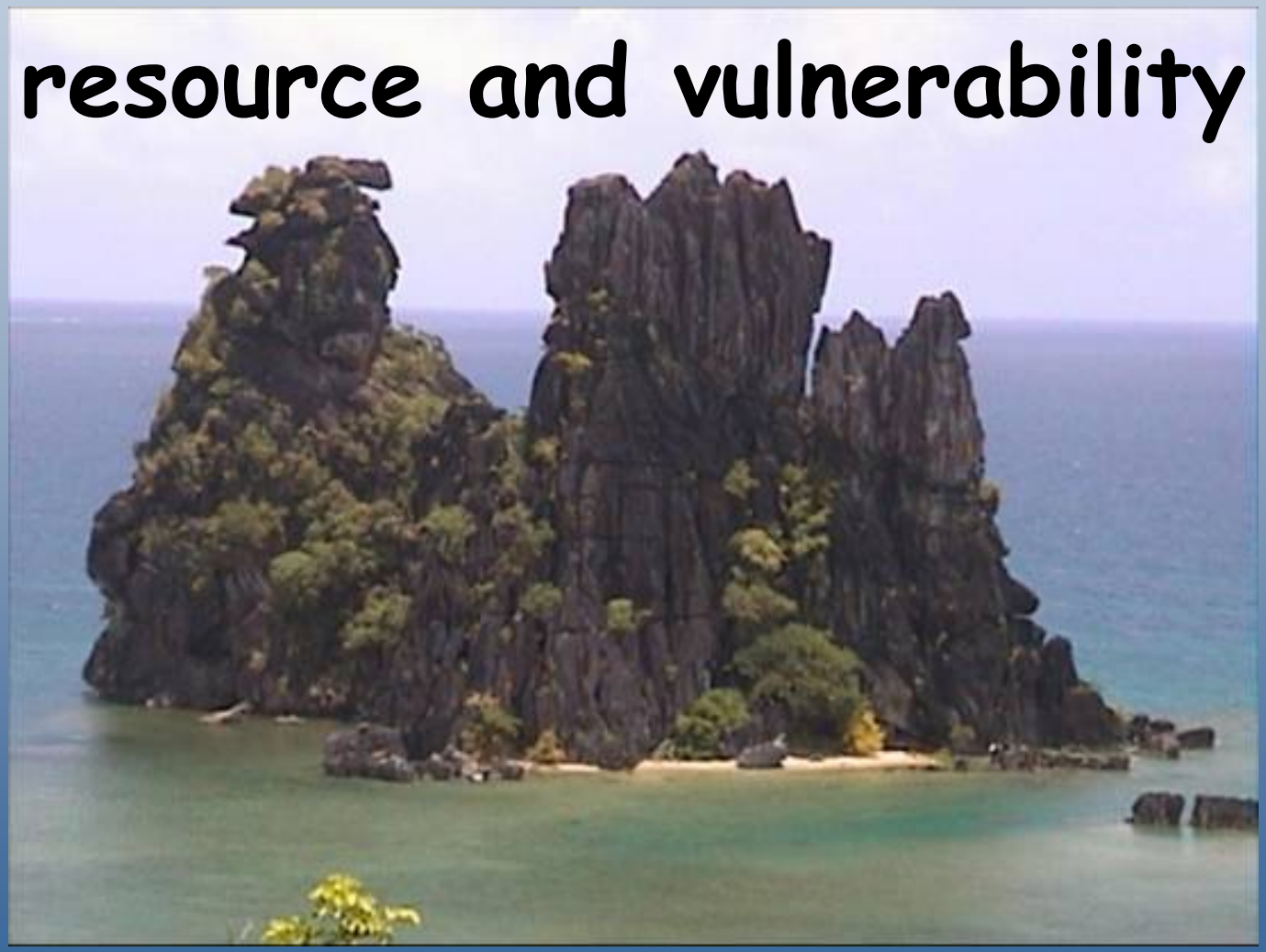
Groundwater in tropical islands

resource and vulnerability



Diversity of hydrogeological environments in coastal areas of tropical islands :

- Hydrologic conditions (surface waters)
- Geomorphological context
- Rock type

A simple classification :

- Low flat islands
- High and rugged islands

Low flat islands

- No perenial surface flow
- Moderate rain fall
- Low flat topography
- Porous or karstic rocks (detritals or limestone)
- Outflows along the shore
- aquifer = fresh to brackish water lens

Volume depending on surface, rainfalls, permeability

Very low & small atoll islands and sandy keys

Tuamotu, Ouvéa, Tuvalu…

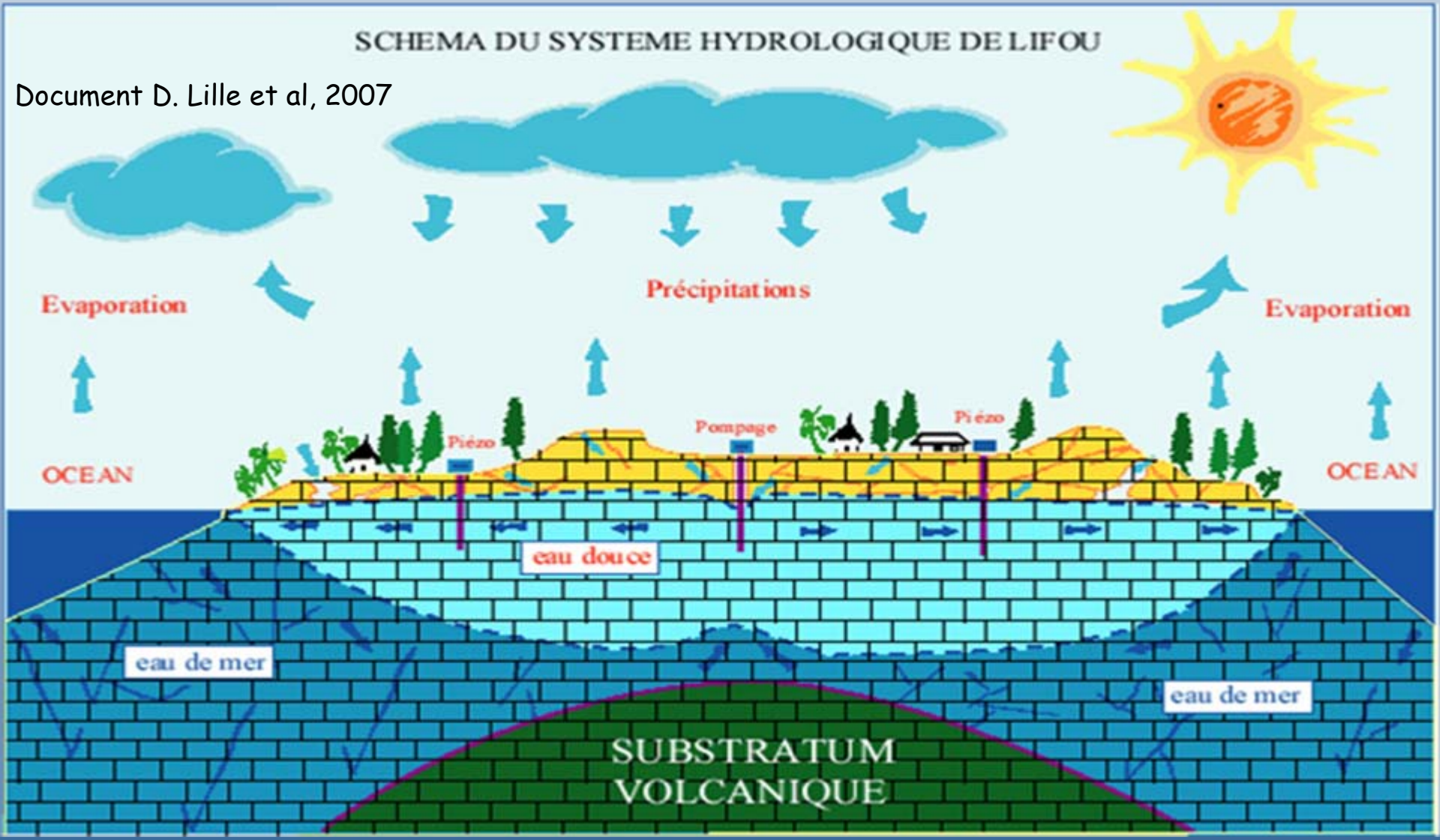
- Shallow thin fresh water lens
- Highly vulnerable to anthropic pressure & climatic changes

Flat uplifted limestone island

Groundwater resource depending mainly on the island surface

- deeper voluminous lens of good quality fresh water
- vulnerable to pollution because of karstic flows in the limestone.

Hydrogeologic system



High rugged islands

- Volcanic islands

  - Young shield volcano type
    Tahiti, Hawaii, Wallis, Grande Comore, Reunion…

  - Older eroded/weathered shield volcano type
    Bora Bora, Hawaii, Mauritius…
    & Subduction explosive volcano type
    Vanuatu,

- Continental islands
  New Caledonia, New Guinea, Solomon,

- Good recharge on windward coast
- Abundant surface flow (except on young shield type)
- Various aquifers

Robineau & Join, Nov 2007

Young shield volcano (hot spot) type

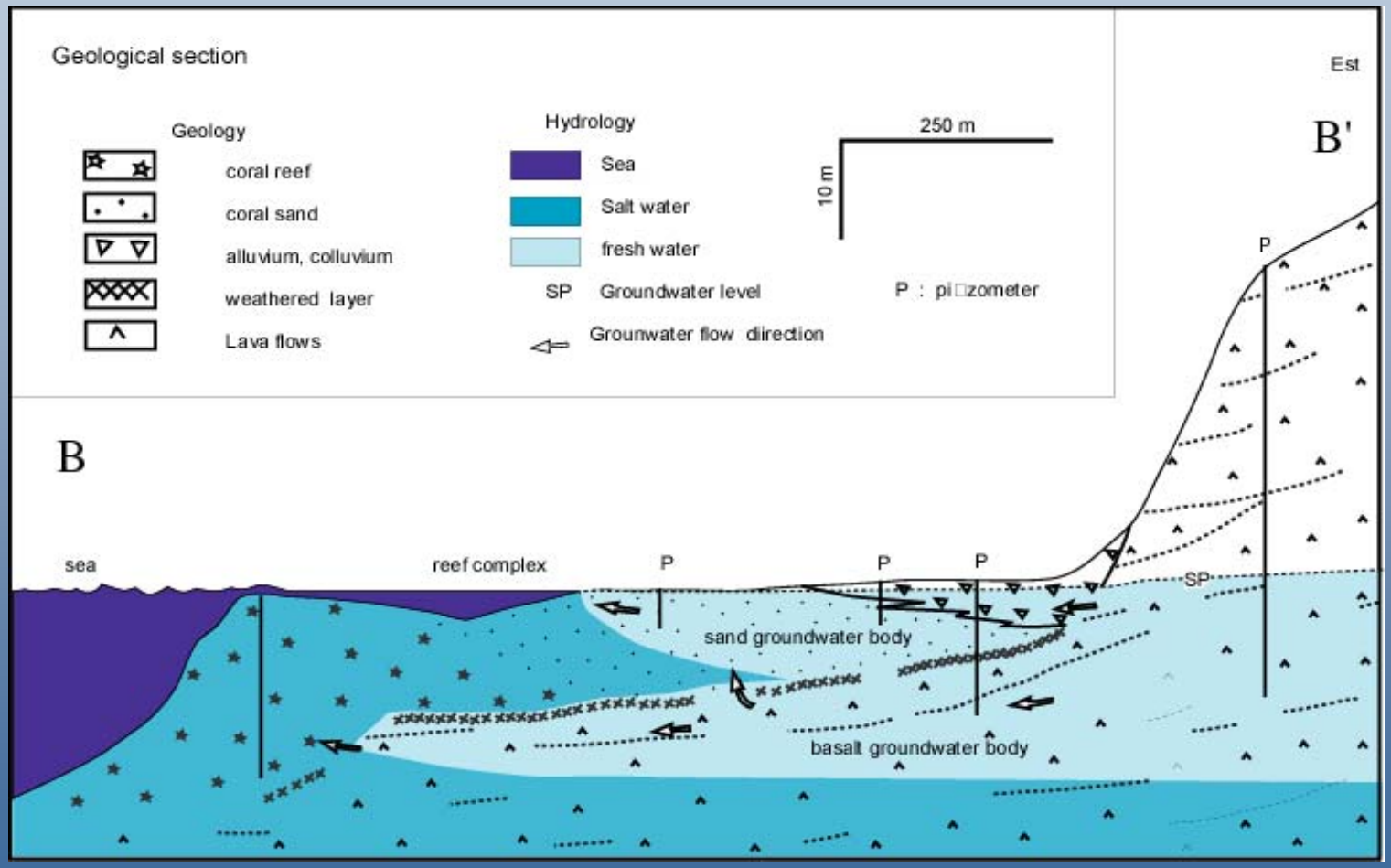
Very permeable lava : no perenial or poor surface flow

Good recharging

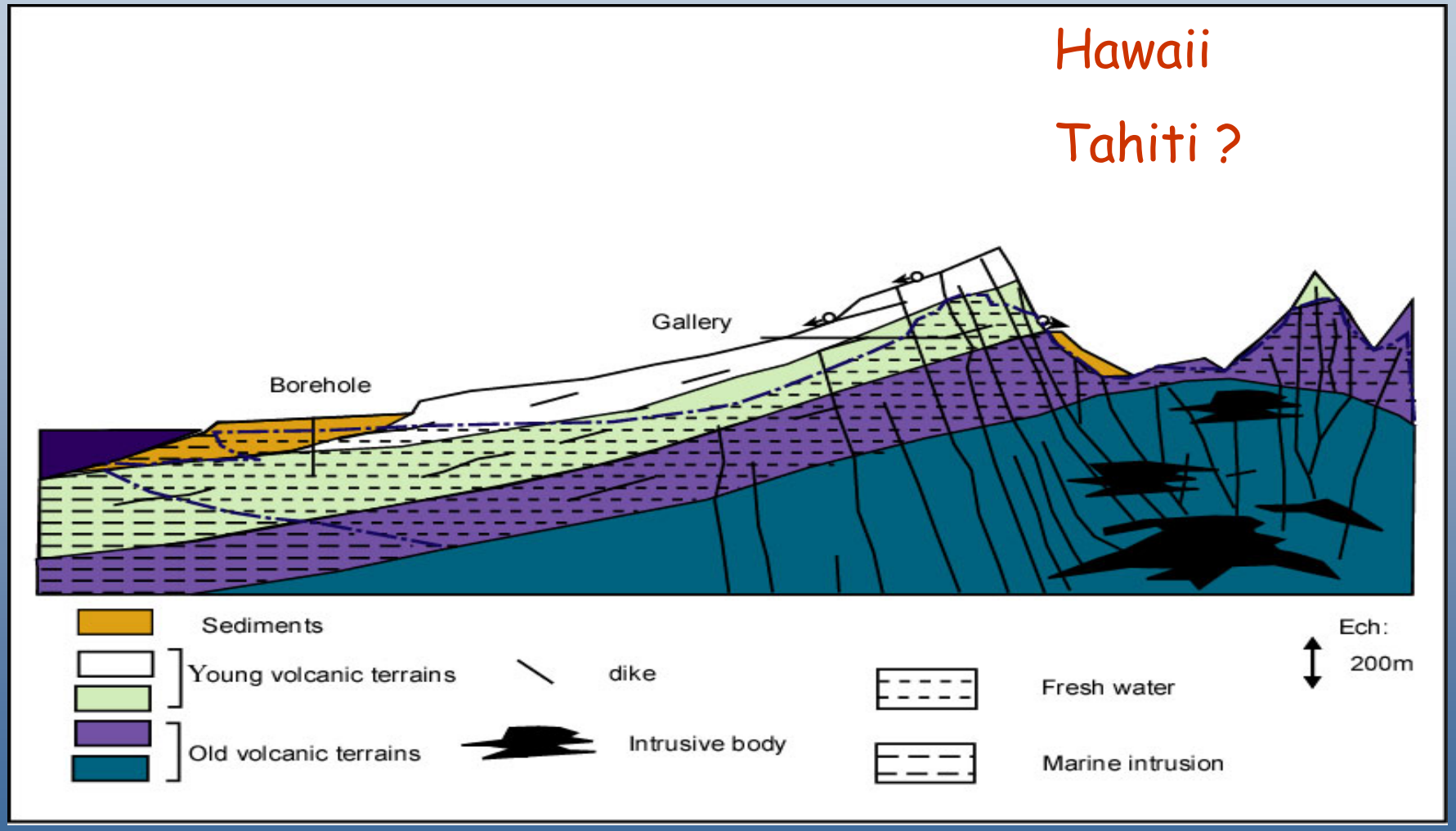
Impermeable core

Basal groundwater reservoir
- Shallow coastal aquifers on the marine intrusion
- Water table deeper inland

Coastal aquifer in a young volcanic island with a fringing barrier reef



Hydrogeological model for La Réunion



Eroded/weathered shield & explosive volcanic islands

Impermeable ash or weathering layers
Perenial surface water : rivers, springs…
Impermeable core
Good recharging

Various aquifers

- Productive alluvial aquifers
- Smaller perched reservoirs
- Basal reservoir (salt wedge)
- Poor surface aquifers

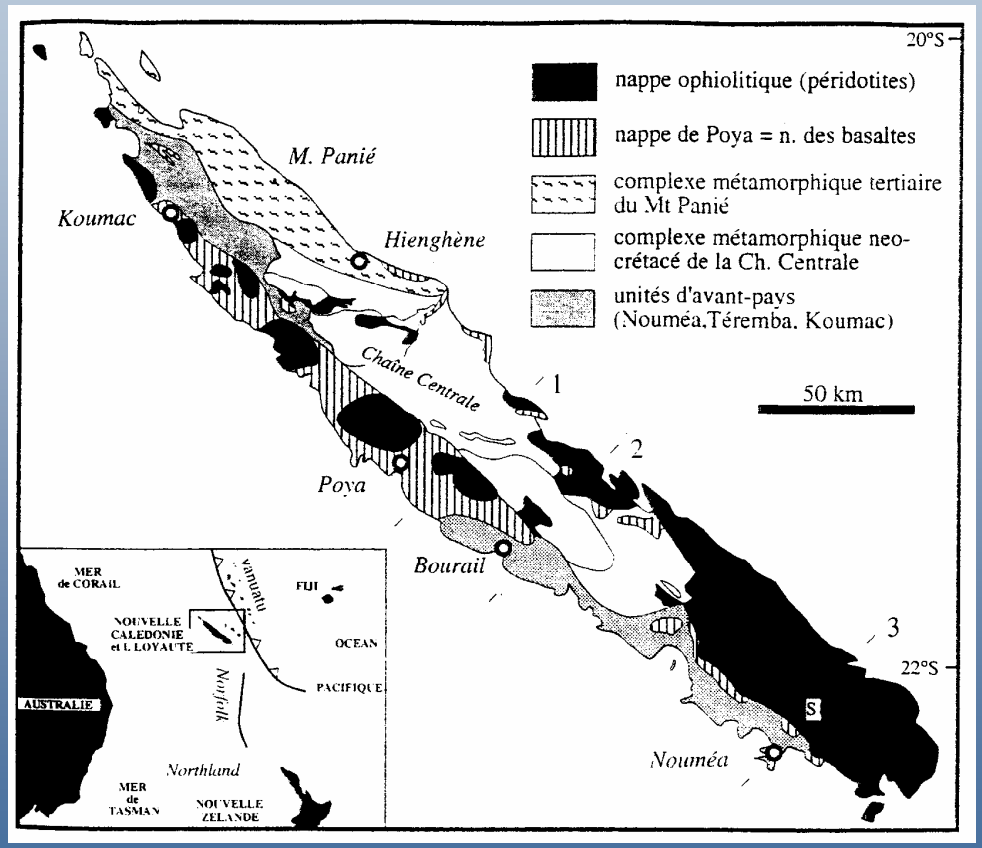
Continental tropical islands

Substratum with various continental crustal rocks
- Sedimentary
- Granitic (Seychelles)
- Obduction (New Caledonia, Solomon, New Guinea)

Climatic contrast on coastal areas (windward)

New Caledonia : a continental piece with obducted oceanic nappes

Along coastal areas a large diversity of geological, morphologic and climatic environnements with specific groundwater resources

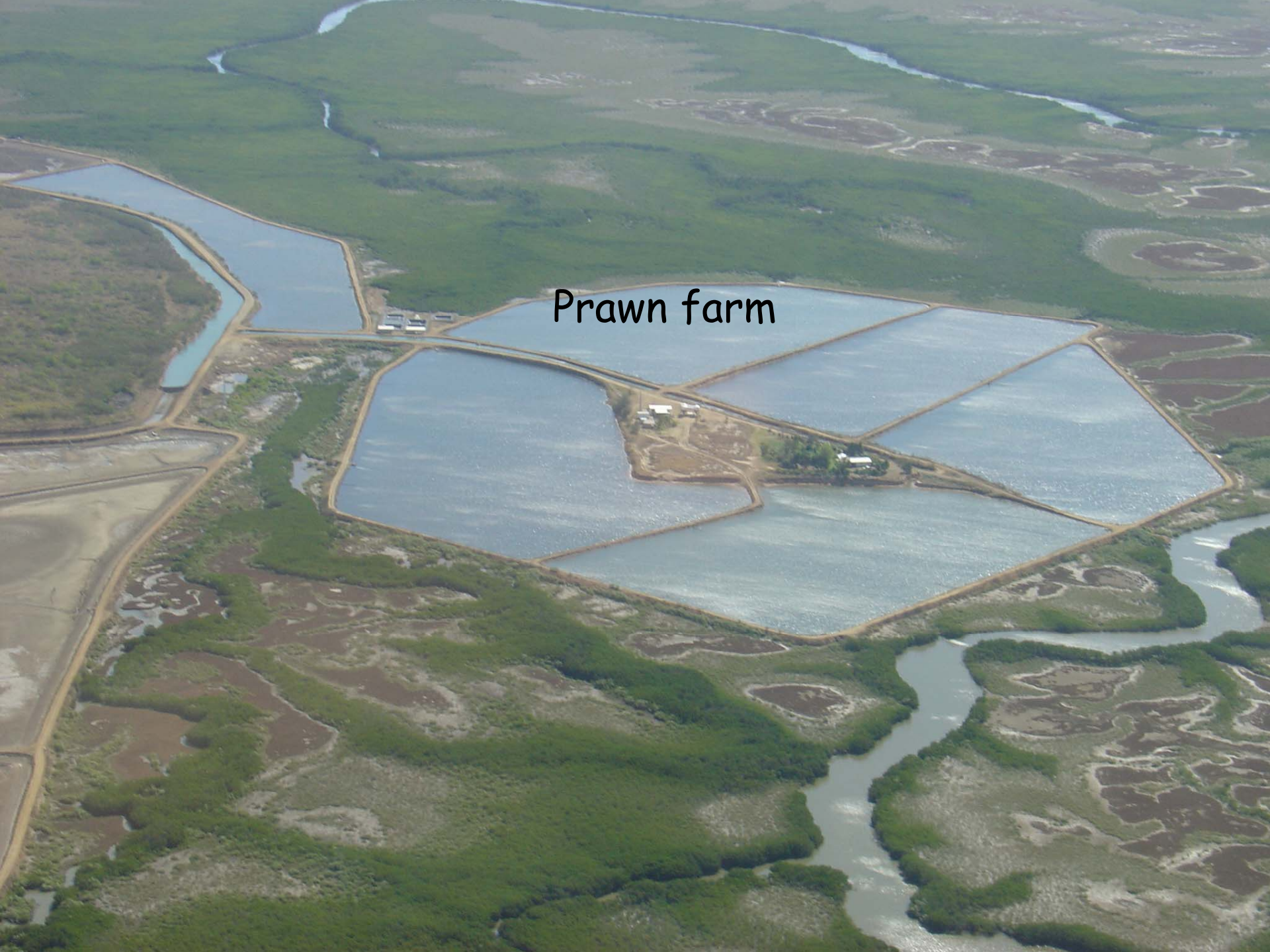


Coastal aquifers

- Extensive and productive –but vulnerable- shallow alluvial aquifers
- Poor and discontinuous regolith or fracture reservoirs

Coastal sand deposits and canyons in the reef flat


Marine intrusion
& alluvial aquifer
= salt wedge


Prawn farm


Pumping & irrigation


« anti-salt » dam

Specificities of insular & coastal environments

- Small surfaces et resources
- High exposure to natural disasters

- Isolated & scaterred lands
- Marine environment

Water resource issues

Climatic variability

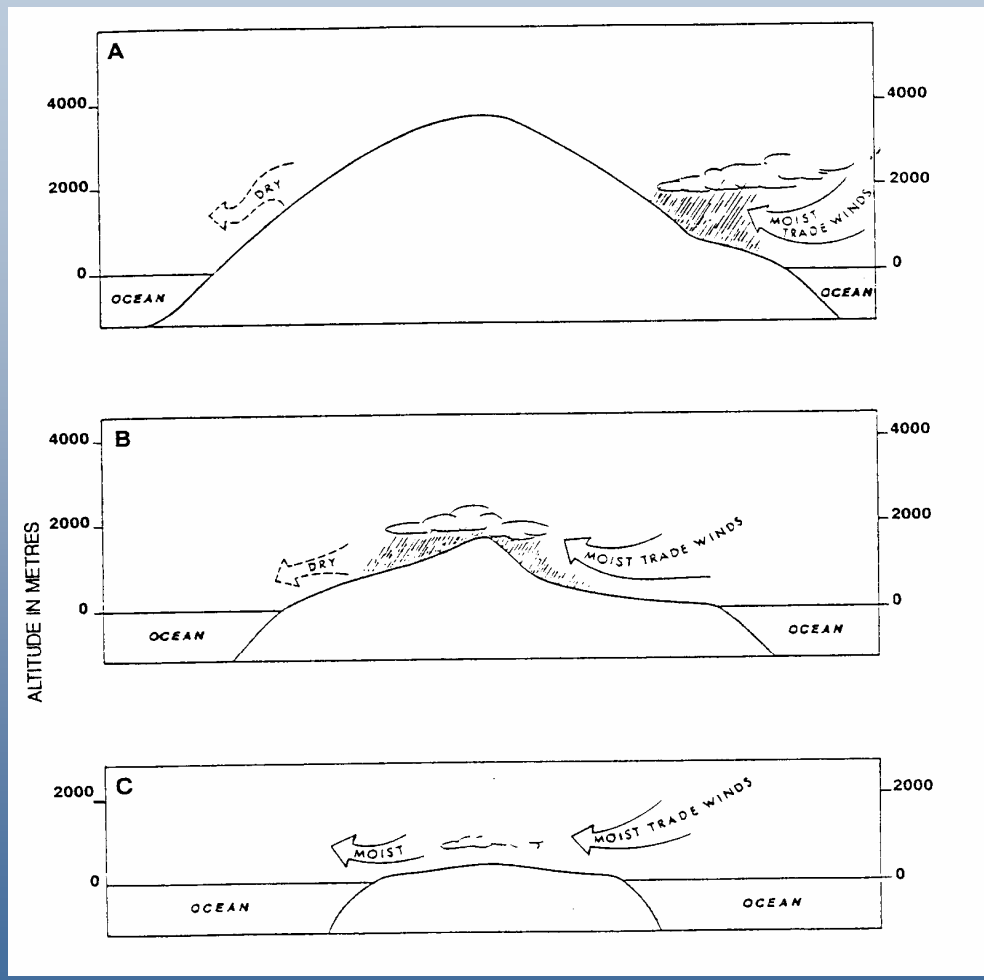
Depending on the morphology and wind direction

Restricted aquifers

Perched water tables
Coastal water lens

Small drainage bassins

Large fluctuations



Exposure to geohazards

- **Cyclones**
- **Landslides**
- **Tsunami**
- Volcanic events

Most tropical coastal areas are exposed to cyclones
It affects mainly the substructures and impacts the resource, essentially surface water catchment and storage

Management issues

- Population : density & growth
- Touristic activities
- Economic growth & industrial development
- Pollution , wastes, sullage
- Over pumping & marine intrusion

To mitigate anthropic and climatic pressures and to guaranty both quality and quantity of the very vulnerable groundwater resource, an integrated management approach is recommended


Thank you

Some study cases in New Caledonia

- Koumac aquifer: water for an ore washing plant on Tiebaghi mine, conflict with native people
- Lifou island: fantastic but vulnerable groundwater resources, the need of education
- Tontouta : users conflict, how to preserve Noumea water supply
- Goro: mine tailings storage and groundwater, the impermeable solution

Koumac case

Ni mining plant on Tiebaghi massif

- 600 000 m3/y for the ore washing plant
- Close water supply is not sufficient

Koumac alluvial aquifer

- Estimated resource: 1 000 000m3/y
- Koumac city + agriculture = 900 000 m3/y

City+agriculture+mining needs represent 1.5 % of the resource, but natives stop the project…

many informations meetings have been organized

The need to inform local populations about any development

Tontouta river case

Users conflict

- Gravel quarries in the river bed
- Pumping for agriculture and gravel washing
- Bore holes field for Noumea water supply

A critical evolution

Salt content increasing in the « lower » borehole due to:

- Lowering of the river bed by material removal
- Washing of salted material
- Over pumping

Possible solutions

- Water recycling on the washing plant
- Displacement of quarries

Lifou case

A 180 m thick fresh water lens at sea level in the middle of Lifou, only used for domestic purpuses

Raised limestone islands have no surface flows but a good potentiel for groundwater resource

Problems:

- Knowledge = prospecting, exploration, monitoring
- Vulnerability = pollution, waste, used water

Solutions

- Coastal waste disposal
- Good sceptic tanks…
- And over all : education

Goro tailings

A huge industrial and mining plant

- Hydrometalurgy (chemicals)
- 12 MT/y of tailings

How to store such volumes with no impact (leaching and leaking)

A specific aquifer: multilayer with « karstic » flows along fractured zones and outflows in the lagoon

A very expensive solution: **impermeable storage**
water dam, under drainage, liner, small catchement 150ha
monitoring