Acacia Institute

Solutions in Groundwater

Sustainable Development of Water Resources on Small Islands by optimizing local available water resources, storage options and renewable energy

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1 Acacia Institute

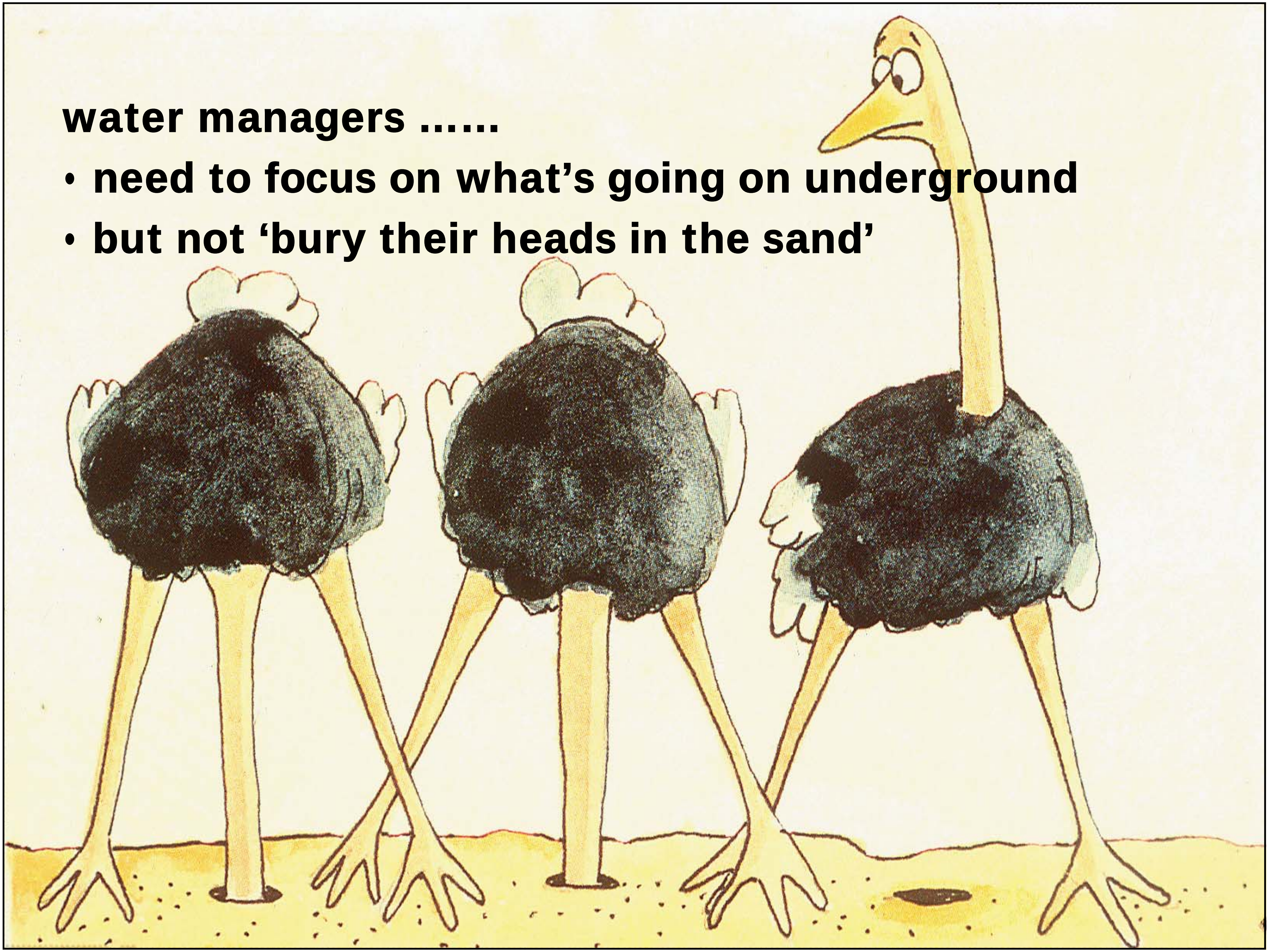
- Self-supporting foundation associated with the Vrije Universiteit Amsterdam
- Launching platform for new and innovative solutions in groundwater management
- International scope, operating as a network organization
- Four themes:


Groundwater and coastal lowlands

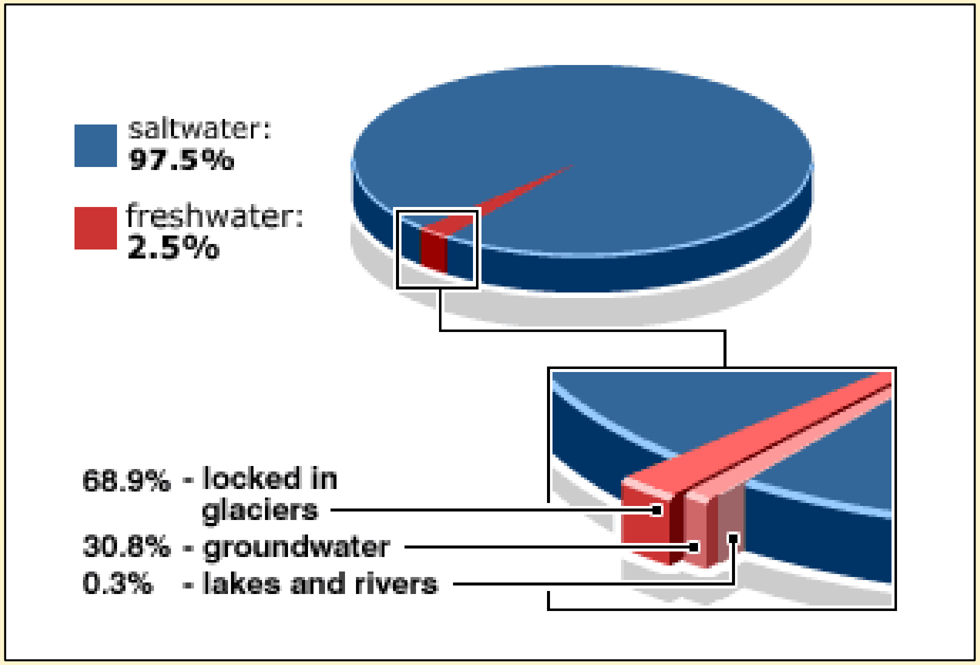

Groundwater and climate change


Training and education


Groundwater and small islands

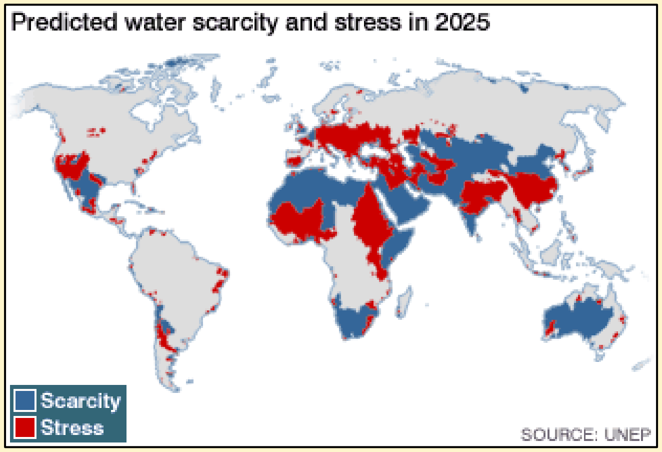

water managers ……
• need to focus on what’s going on underground
• but not ‘bury their heads in the sand’

2 Importance of groundwater



- 20% of the water used worldwide comes from groundwater (600- 700 km^3)
- Much of it from shallow aquifers (UNDP)
- Many rural dwellers depend entirely on groundwater

Water scarcity



- Growing use of fresh water per capita, increased pressures and impacts of climate changes require new development strategies for (ground)water resources
- In particular small islands face an increasing constraint of freshwater resources, both in terms of quantity and quality.
- Options for fresh water supply limited to groundwater development and rain water harvesting

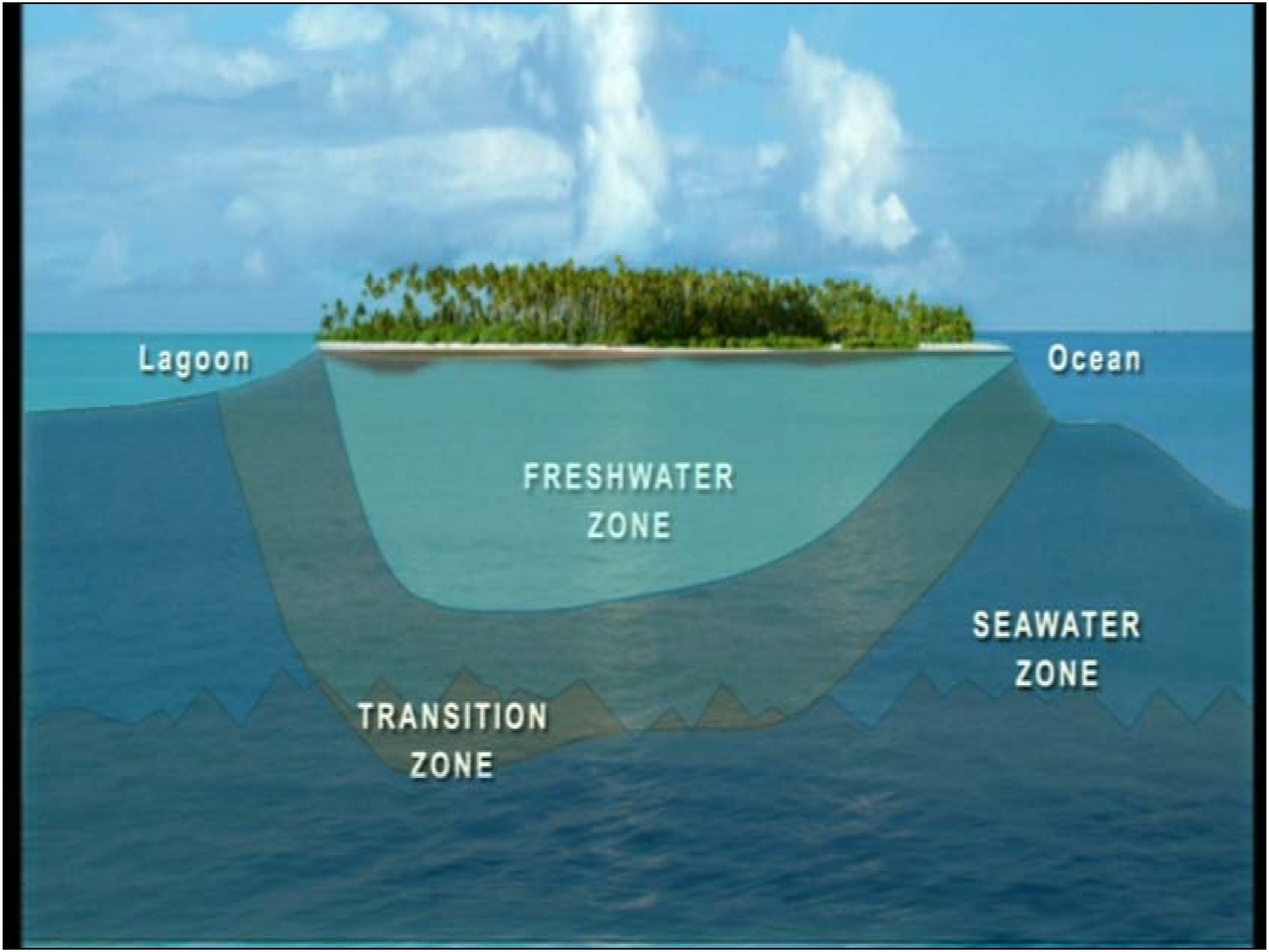
3 Small island and water resources

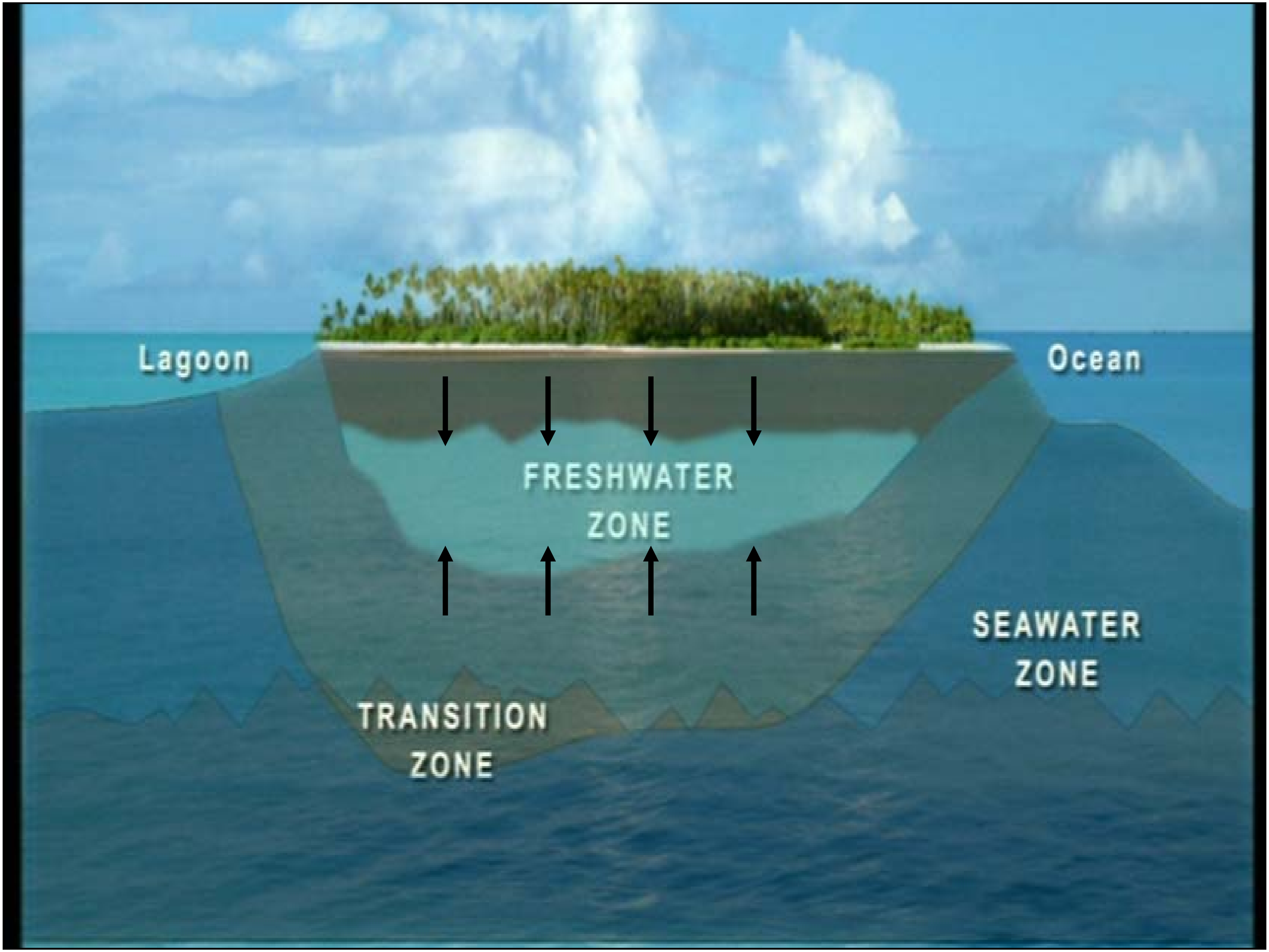
- small size, and specific geologic, topographic and climatic conditions
- socio-economic characteristics offer specific limitations and opportunities to water resources development – high demographic pressures (high water demand)
- Limited surface areas and natural resource base (arable land, freshwater, conventional energy sources)
- Sensitive to natural disasters and sea level rise
- Face difficulty in managing the water resources

→ ***High vulnerability of water resources***

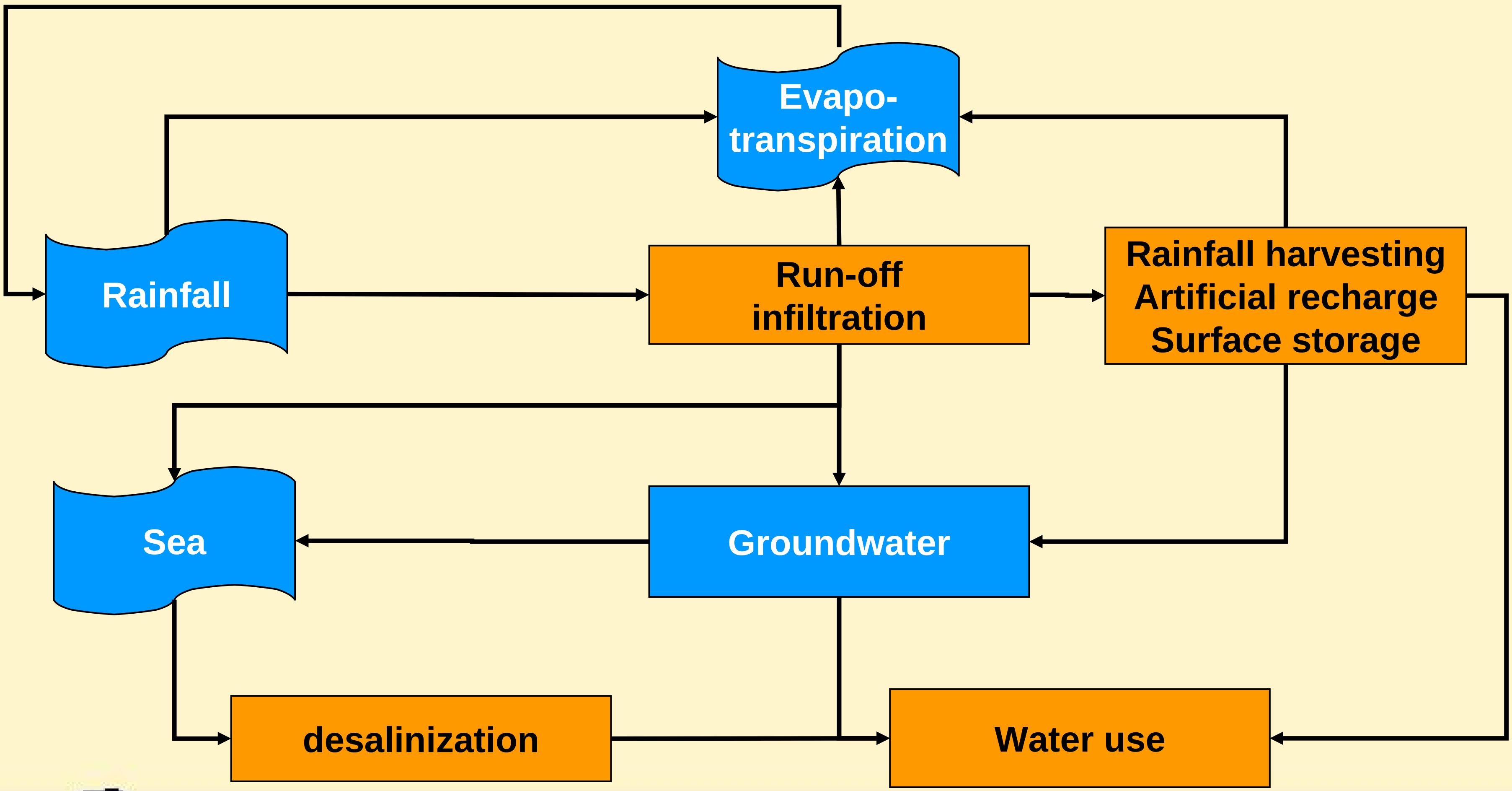
Fresh water availability

- Many islands face freshwater shortage (all freshwater originates from rainfall)
- Often a limitation to economic development (tourism)
- Limited possibilities for water storage
- Existing local water resources are often under-developed whereas traditional water conservation techniques disappear
- Fresh water lenses can deplete in dry season, even without pumping
- Seawater intrusion and (in)organic contamination pose serious threat to water quality
- Other sources can be desalinated brackish/salt water, treated wastewater, artificial recharge or importation


Lagoon
Ocean
FRESHWATER ZONE
SEAWATER ZONE
TRANSITION ZONE


Lagoon
Ocean
FRESHWATER ZONE
SEAWATER ZONE
TRANSITION ZONE

Water balance



4 Options for water resources development; Acacia approach

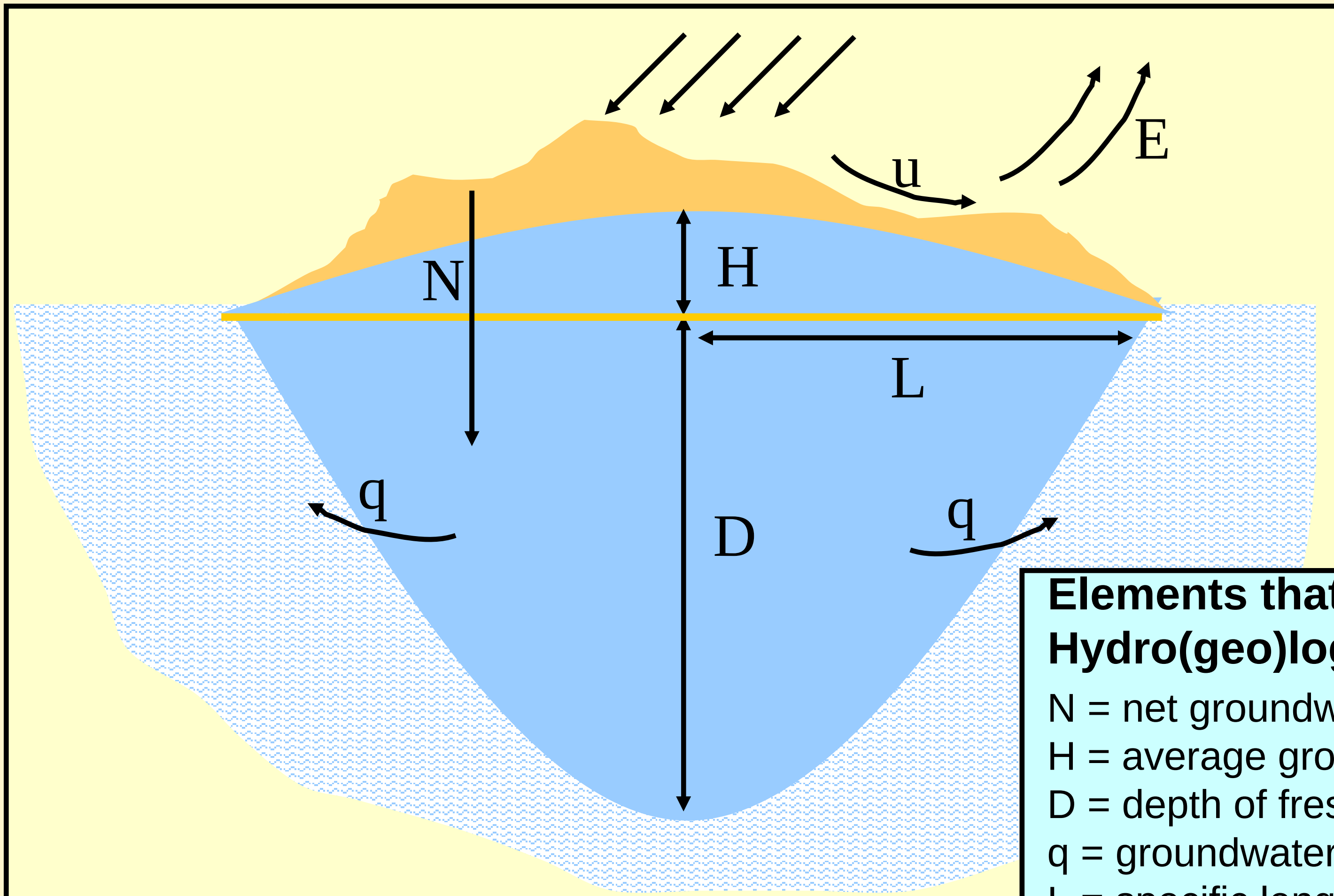
Quick scan

- Characterization of hydro(geo)logical conditions, based on existing information and quick field survey
- Systematic overview of water resources and potential development options
- Assessment of socio-economic aspects – demand for water resources (present and future)

Methodology

- Collection of existing information on:
  - water flows,
  - water quality,
  - geology,
  - changes in climate variability,
  - vegetation and land use,
  - present and future water demands and
  - sectoral development plans
- Field data collection including infiltration tests, geophysical surveys, groundwater level, water quality, mapping of land use and vulnerability mapping

Assessment of resources



Elements that describe the Hydro(geo)logical conditions

N = net groundwater recharge
H = average groundwater level
D = depth of fresh/salt water interface
q = groundwater outflow
L = specific length of aquifer
u = run-off
E = evapo-transpiration

Options

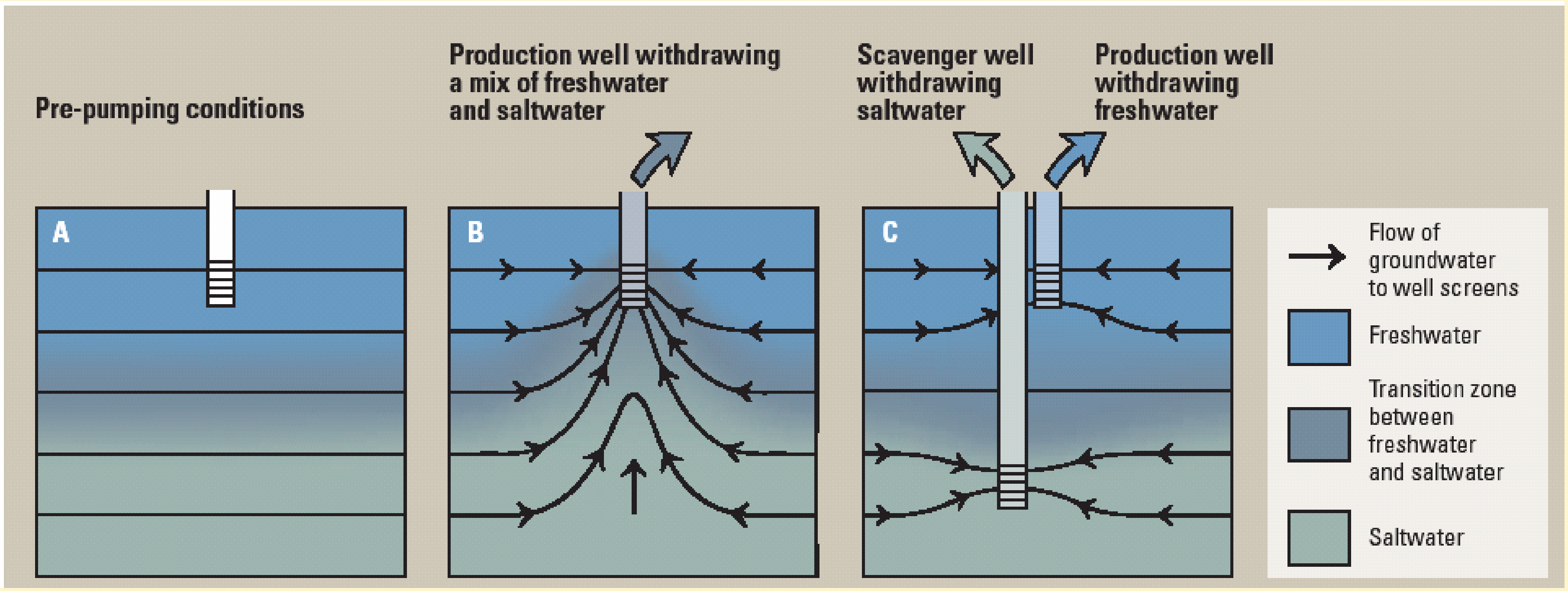
1. Optimizing sustainable use of groundwater resources
   - Minimizing groundwater outflow (lost to sea)
   - New exploitation methods, such as horizontal wells
   - Maintain quality
2. Reduce surface run-off (storage)
   - Water harvesting
   - Artificial recharge
3. Other
   - Bio-saline agriculture
   - Desalinization
   - Use of renewable energy

4.i Groundwater Resources

Given by groundwater recharge (potential available)

1. Mainly depends on rainfall, evapotranspiration, surface run-off and geology
2. Favorable conditions are:
   - High rainfall intensity exceeding evapo-transpiration
   - High infiltration rates that reduce run off
   - Accumulation (natural and artificial) to increase infiltration

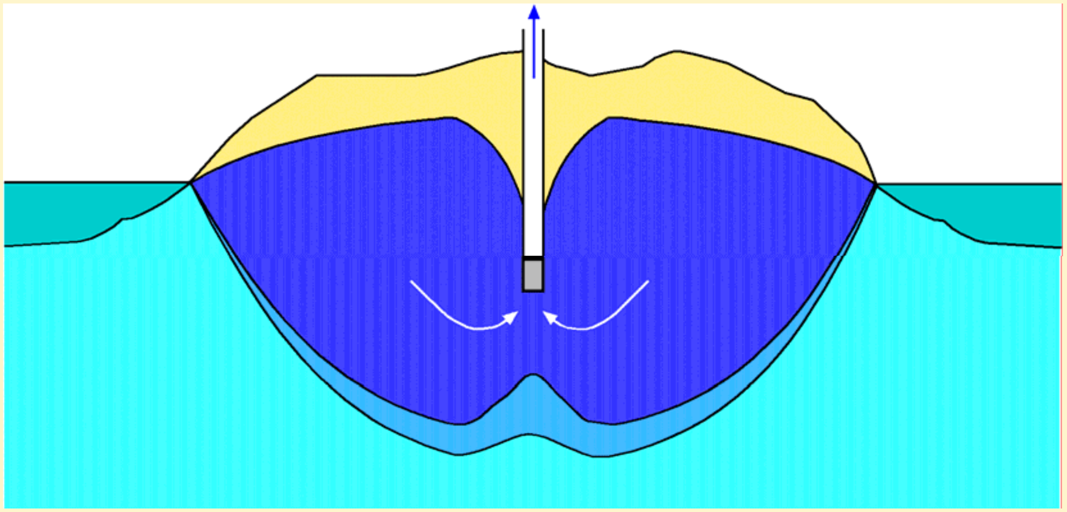
Example of practice; scavenger well

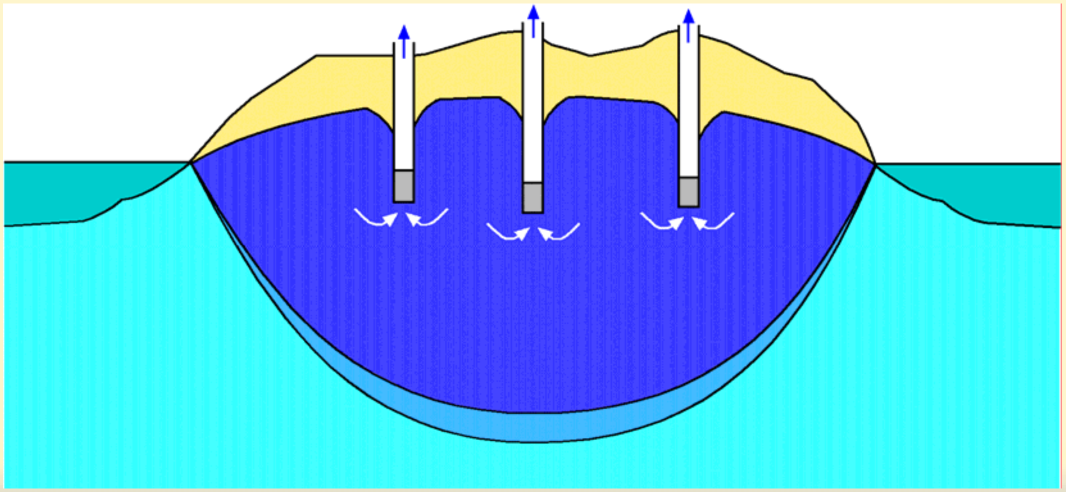


- Greater quantities of fresh groundwater continuously
- effluent must be discharged to the sea or deep wells – or used for some non-potable water use

Allen L. Zack,UNDESA

Extraction practices





4.ii Options to reduce surface runoff

- Rainwater harvesting
  - Roof catchments
  - Bench terracing
  - Contour bunds
  - Percolation tanks
  - dams
- Managed Aquifer Recharge & Storage MARS
  - possibilities for the use of the underground for temporary storage of excess water
  - Sustainable use of resources
  - Improve quality

Examples of MARS

		Names used	Countries examples
1	**Village level gravity injection**	Dug wells, recharge shafts, village tanks, trenches, gravity injection wells	China, India, Thailand
2	**In-channel structures**	Gabions, percolation tanks, subsurface dams, sand-river dams, recharge dams	Egypt, India, Kenya, Namibia, Oman
3	**Off channel infiltration ponds**		Egypt, The Netherlands, Taiwan, South Africa
4	**Pressure injection**	aquifer storage and recovery wells (ASR)	Australia, Mexico, USA
5	**Induced Bank infiltration**		Germany, Hungary

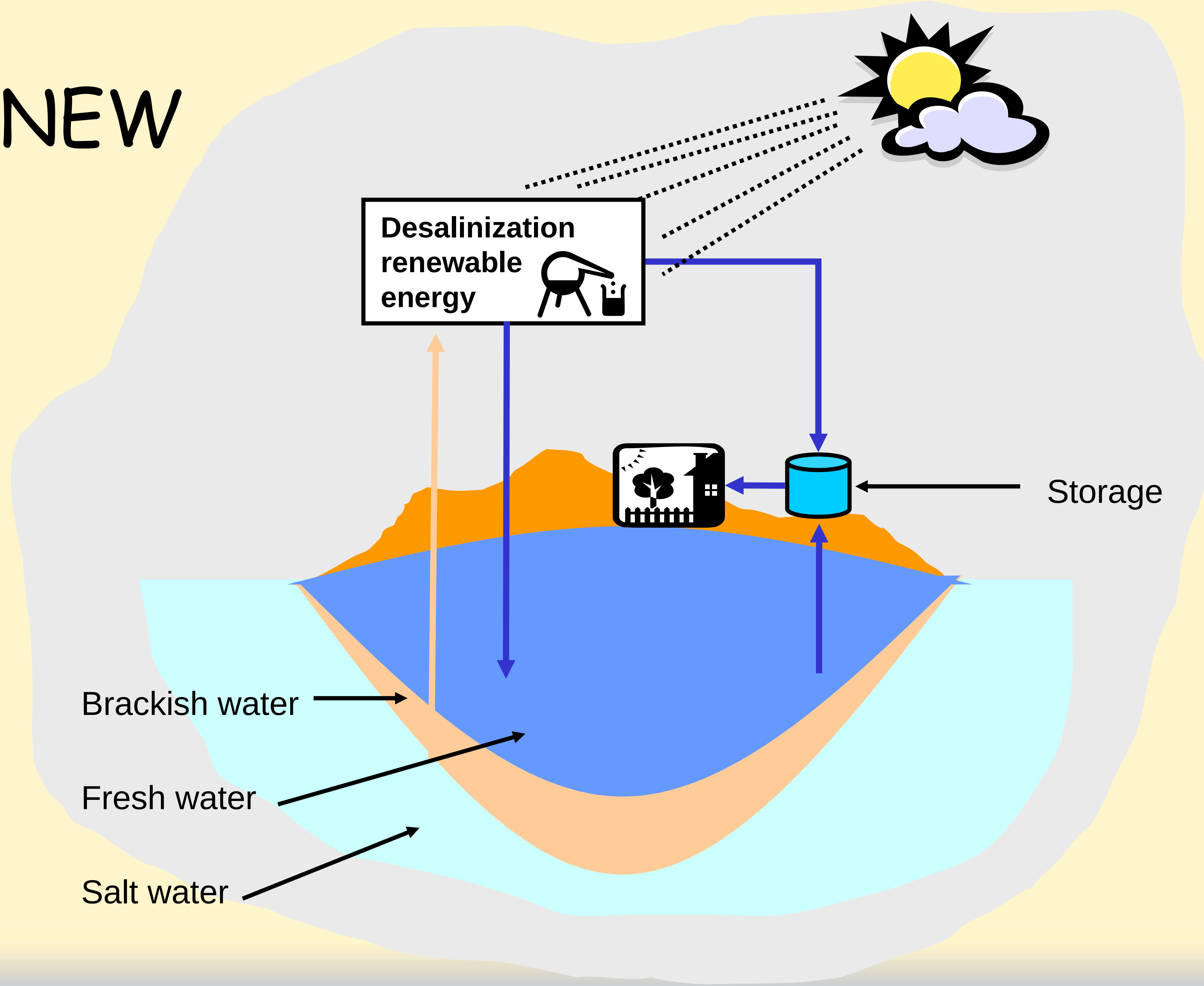
4.iii Other options

- Desalination of brackish groundwater as a source of water for drinking water, agriculture and livestock
- Treating wastewater for non-potable water
- Importation – pipelines, transporting
- bio-saline agriculture
- combination with renewable energy sources (sun, wind, tides)

RENewable Energy and Water sources (RENEW)

- Integrated small scale system of wells, dams, windmills, solar panels and reverse osmosis units
- storage is the key word in definition of these systems
  - subsurface storage of storm flow water in areas with a strongly seasonal climate.
  - subsurface storage of treated or desalinated water in periods of energy supply and little demand
- Typical capacities of RENEW systems:
  - 500 to 5000 m^3/day,
  - serve communities of 4000 to 40000 people
  - 6 to 120 hectares of irrigated cash crops
- Fine tuning of components crucial to guarantee success

RENEW


Desalinization renewable energy
Storage
Brackish water
Fresh water
Salt water

What are the quick scan results ?

- An integrated “water map” of the island
- Recommendations for development of relevant options
- Monitoring requirements for sustainable exploitation of the resources
- Formulation of activities needed for implementation