Third Space4Water Stakeholder Meeting

United Nations Office for Outer Space Affairs

24-25 October 2023

Session: Multi Stakeholder engagement, communities, informed decision-making

Indigenous knowledge in Earth Observations: A toolkit to support groundwater literacy and decision-making among science, policy & society

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This presentation

- Groundwater systems
  - ✓A complex problem
  - ✓A social-ecological system
  - ✓A life sustaining resource
  - ✓A resource of cultural and spiritual significance
- What is groundwater literacy?
- Indigenous Peoples systemic approach
- A toolbox for groundwater literacy
- Final remarks

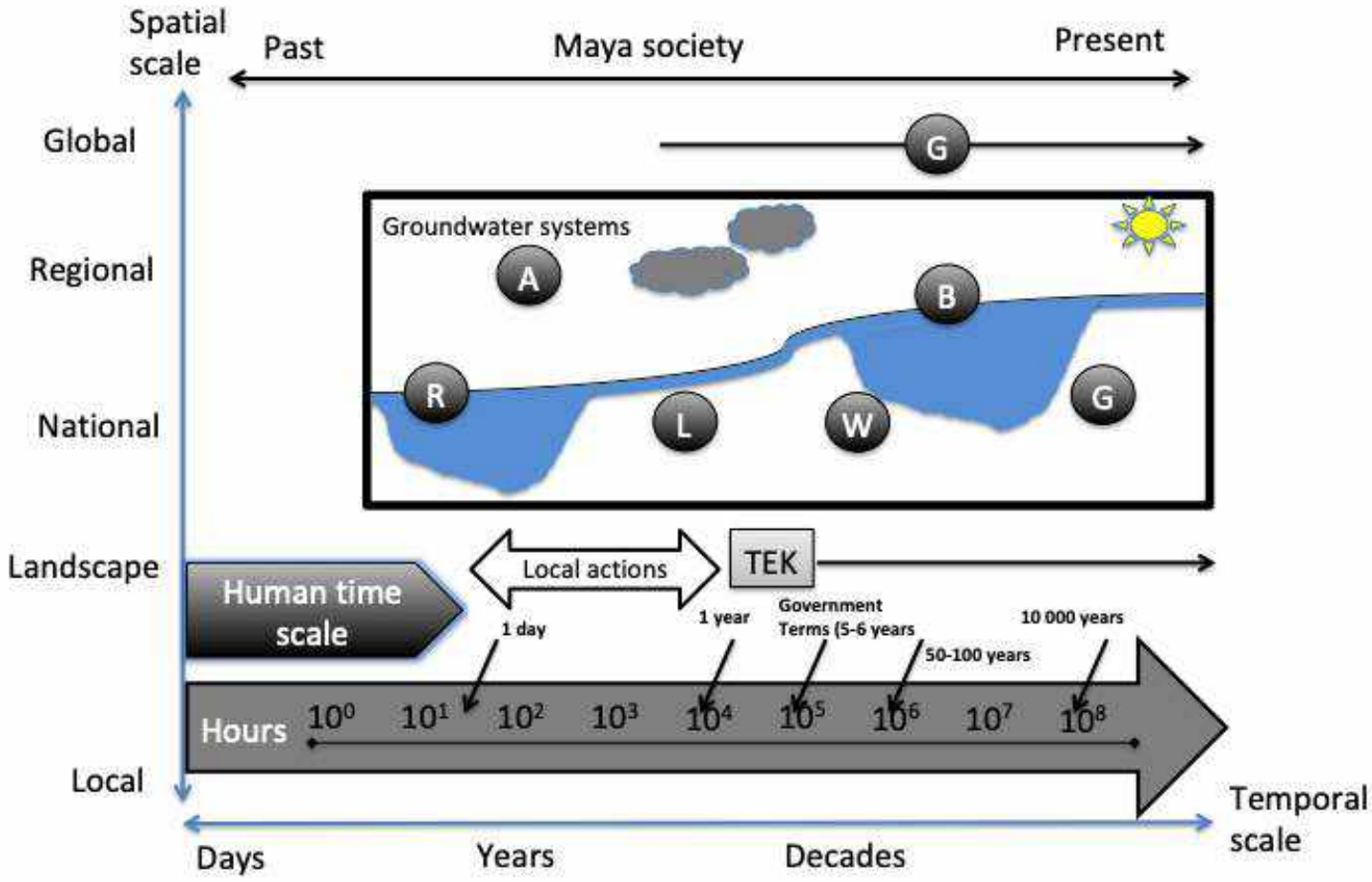
Groundwater systems: a complex problem

- Complexity and unpredictability
- Times: an issue (when finally understood)
- Non-linear in nature
- Cross-scale (space-time)
- Evolutionary character
- For both natural & social systems
- Unknown in EO

A social-ecological system

Due to its complex characteristics groundwater systems requires:

- Use of different tools, methods and approaches for its study
- Application of different knowledge systems for its understanding:
  - Indigenous knowledge
- Recognition of the cultural and spiritual value of nature



Based on an original figure by Gleeson, et al. (2012), with own additions

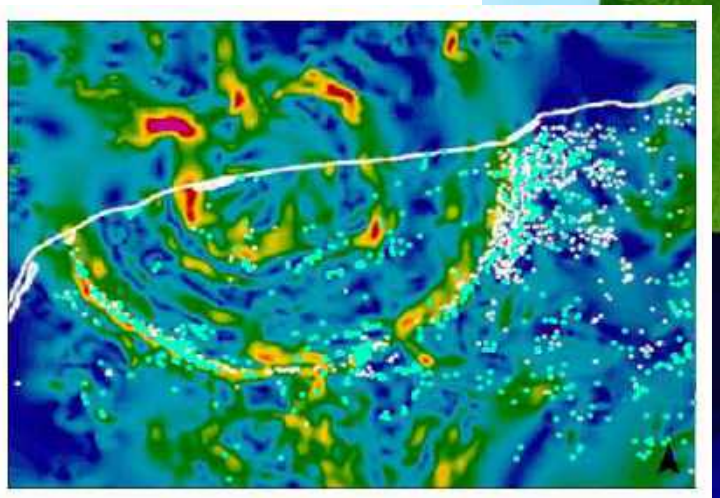
Complex problems can not be solved by single disciplines, approaches, knowledge systems, methods, etc.

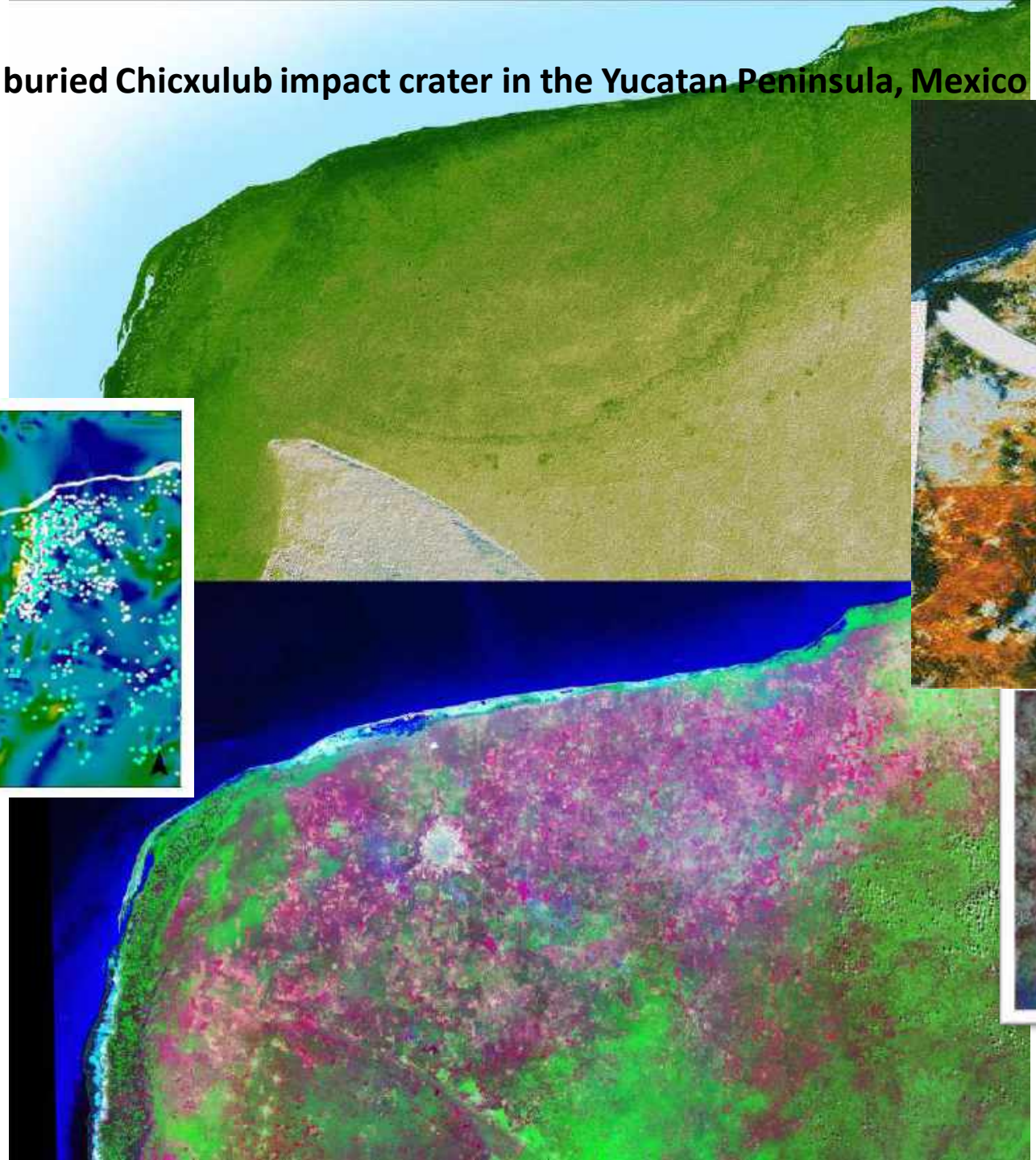
A life sustaining resource

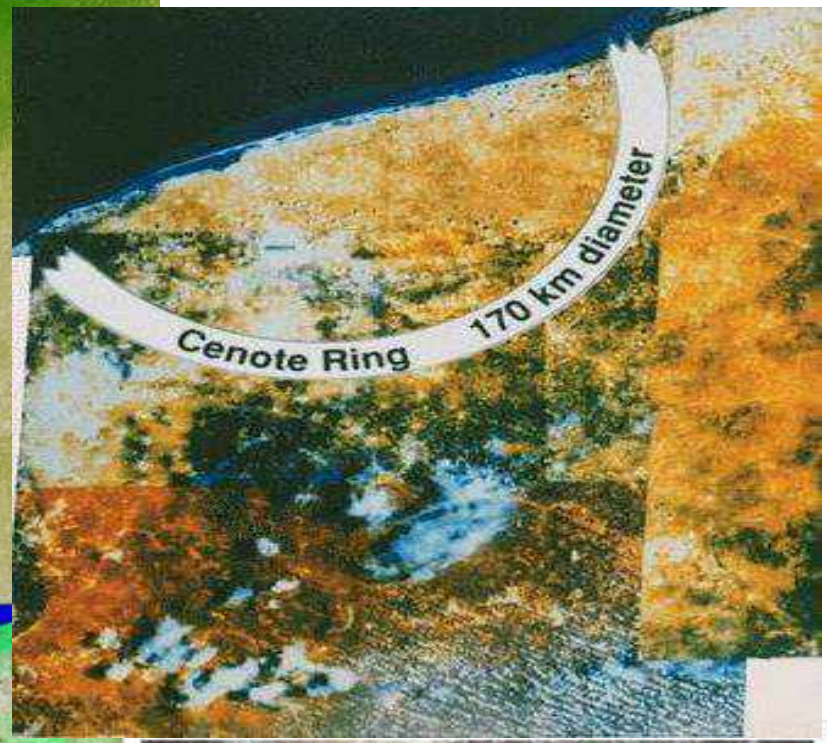
Photos: Yolanda Lopez

A highly permeable karstic soil with a notable absence of permanent freshwater resources on its surface

Southwest portion of the buried Chicxulub impact crater in the Yucatan Peninsula, Mexico







Yucatan Peninsula generated from Shuttle Radar Topography Mission (SRTM) data.
It shows a subtle, but unmistakable, indication of the Chicxulub impact crater 65 million years ago

https://photojournal.jpl.nasa.gov/catalog/PIA03381

A resource of cultural and spiritual significance

- Yucatan: an area of places of cultural and environmental importance, most of them related to water
- The water - and the caves- were sacred and spiritual places for the Mayas
  - Ceremonies to honor the God of rain
- Traditional sacred natural sites included: natural springs, landscapes and caves
  - The loss of cultural values can be linked to resource degradation and environmental quality

https://th.bing.com

Photo: Miguel Cetina

Groundwater was a sacred common pool resource for the Mayas

What is groundwater literacy?

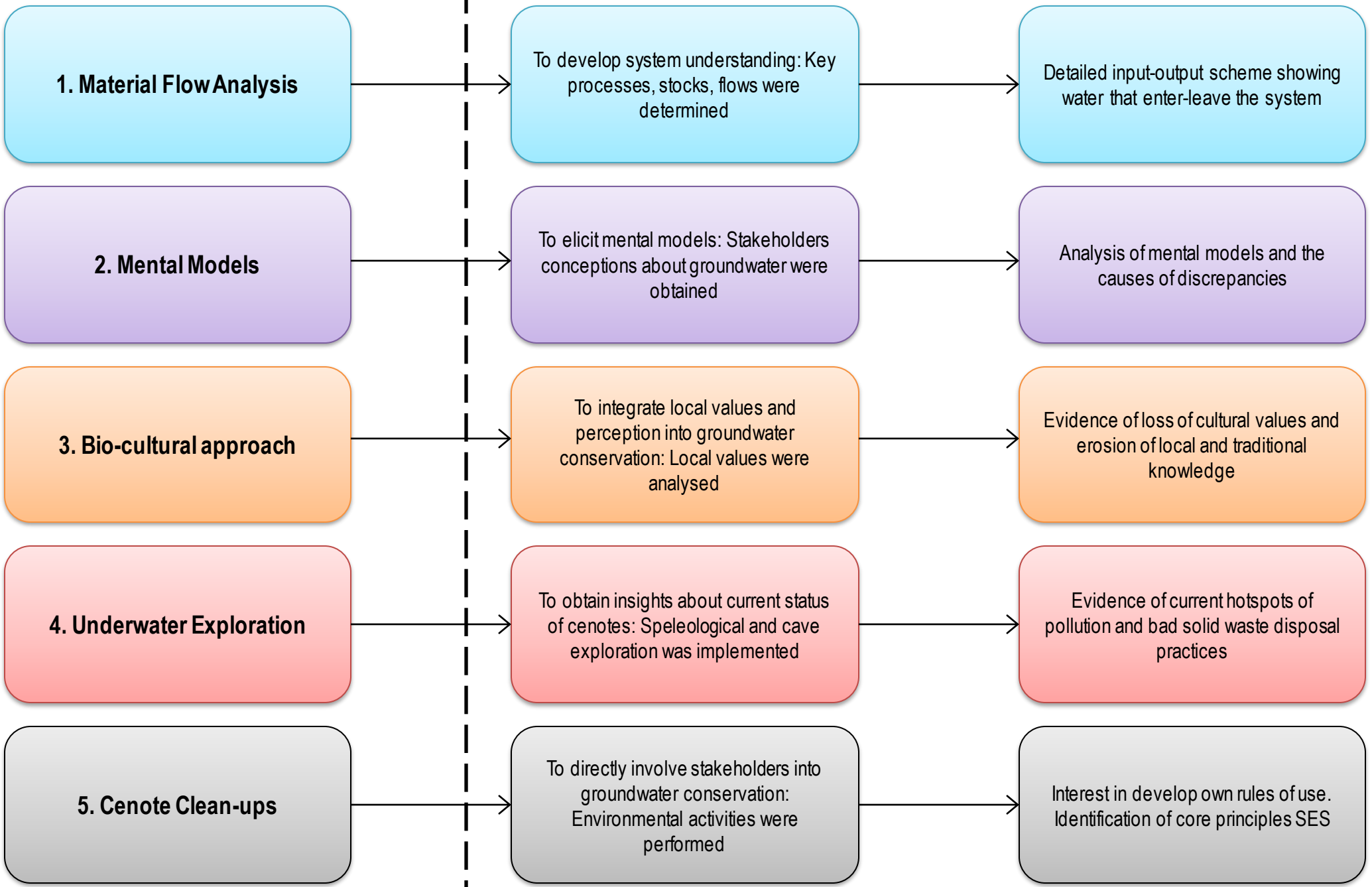
- “The knowledge of the users about the resource and some of its attributes, and their perception and valuation of their impacts in the system”

Photo: Miguel Cetina

Indigenous Peoples systemic approach

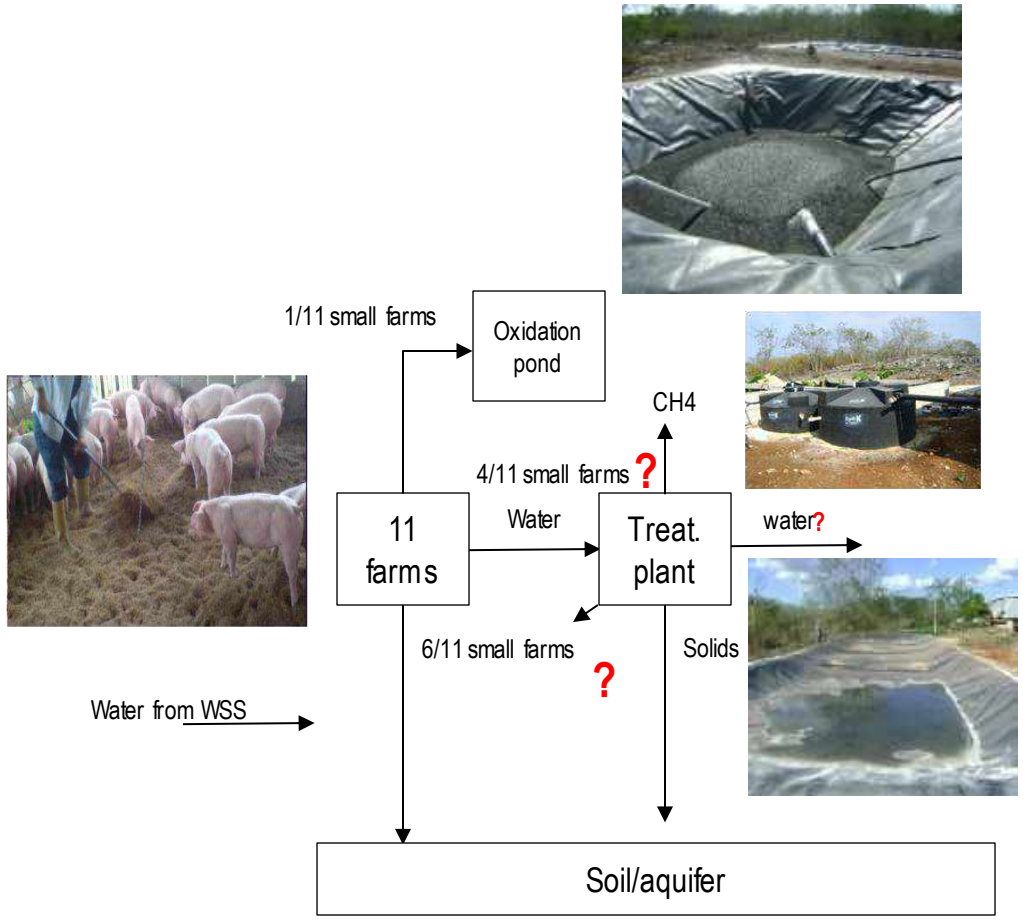
- Indigenous peoples were among the first to observe and understand Earth processes, notice and report on environmental change, and have critical knowledge to adapt to it
- This knowledge has evolved over generations through direct contact with the environment
- Valuable information to understand the functioning of the planet and address current environmental challenges.
  - Manage and maintain the healthiest ecosystems of the planet
  - Hold crucial environmental knowledge to preserve biodiversity and ecosystems

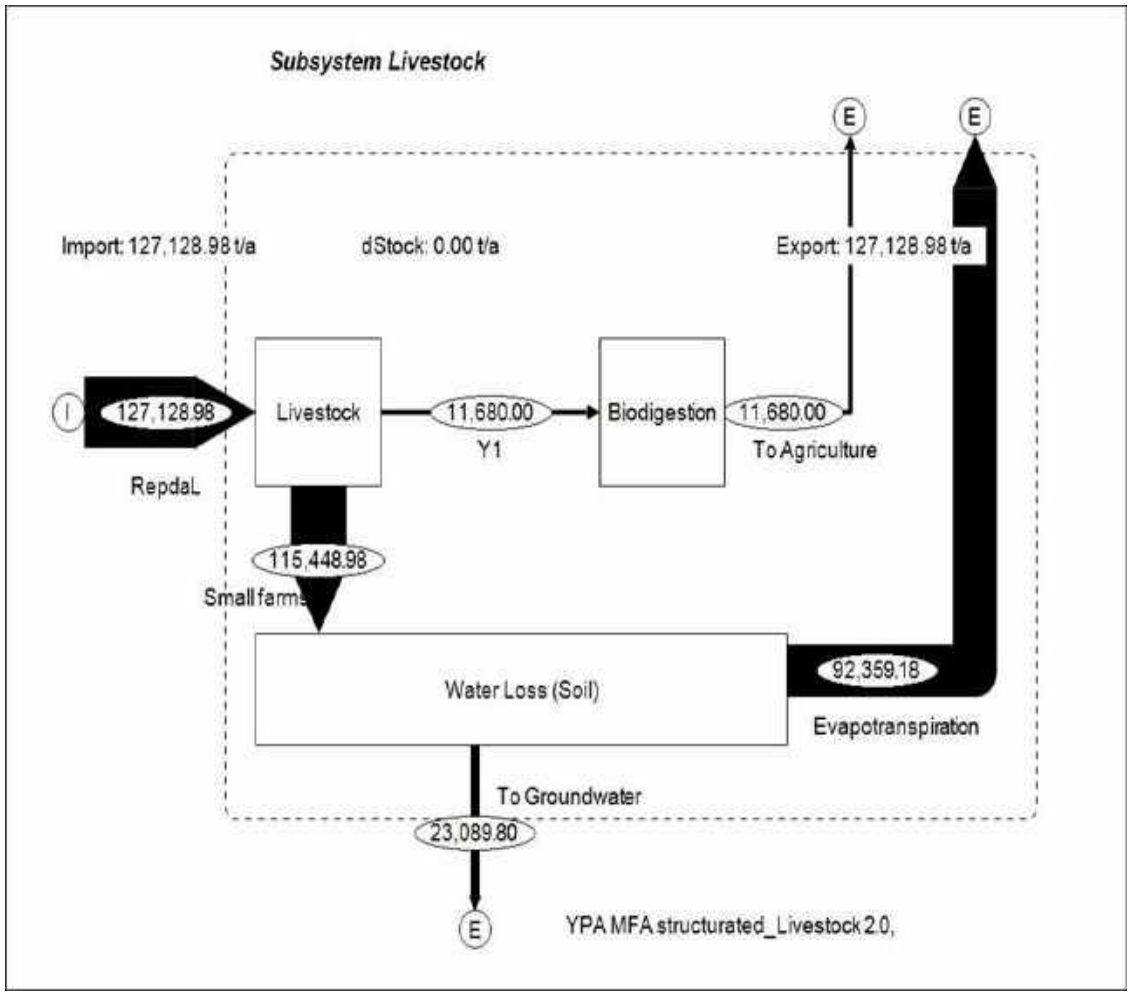
The toolbox


1. Material Flow Analysis
To develop system understanding: Key processes, stocks, flows were determined
Detailed input-output scheme showing water that enter-leave the system
2. Mental Models
To elicit mental models: Stakeholders conceptions about groundwater were obtained
Analysis of mental models and the causes of discrepancies
3. Bio-cultural approach
To integrate local values and perception into groundwater conservation: Local values were analysed
Evidence of loss of cultural values and erosion of local and traditional knowledge
4. Underwater Exploration
To obtain insights about current status of cenotes: Speleological and cave exploration was implemented
Evidence of current hotspots of pollution and bad solid waste disposal practices
5. Cenote Clean-ups
To directly involve stakeholders into groundwater conservation: Environmental activities were performed
Interest in develop own rules of use. Identification of core principles SES

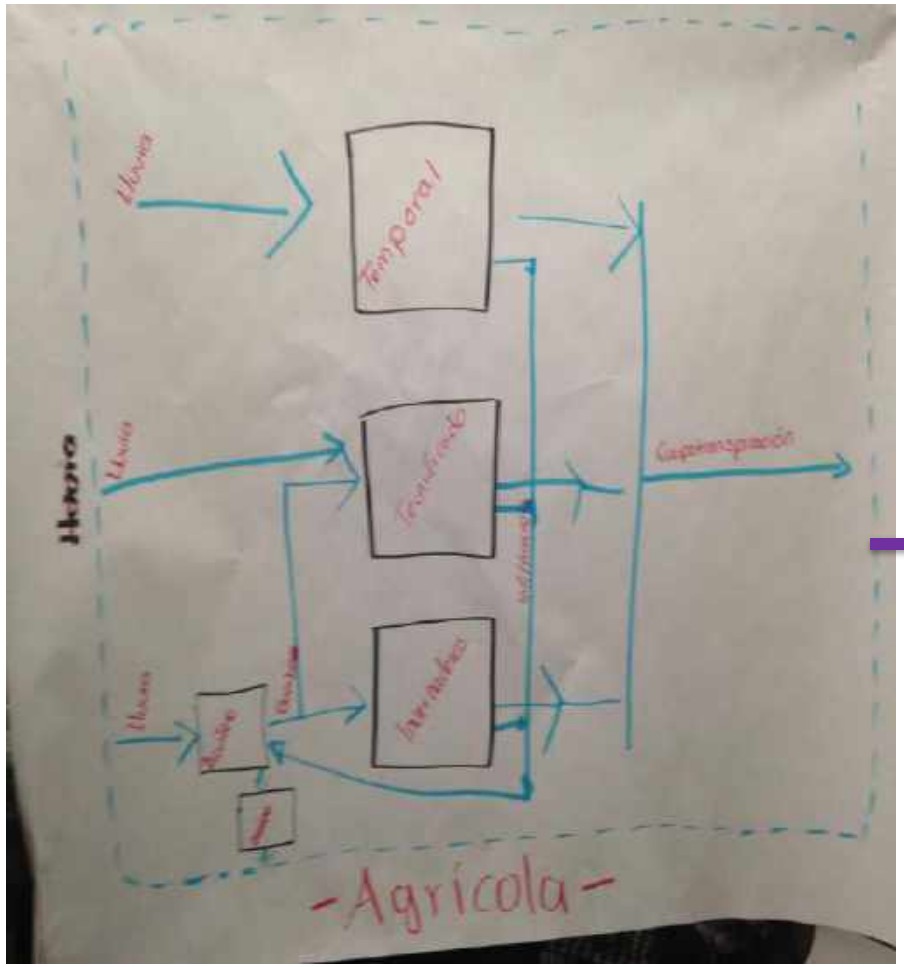
1) Development of a simple system-dynamic model

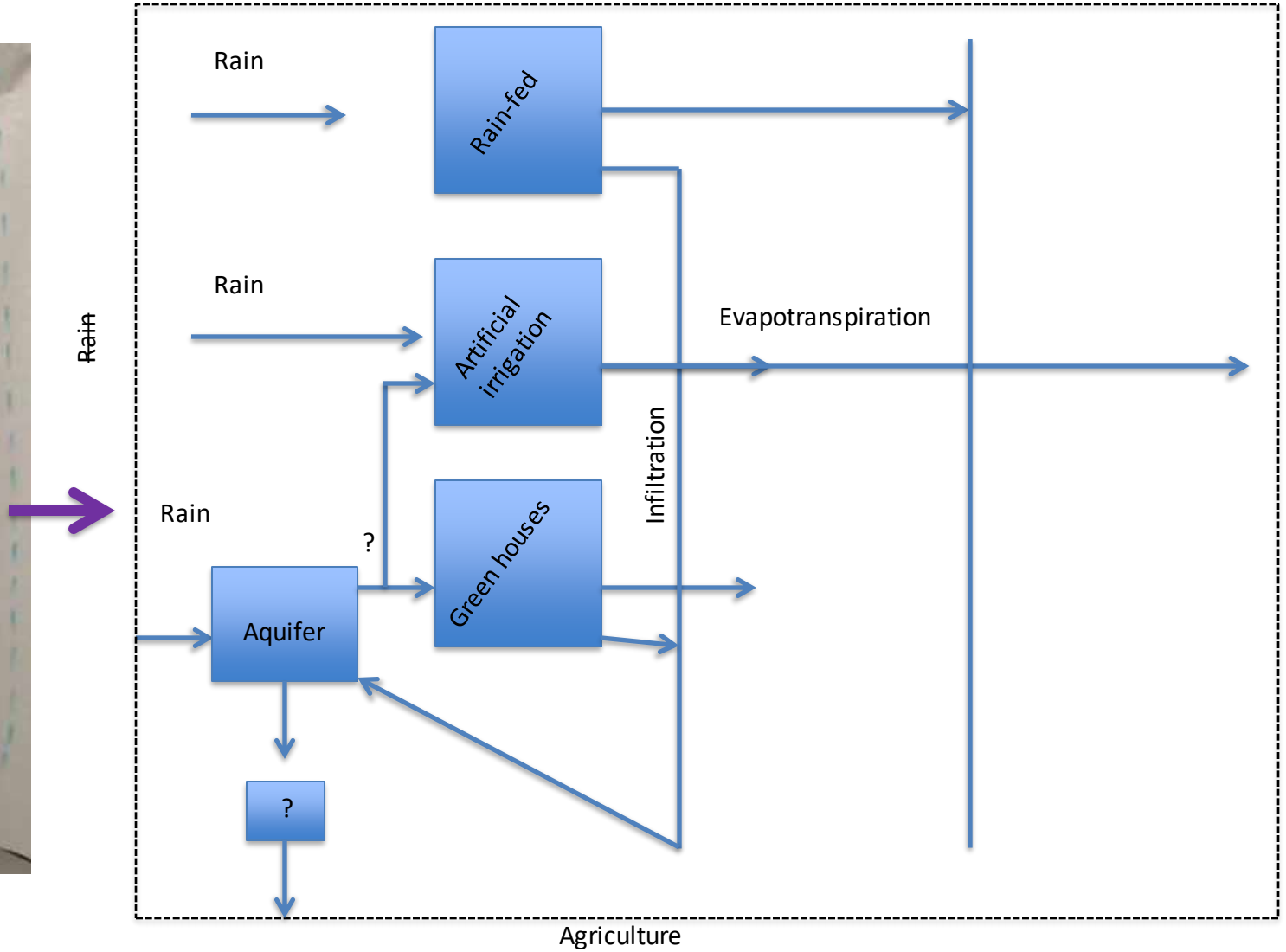
- Based on literature review, develop a simple low order conceptual systems model to have as basis and for a shared understanding of system dynamics





- Lack of knowledge on the area's hydrogeology and groundwater flow patterns and, in general, of the dynamics and functions of the aquifer





Example of expert's drawings illustrating unclear flows, boundaries and features representing the system

Step 1. Developing system analysis.

Step 2. Experts working on small groups.

Step 4. Validation of results among stakeholders working directly in the water sector

Data

Accounted *via*	Collected *via*
Combining System Analysis	Workshops
Mass balance	Literature review
Data estimation	National stats
Expert consultation	Interviews

Data

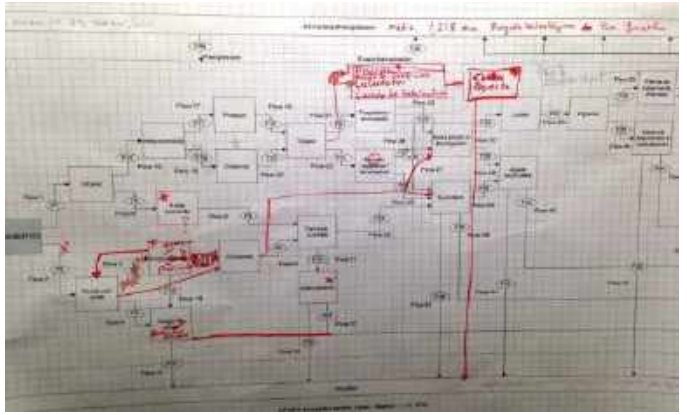
System Analysis Development (Combined Groups)

System Analysis Expert Validation

Step 5. Interpretation of results

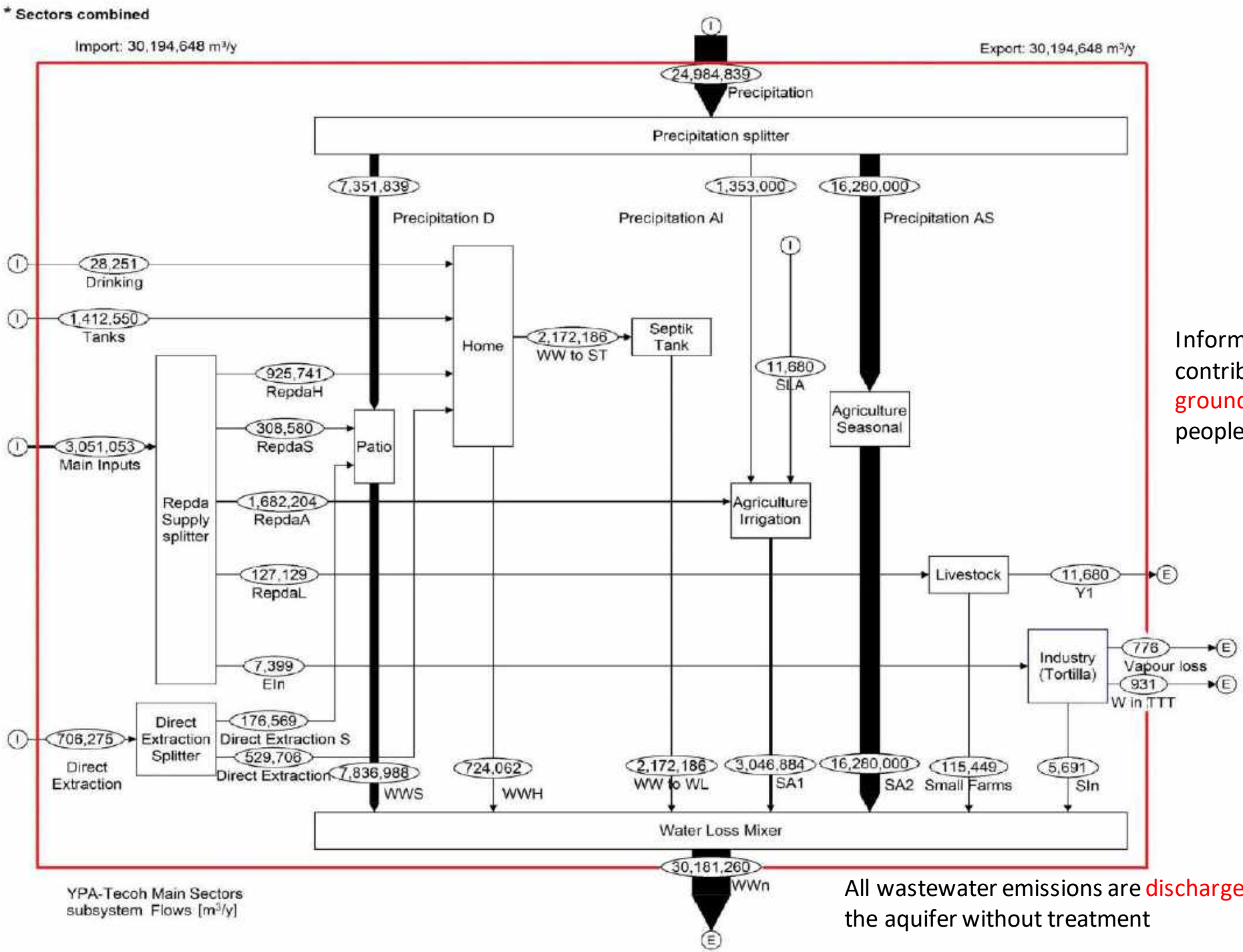
Water Balance

System Analysis Development (Small Groups)



Step 3. Flows modified and corrected by participants

Poor recycling practices (<1%, relative to the total water emissions)



Information was not contributing to the groundwater literacy of the people

All wastewater emissions are discharged directly into the aquifer without treatment

2) Scenario approaches

- Understanding drivers of change, uncertainties, sets of values associated with future/development paths

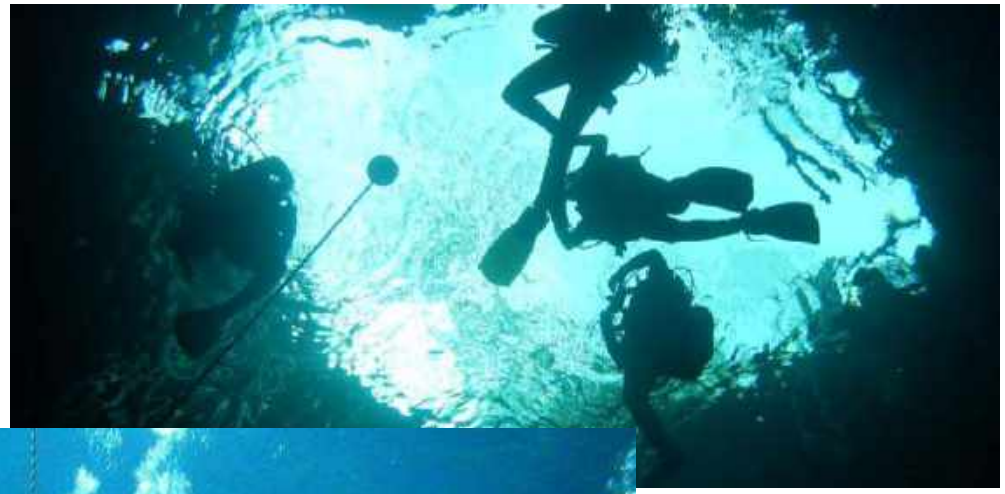
3) Bio-cultural approaches for conservation

- To integrate local and indigenous values into groundwater conservation
- Indigenous knowledge about entrance to caves, cenotes
- Oral traditions, ceremonies, etc.
- **Goal: R**ecover, **R**estore, **R**evitalize Indigenous knowledge

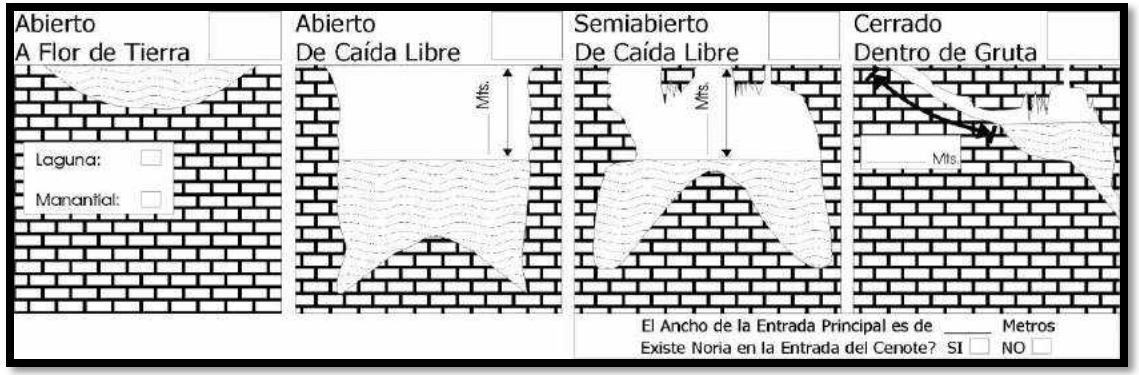
Photos: Yolanda Lopez

4) Underwater and cave exploration

- To obtain real information about the status of cenotes
- To identify hotspots of pollution
- To identify cultural materials
- Speleological prospection with local guides



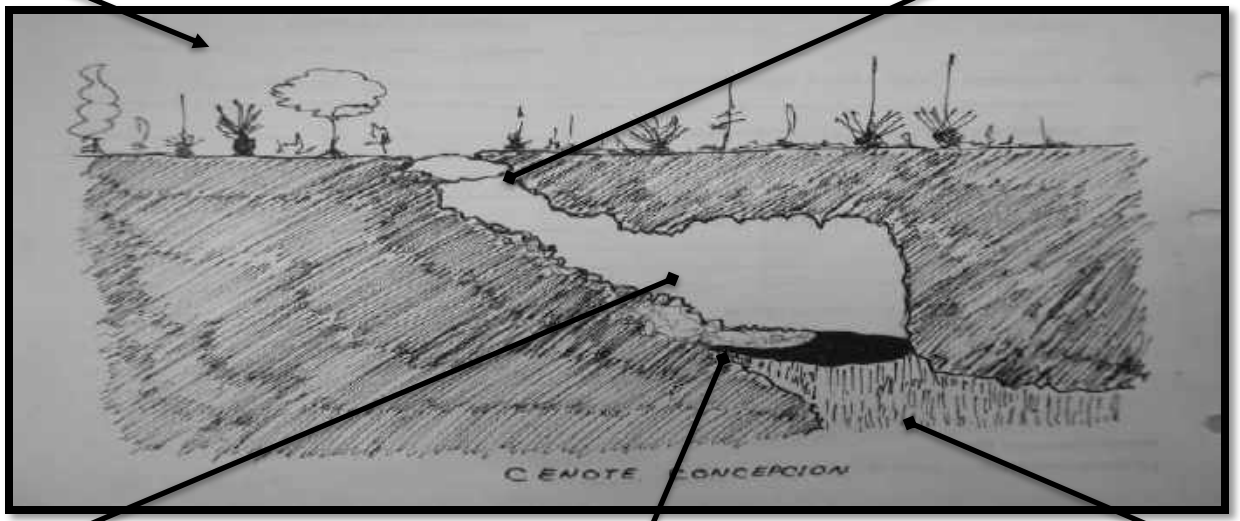
Photos : Yolanda Lopez



Classificatory scheme of the cenote according the entrance

Entrance (e.g. location, pollution, biodiversity, communities, infrastructure)

Example of speleological drowing obtained during fieldwork



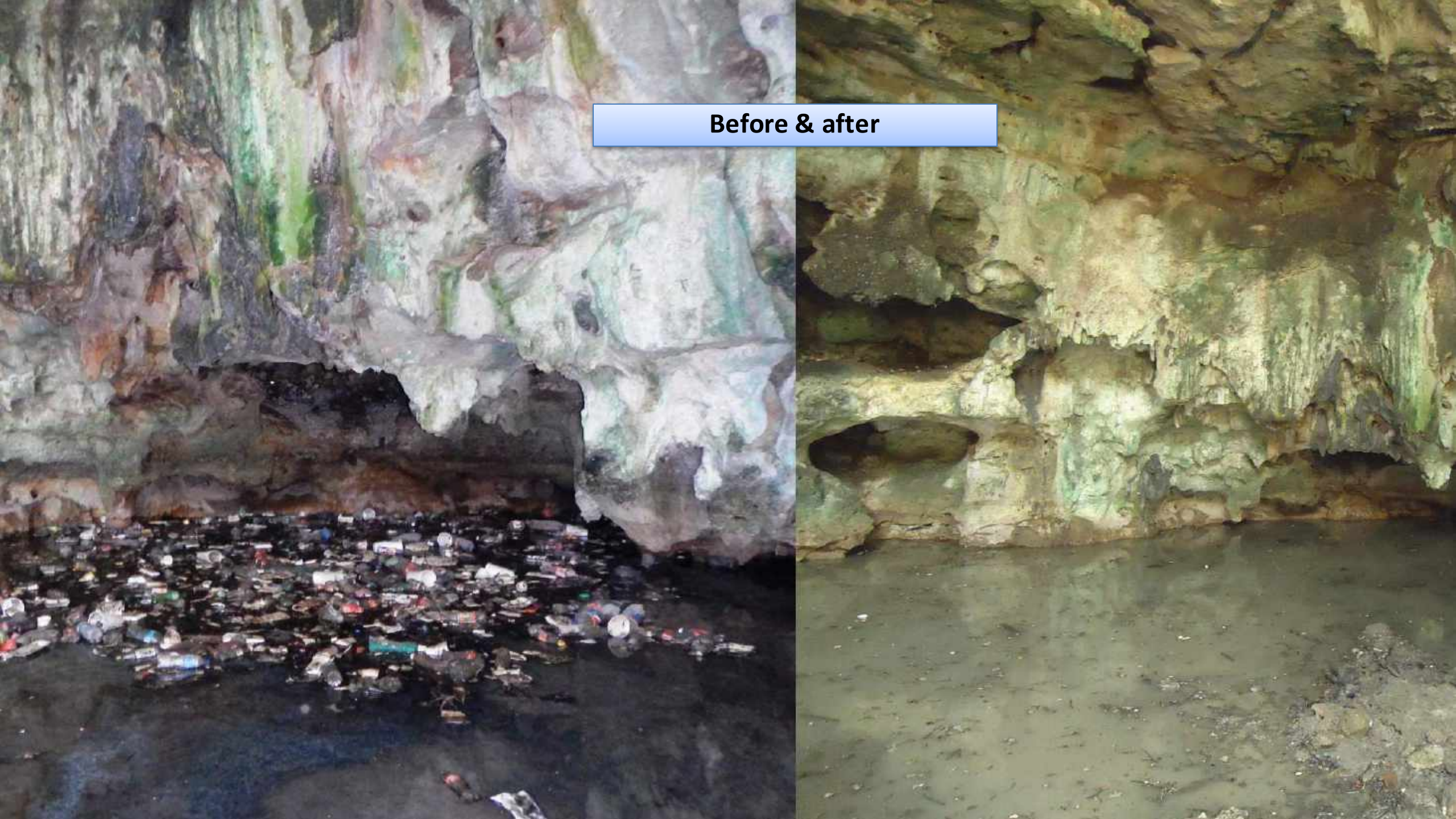
Karst formations (ancient cultural material, pollution, vandalism, presence of biodiversity, etc.)

Cave prospection (e.g. biodiversity, ancient cultural material, extraction infrastructure, etc.)

Underwater exploration (e.g. pollution, biodiversity, ancient cultural material, turbidity, etc.)

5) Cenote clean-ups with the community

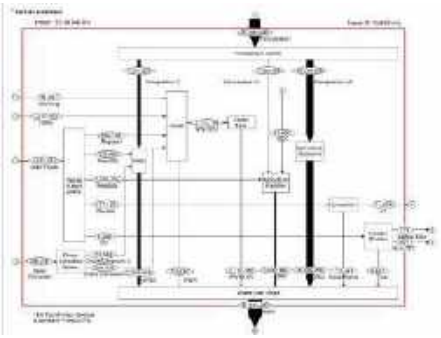
- To restore community values
- To promote & increase collective action
- To restore degraded ecosystems


Before & after

Specific SDG 6 related Targets with toolbox

Target 6.2: Examination of the amount of wastewater treatment processes in specific socio economic sectors

Target 6.4
Promotes monitoring process of water availability and withdrawals
Promotes improved allocations between users by revealing water extraction trends



Target 6.6b: Extremely influence groundwater literacy

Target 6.3: Facilitates the identification of human induced flows and the amount of water recycled
Promotes participation and transdisciplinary approaches

Target 6.1: Facilitates the examination of hotspots of pollution

Target 6.5: Support the involvement of stakeholders in the development and application of results

Final remarks

- How to integrate local information into global monitoring efforts?
- How hydrological models can significantly contribute towards groundwater literacy?
- How can indigenous communities develop their monitoring tools and to produce information to use and monitor groundwater resources properly?
- How can scientists and policy-makers consider local conditions, indigenous knowledge and norms to build local-scale models, considering that groundwater problems are largely local?

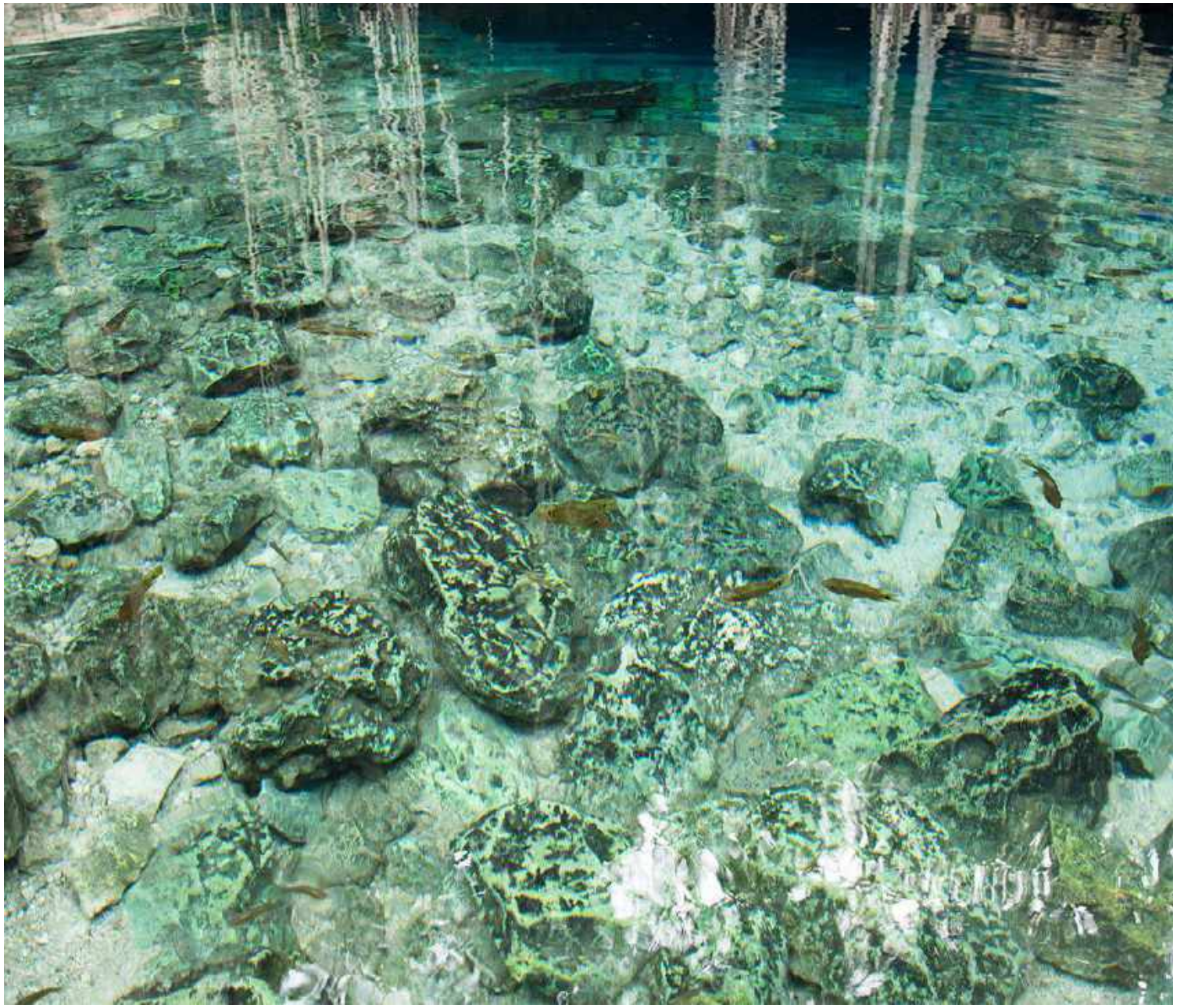


Photo: Miguel Cetina

Thank you
Gracias
Merci

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