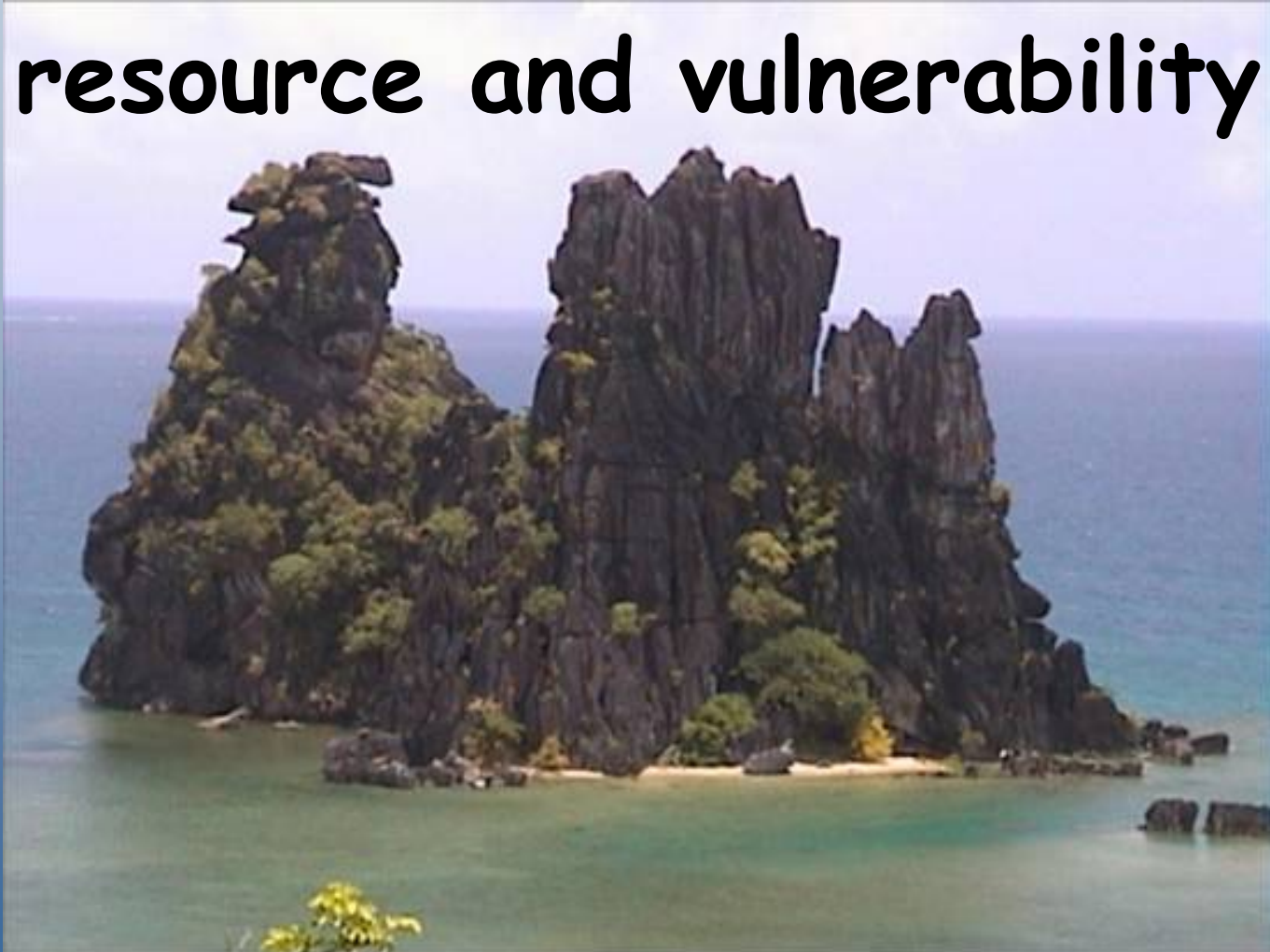


Groundwater in tropical islands

resource and vulnerability



Robineau & Join, nov 2007

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 perennial 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

Loyalty islands, Vanuatu...





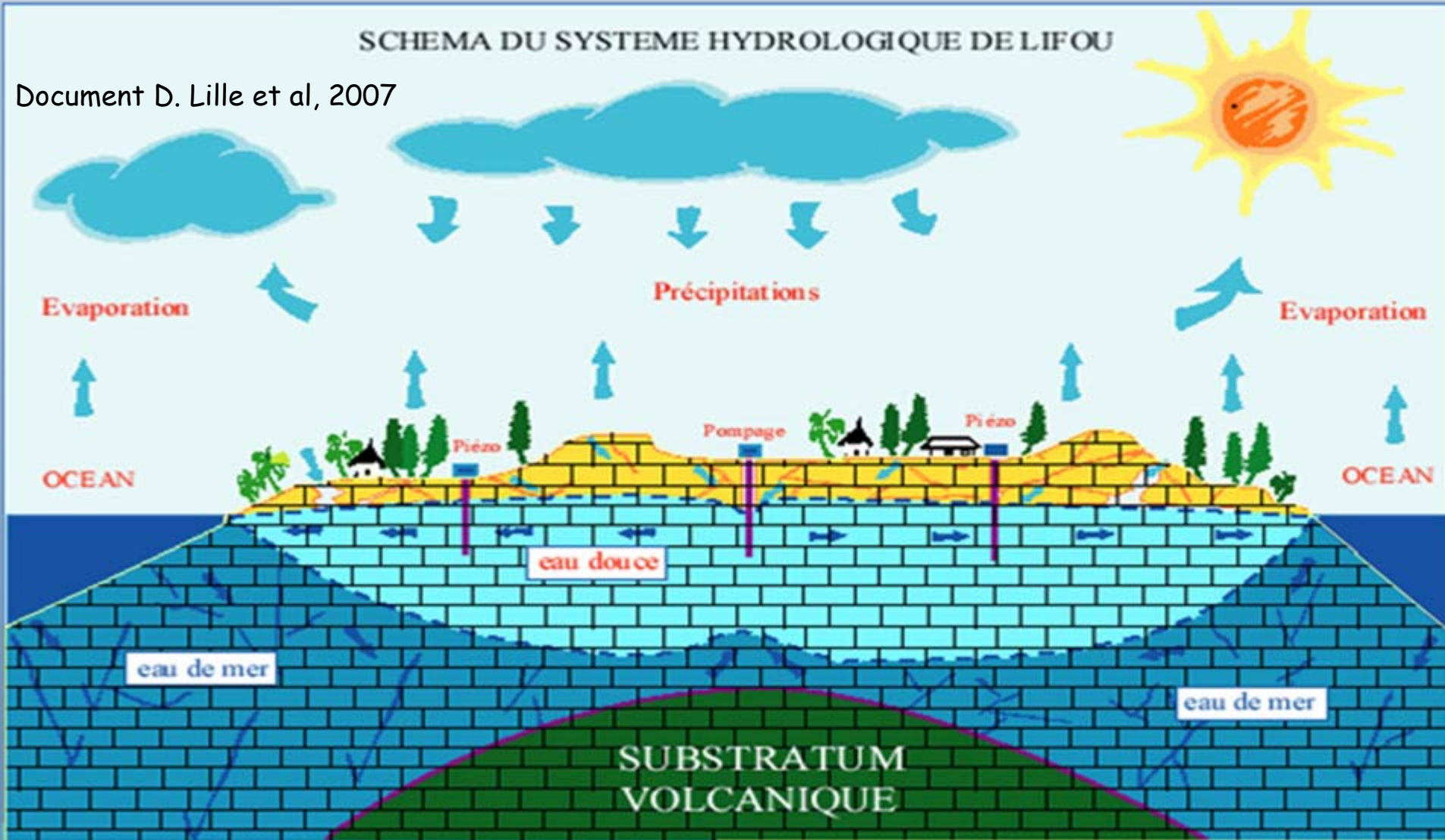
Groundwater resource
depending mainly on
the island surface

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

Hydrogeologic system

SCHEMA DU SYSTEME HYDROLOGIQUE DE LIFOU

Document D. Lille et al, 2007



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

Young shield volcano (hot spot) type

Very permeable lava : no perenial or poor surface flow

Good recharging

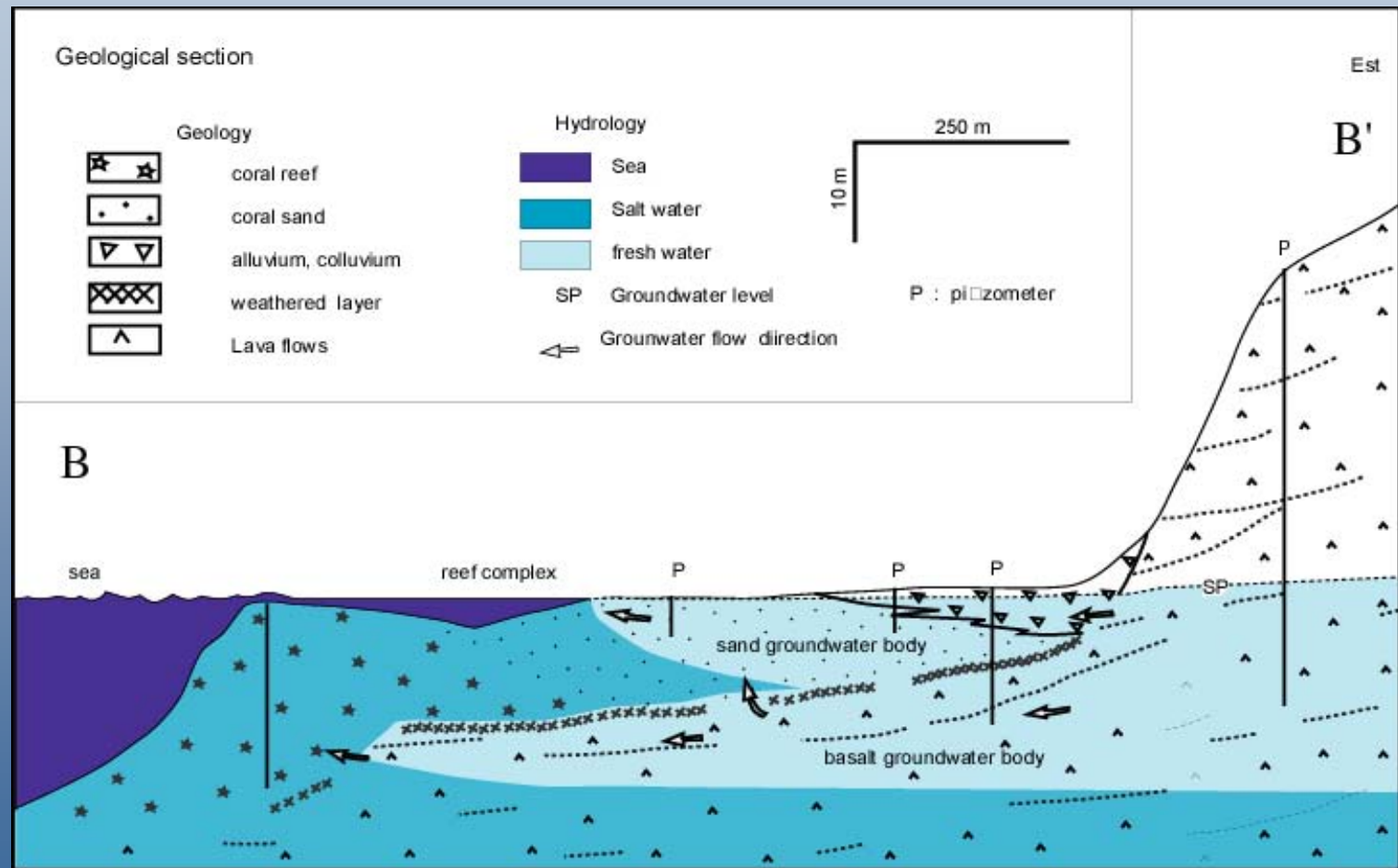
Impermeable core

Basal groundwater reservoir

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



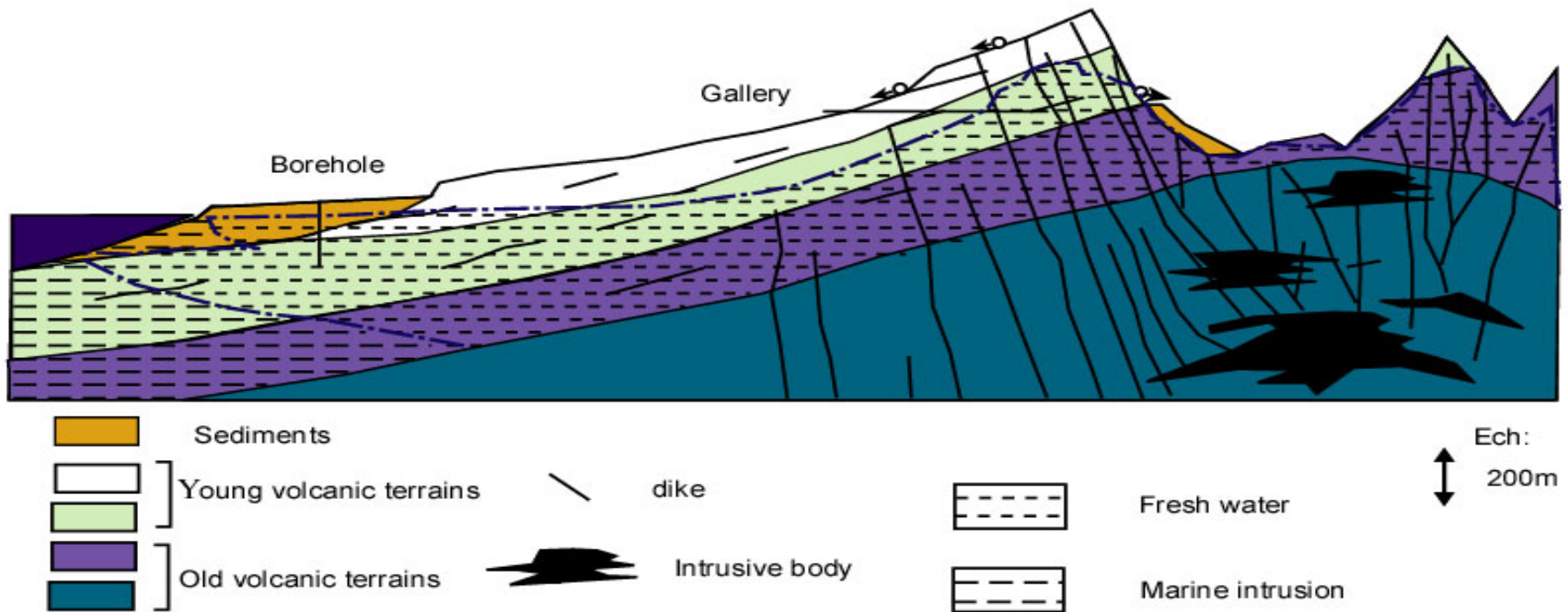
Coastal aquifer in a young volcanic island with a fringing barrier reef



Hydrogeological model for La Réunion

Hawaii

Tahiti ?



Eroded/weathered shield & explosive volcanic islands

Impermeable ash or weathering layers
Perennial 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

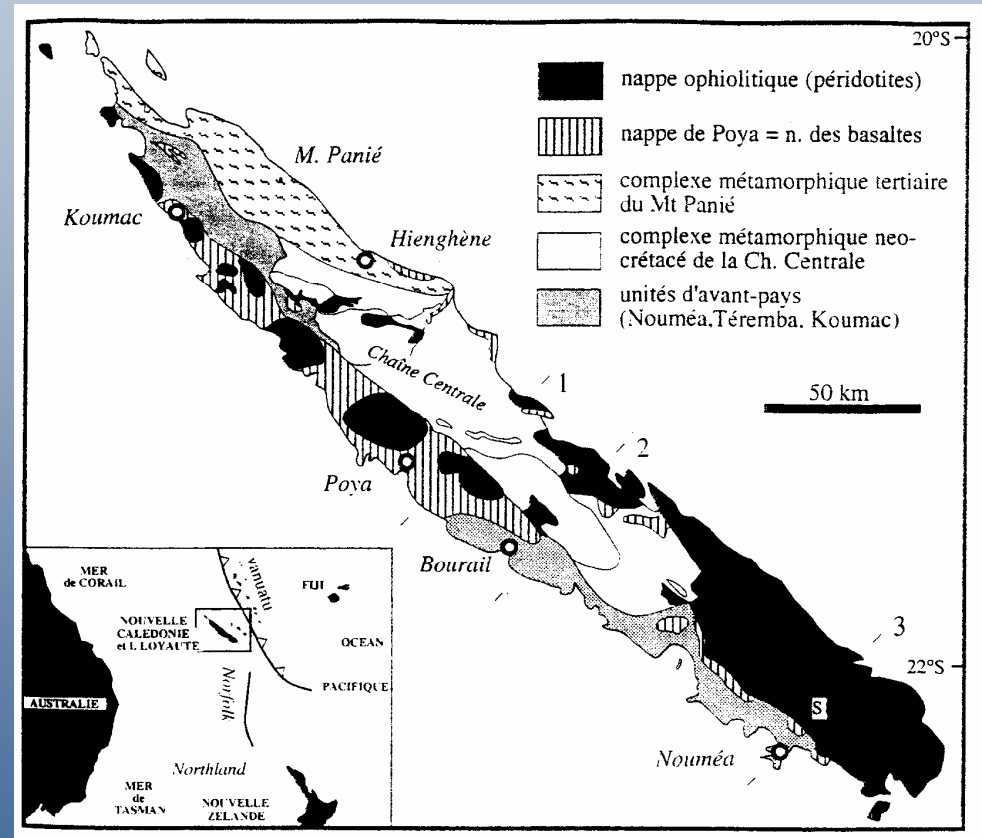
Substratum with various continental crustal rocks

- 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 environments with specific groundwater resources



Coastal aquifers

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



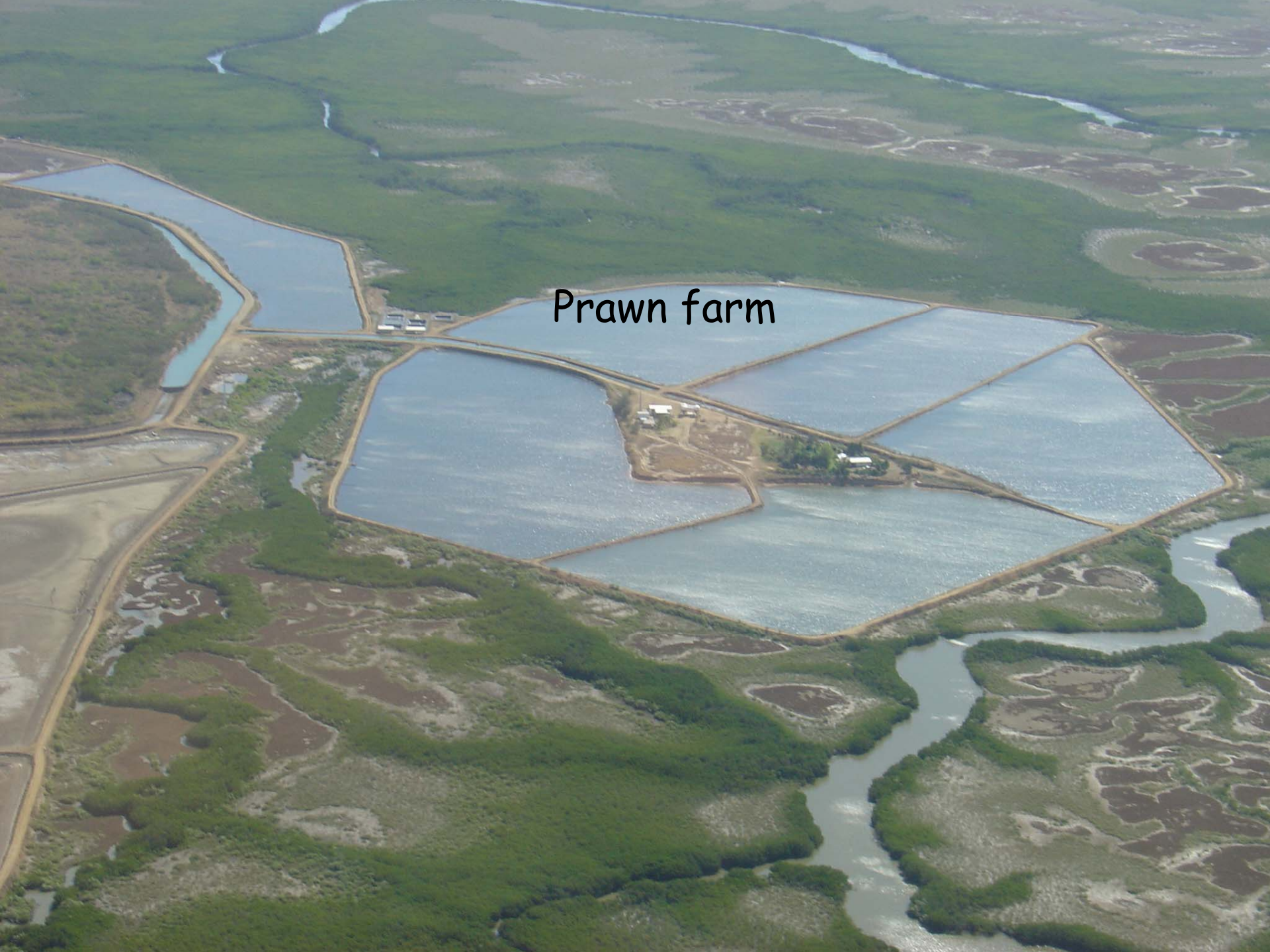
Coastal sand deposits and canyons in the reef flat

Groundwater resource ?



An aerial photograph showing a river delta where a river meets a larger body of water. The river channel is a dark, winding line. The surrounding land is a mix of green vegetation and light-colored, sandy or silty areas. A prominent feature is a large, light-colored, wedge-shaped area extending from the river towards the top left, representing a salt wedge. The text "Marine intrusion & alluvial aquifer = salt wedge" is overlaid on the image, pointing to this feature.

Marine intrusion
& alluvial aquifer
= salt wedge



Prawn farm

An aerial photograph of a prawn farm. The farm consists of several large, rectangular ponds filled with water, surrounded by a network of earthen dikes. The ponds are situated in a coastal area with extensive mangrove forests. A small cluster of buildings is visible near the center of the farm. The surrounding landscape is a mix of green mangrove vegetation and brown, muddy areas.

An aerial photograph showing a winding river or canal flowing through a landscape of agricultural fields. The river is dark blue and meanders through various shades of green and brown fields. Some fields are rectangular and appear to be planted in crops, while others are more irregular and grassy. The river is bordered by dense green trees and vegetation in several places. The overall scene suggests a rural or agricultural area with water management infrastructure.

Pumping & irrigation

An aerial photograph showing a landscape with a river, forest, and a dam structure. The river flows from the top right towards the bottom left. A large, irregularly shaped body of water, likely a reservoir or pond, is situated in the upper middle part of the image. The surrounding area is a mix of green forest and light-colored, possibly salt-affected, land. A network of thin, light-colored lines, likely roads or tracks, is visible in the lower right quadrant. The text « anti-salt » dam is overlaid on the image, positioned near the center-left.

« anti-salt » dam



Specificities of insular & coastal environments

- Small surfaces et resources
- High exposure to natural disasters
- Isolated & scatterred lands
- Marine environment

Water resource issues

Climatic variability

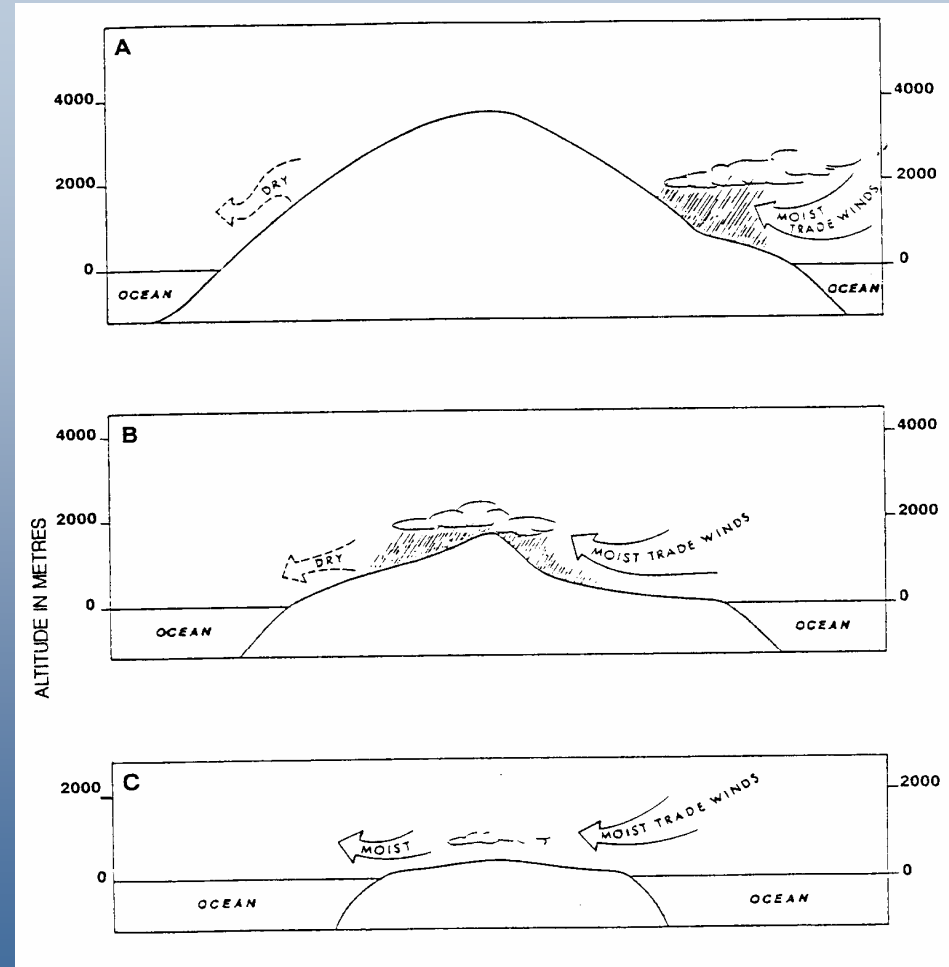
Depending on the morphology and wind direction

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

An aerial photograph of a tropical coastline. The foreground is dominated by a vibrant blue lagoon with a complex pattern of dark, submerged coral reefs. A narrow strip of white sand beach separates the lagoon from a dense, green forest. In the background, the forest extends to the horizon under a clear blue sky with a few wispy clouds. The text "Thank you" is overlaid in the upper right quadrant of the image.

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: 1 000 000 m³/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 purposes

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