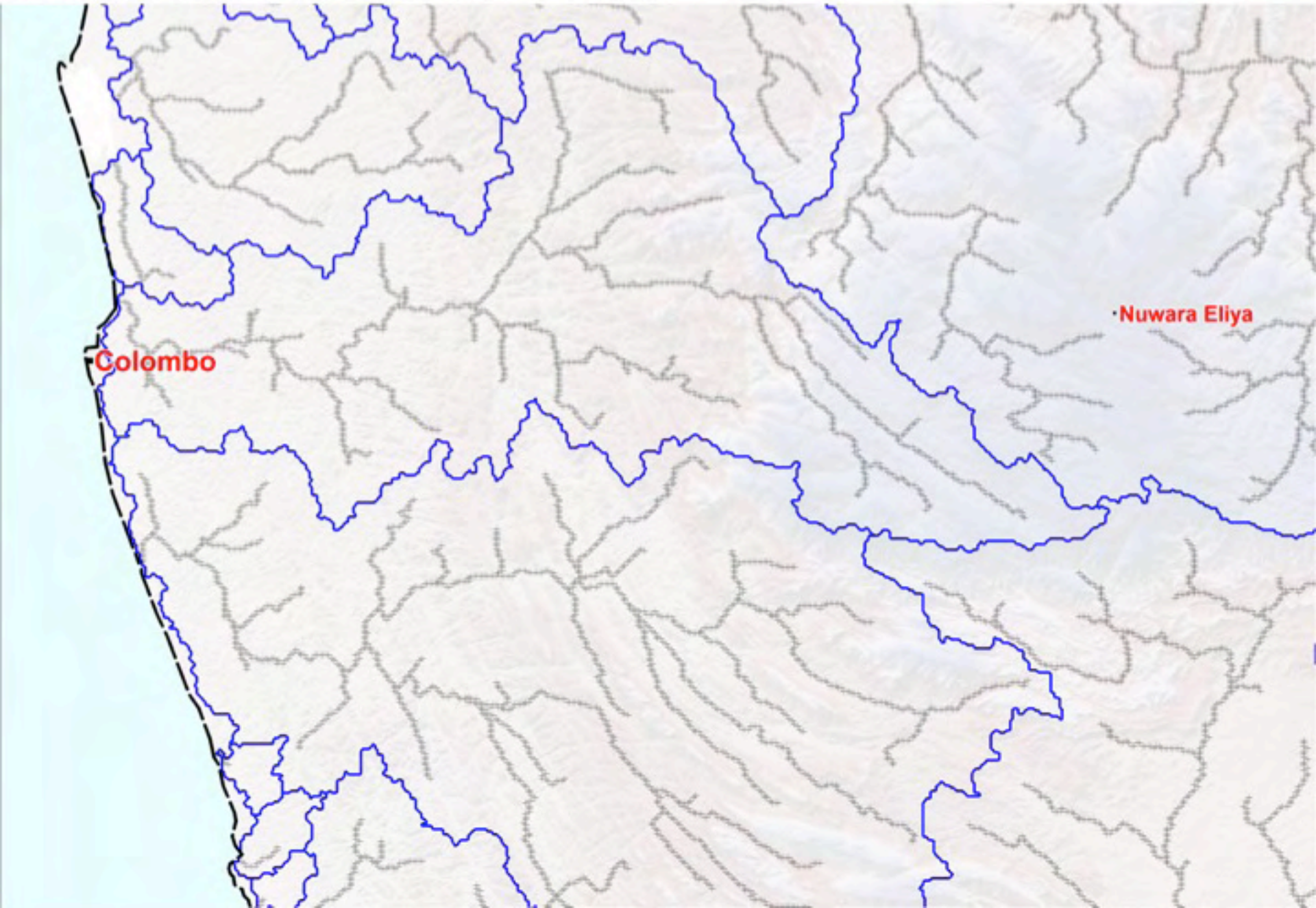



Order 5 -> R and I
depending on Land use
Order 10 -> R important,
I small and ~ to P
Order 0 -> R = 0, I > 0

Watersheds and rivers - vector

- The second example is the automatic treatment of a watershed in a vector mode, which allows different mathematical analysis if data
- Within each watershed, the rivers can be computed, which in turn allows analyses only based on the spatial relationships between the different branches in a network

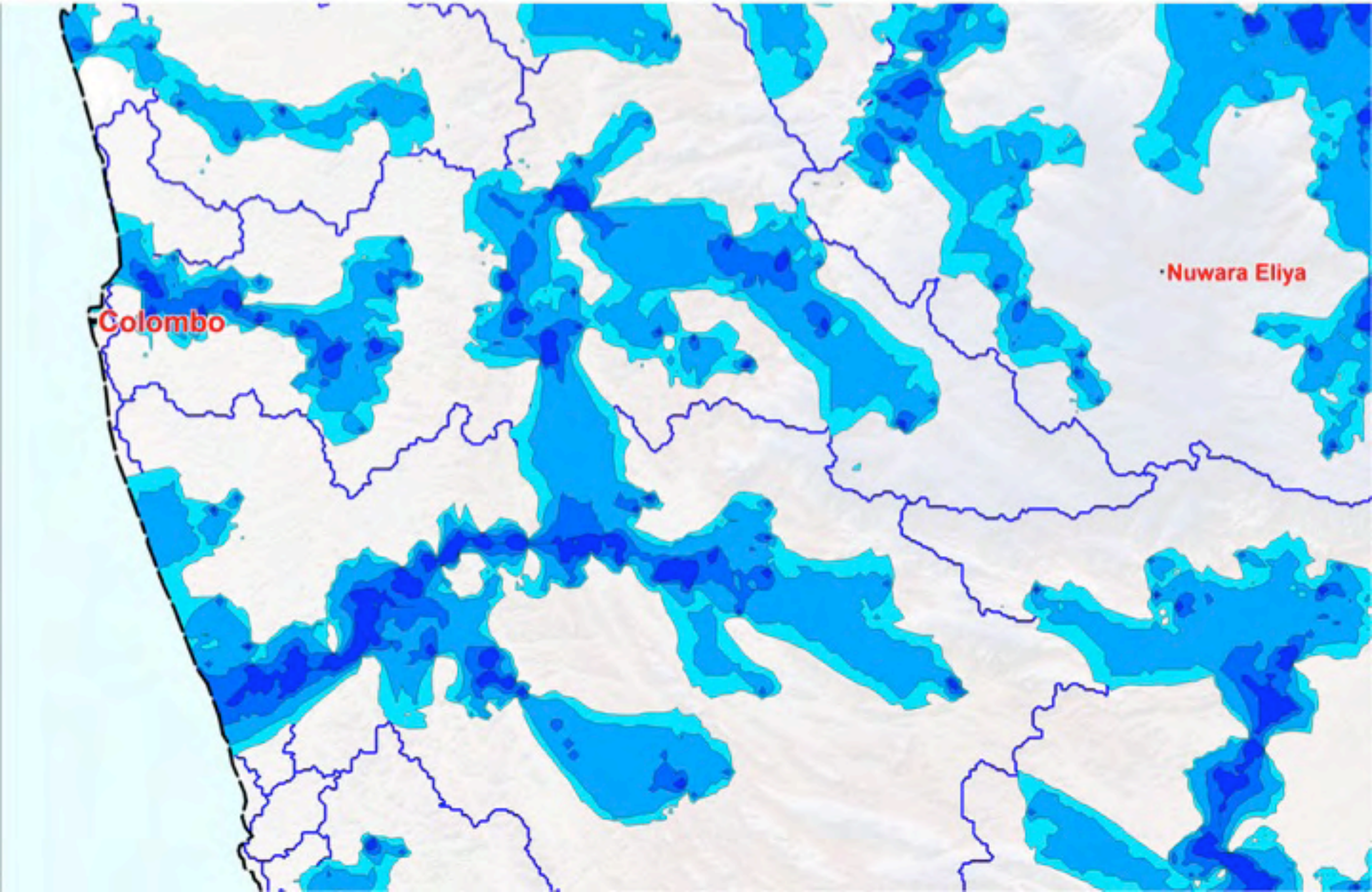
Discretized network



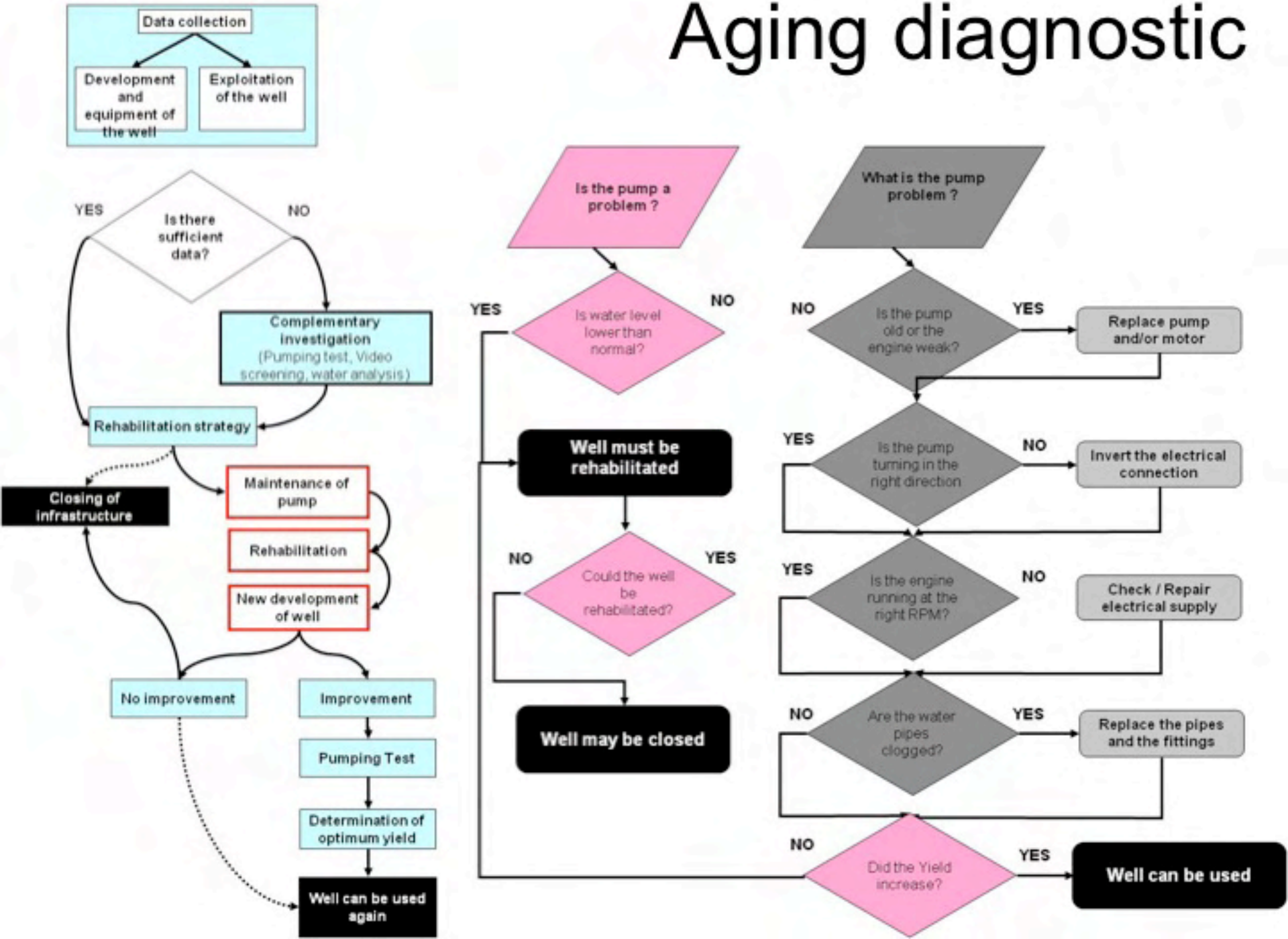
River network analysis

- The river network has been disaggregated in nodes
- Each node was numbered with the highest value of the branches joining there
- Interpolation based on the Inverse Distance Weighting (proximity only) evaluates the flooding potential in case of heavy rain
- Interpolation based on Kriging (a combination of distance and weight based on value) allows to estimate the potential groundwater recharge

Flooding potential



Aging diagnostic



IWRM

Possible inputs from RS studies and use of GIS when water availability is at stake

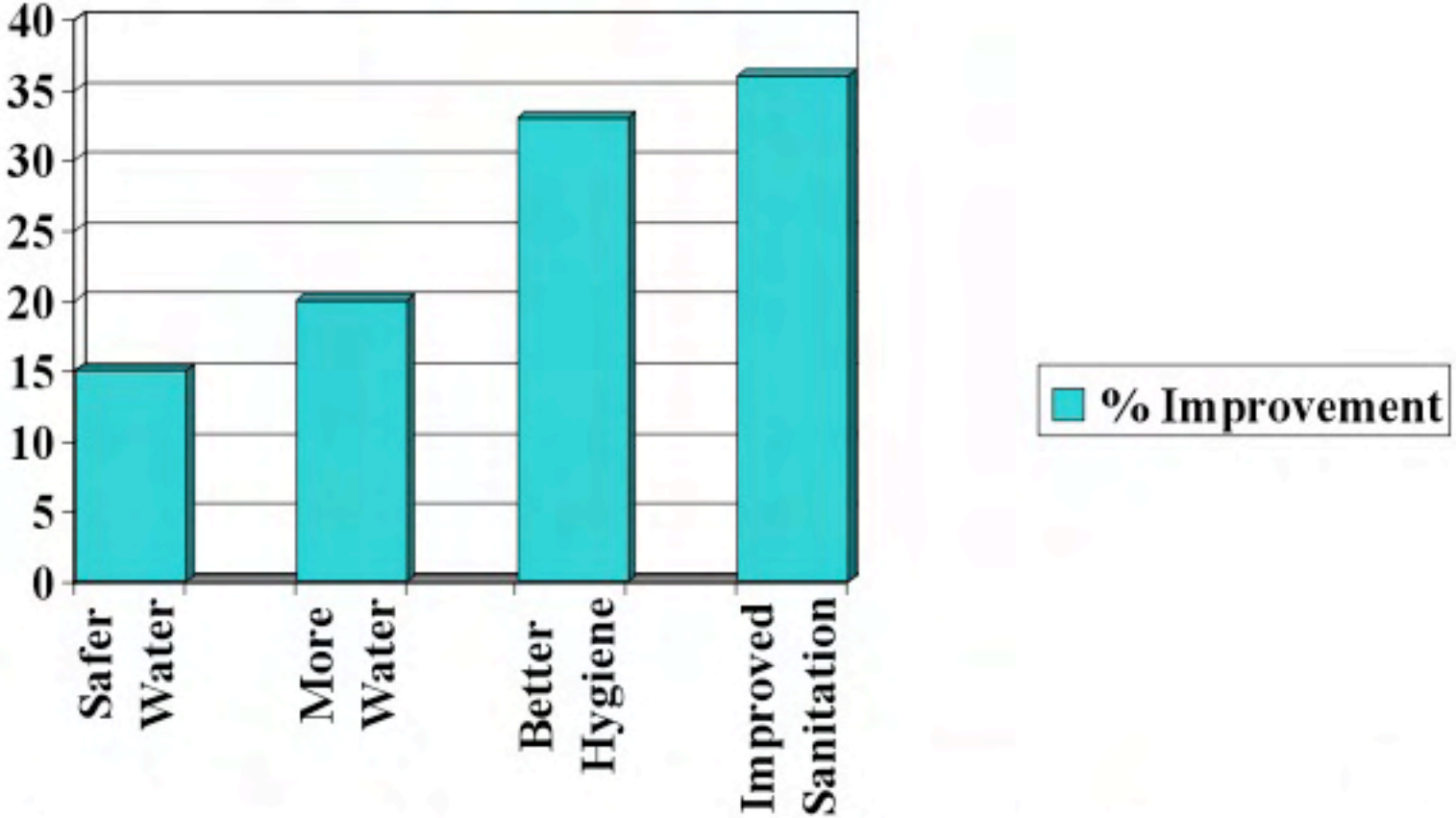
Emergency Sanitation

- The red and the blue blood - what to do with dirty water
- The yellow water - gold to recycle
- The brown water - the killer to control
- From defecation fields to communal latrines to family latrines
- Cholera Treatment Centres
- Cemetery, too often forgotten in Site Planning

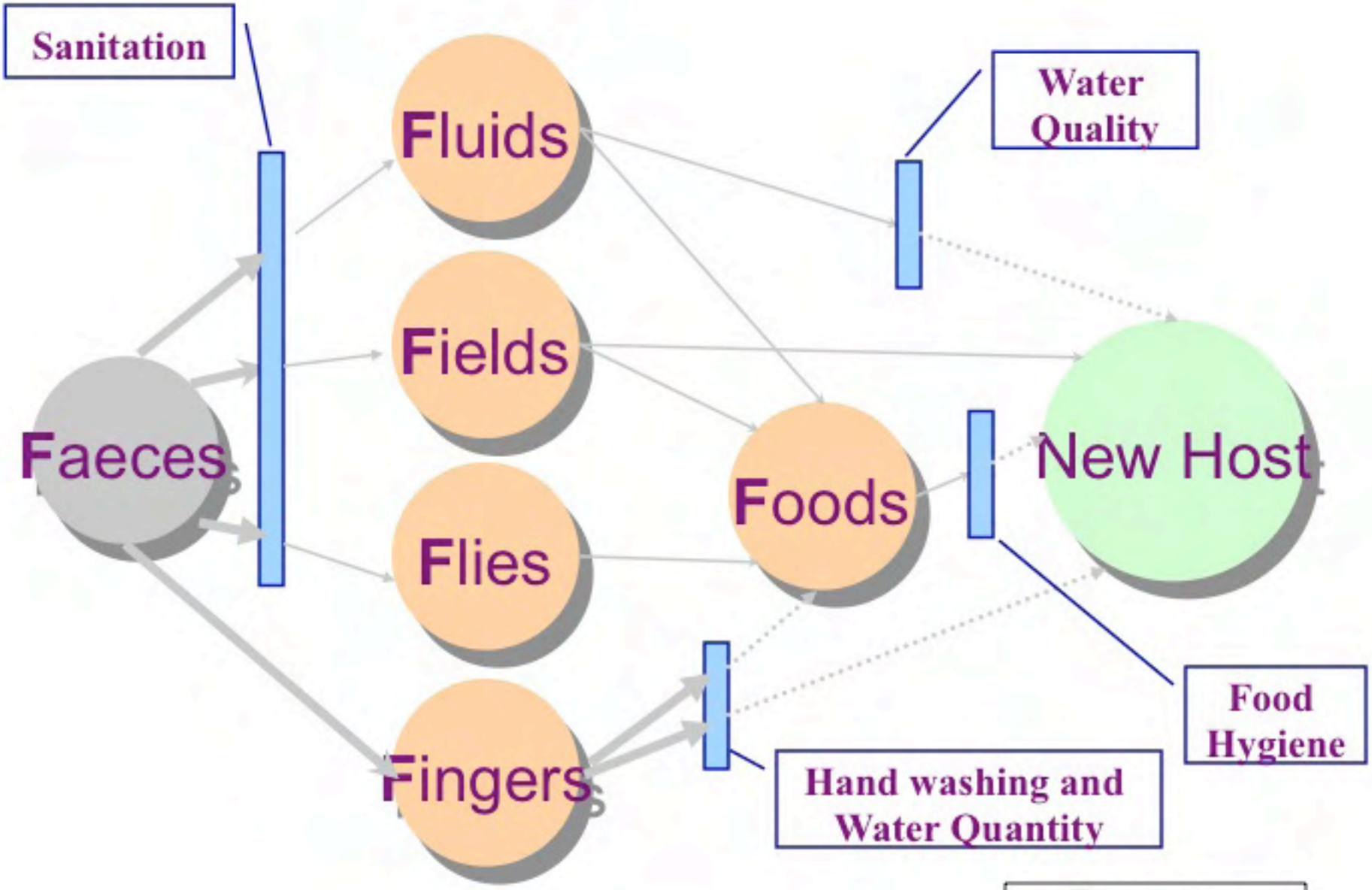
Assessment of Risk

- People drinking contaminated water
- Excreta not disposed of adequately
- People not washing hands at key times
- Poor drainage
- Caretakers unaware of how to manage diarrhea or malaria

Relative Impact of Different Water and Sanitation Interventions



From: Esrey, SA (1996) No Half Measures, Waterlines Vol 14 No 3 IT Publications London


Sanitation
Fluids
Water Quality
Fields
Faeces
Foods
New Host
Flies
Fingers
Food Hygiene
Hand washing and Water Quantity

Water or Sanitation ?

- Please analyse the next table and draw some useful conclusions –
- Draw some general conclusions
- What would you advise to do in Zimbabwe and Malawi ?
- A note of caution – these are old data and not related to the current cholera outbreak

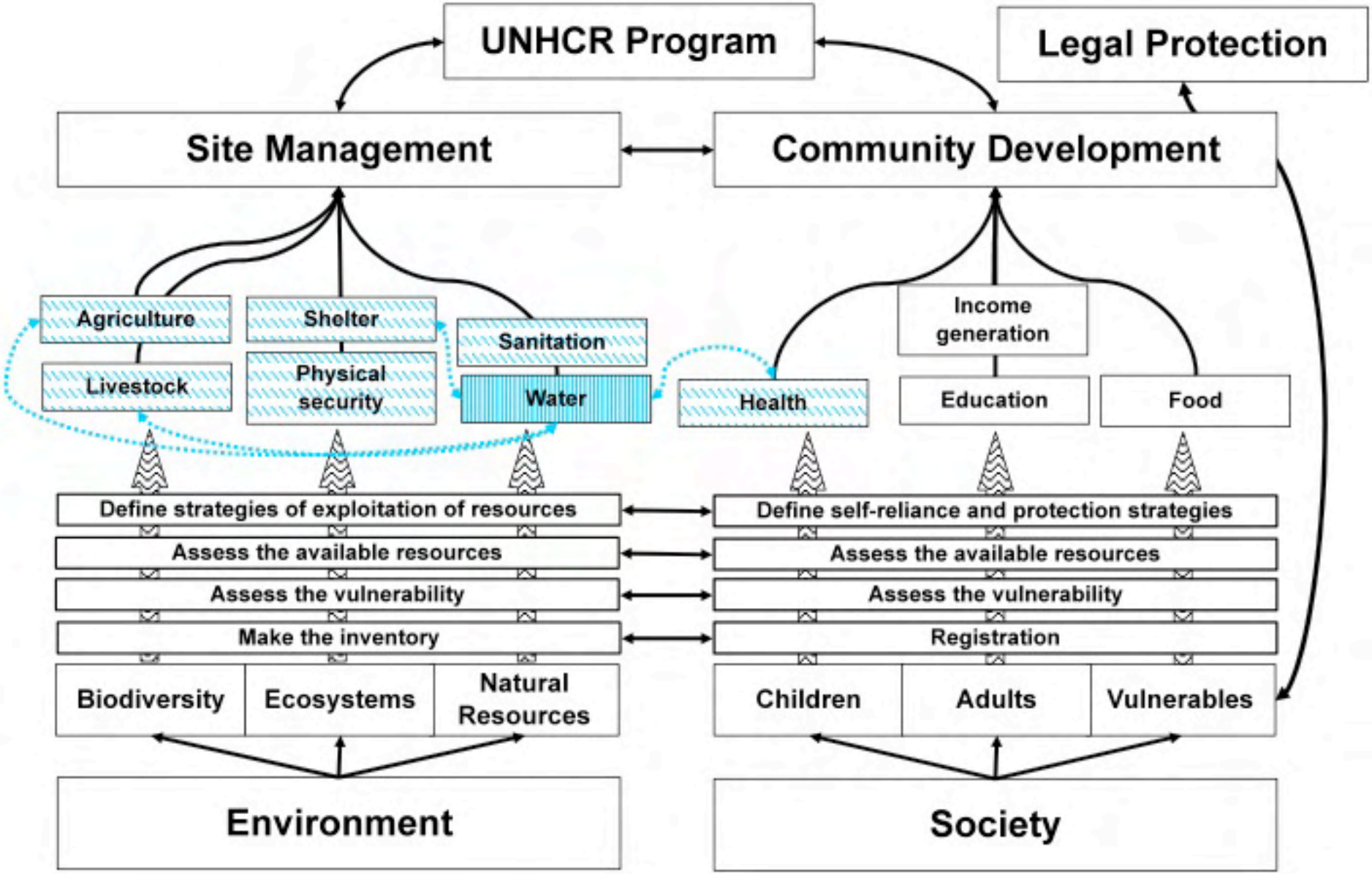
Mozambique Refugees, 1992

	Chambuta, Zimbabwe	Lisungwe, Malawi
Diarrhea Mortality (/10,000/day)	1.5	0.25**
Water Availability (l/p/d)	17	11
Chlorination	100%	20%
Persons/latrine	290	14

Is sanitation more important than water?

- We must always consider both aspects
- More human activites are based / focus on water issues
- But it's a natural resource, following its own pattern of evolution in time…

Site Planning



And now an exercice

- You will now receive data representing the results of a percolation test conducted in a site where you are supposed to develop a refugee camp for 20’000 people.
- Please make a proposal for the optimum number of latrines to be dug there before the refugees will be resettled to the new camp