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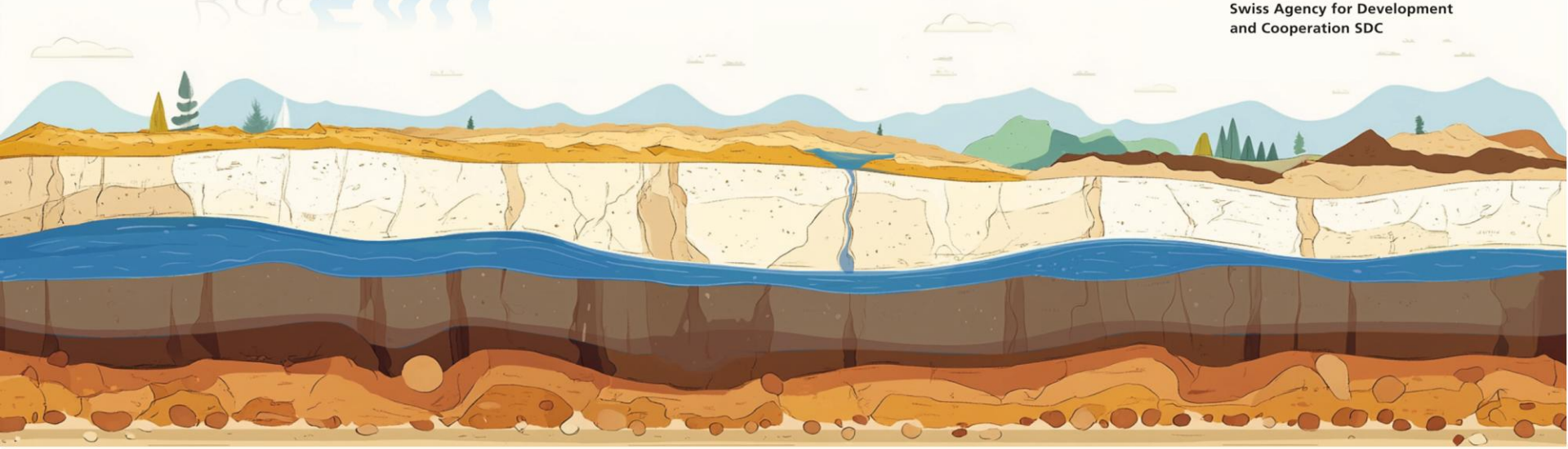

Groundwater data and monitoring

RésEAU Learning Journey on Groundwater 2024/2025
Webinar 2 - 13.5.2025

we are starting soon!

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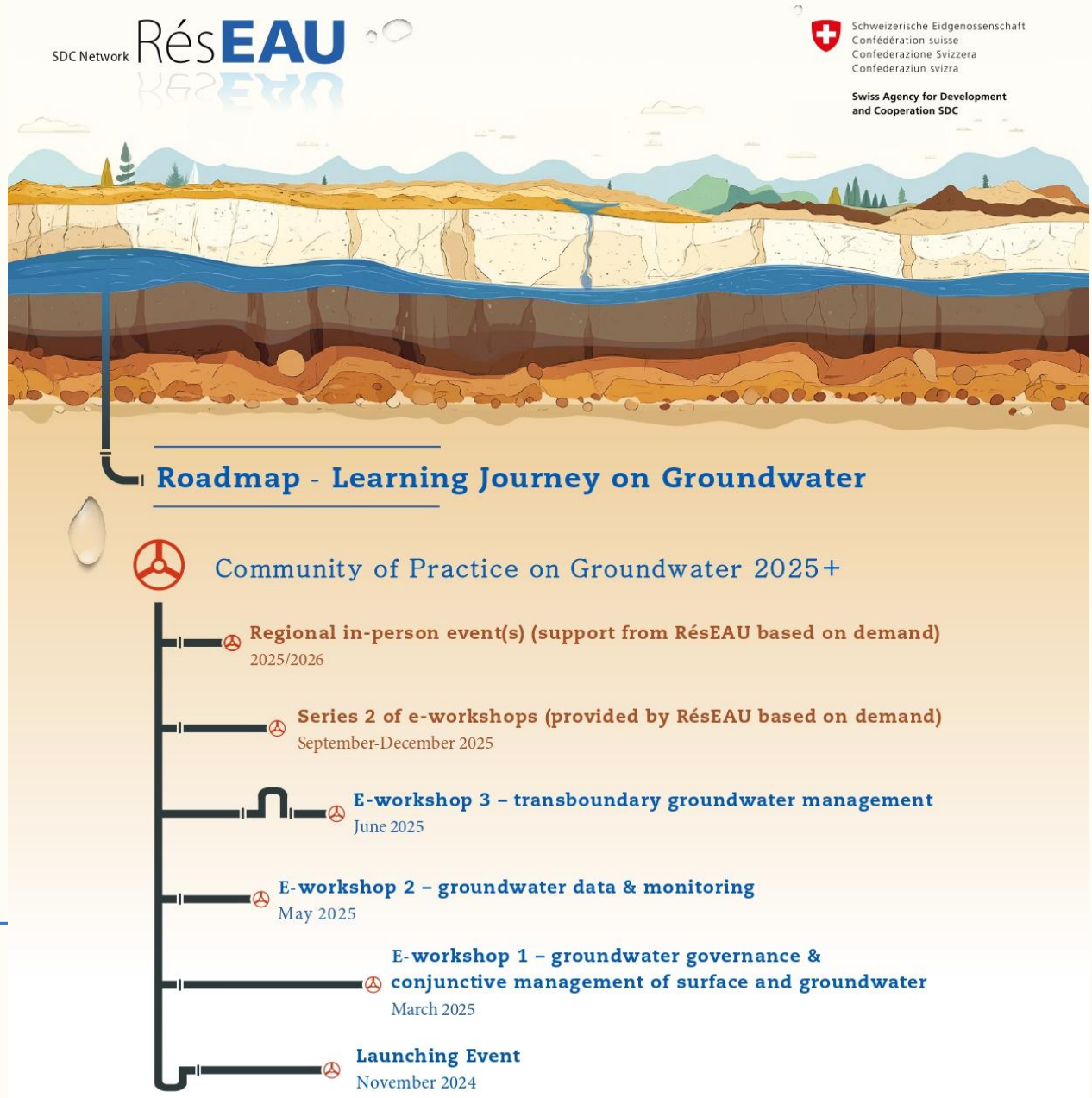
Introduction



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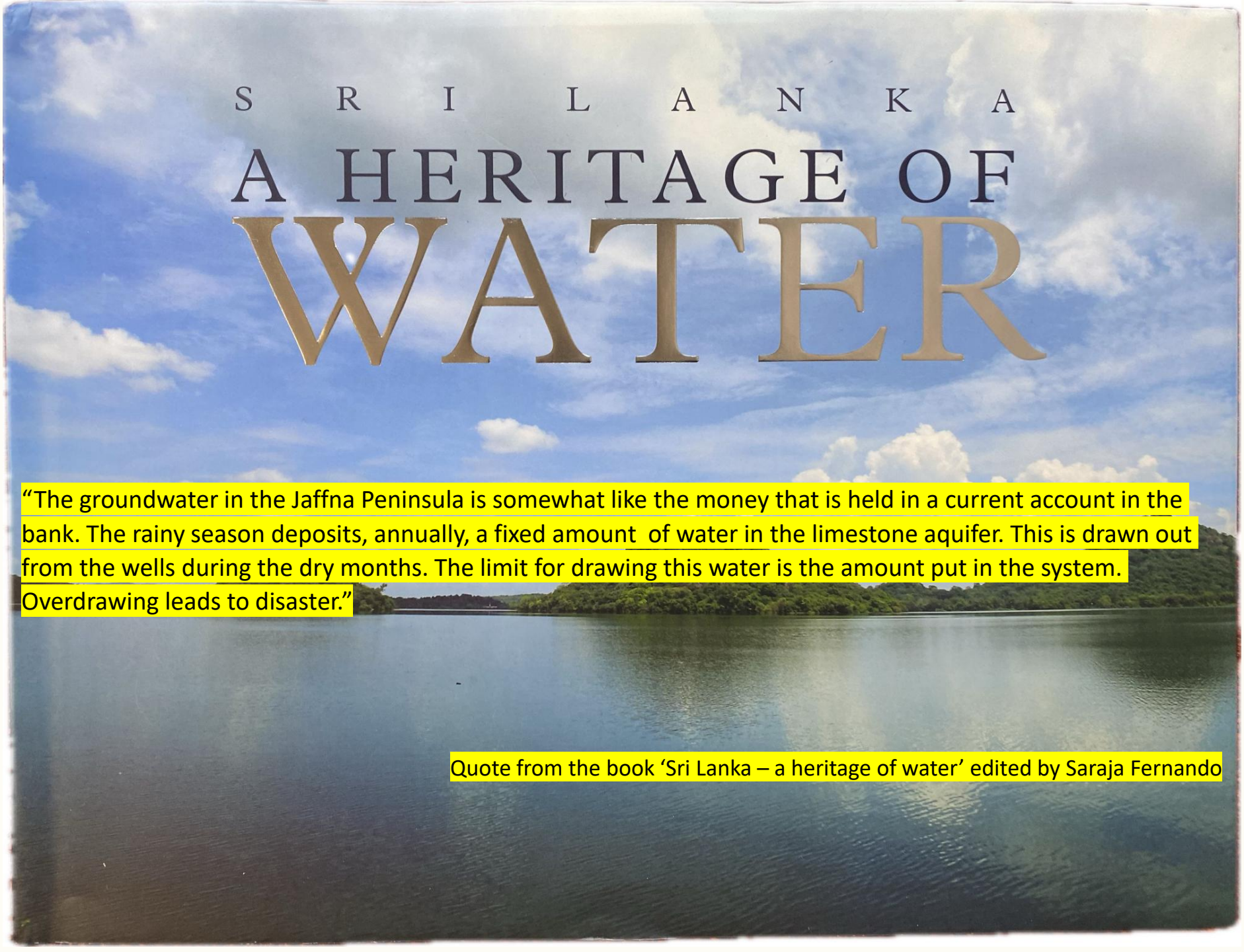
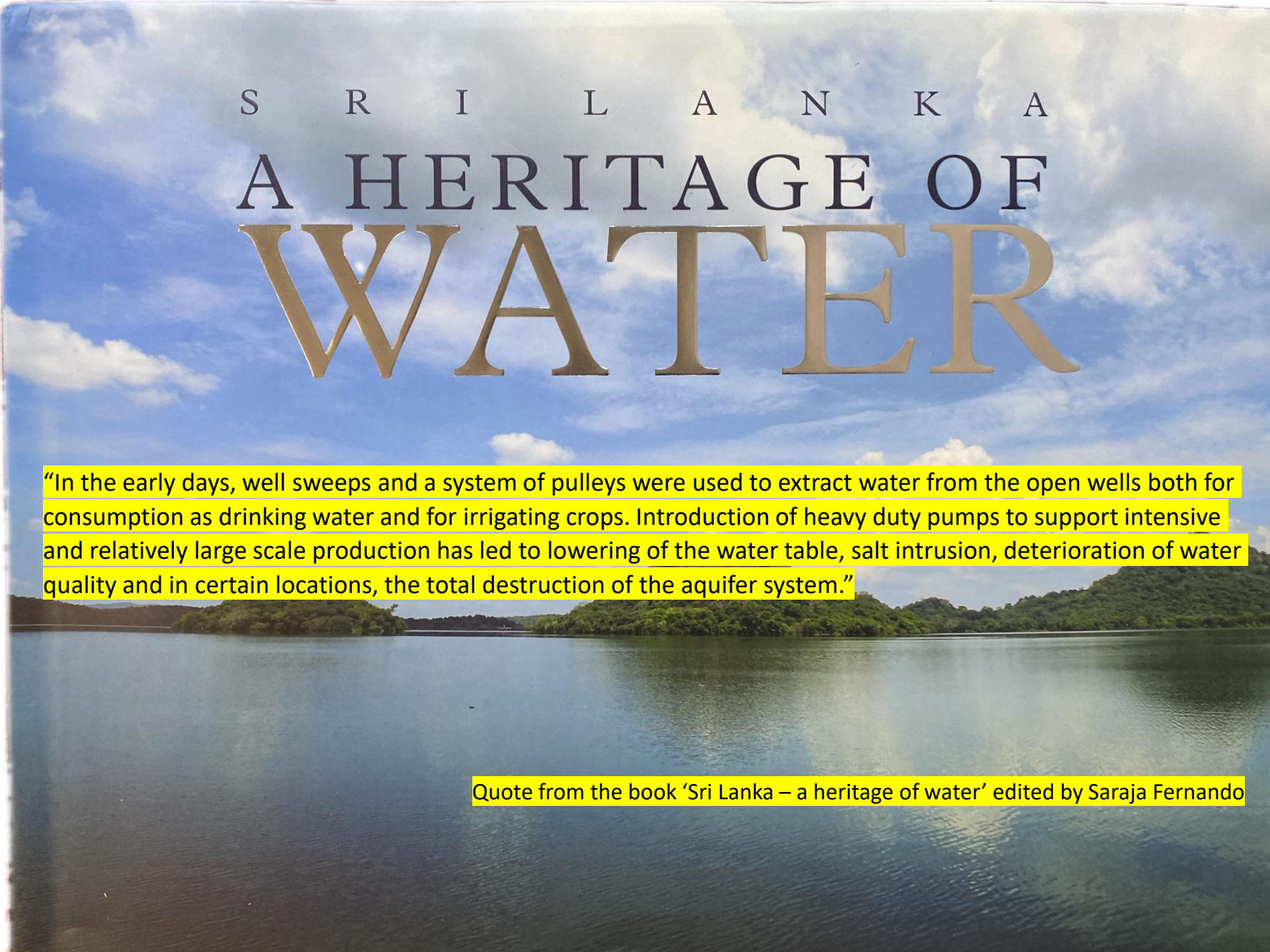


"The groundwater in the Jaffna Peninsula is somewhat like the money that is held in a current account in the bank. The rainy season deposits, annually, a fixed amount of water in the limestone aquifer. This is drawn out from the wells during the dry months. The limit for drawing this water is the amount put in the system. Overdrawing leads to disaster."

Quote from the book 'Sri Lanka – a heritage of water' edited by Saraja Fernando



"In the early days, well sweeps and a system of pulleys were used to extract water from the open wells both for consumption as drinking water and for irrigating crops. Introduction of heavy duty pumps to support intensive and relatively large scale production has led to lowering of the water table, salt intrusion, deterioration of water quality and in certain locations, the total destruction of the aquifer system."

Quote from the book 'Sri Lanka – a heritage of water' edited by Saraja Fernando

Agenda

Introduction to the webinar	**Dr. Daniel Maselli**, Focal Point water network 'RésEAU', Swiss Agency for Development Cooperation (SDC)
Keynote: Global overview in groundwater data and monitoring	**Dr. Elisabeth Lictevout**, Director of the International Groundwater Resource Assessment Centre (IGRAC)
Q&A on keynote	
Water quality data in emergency settings for the city of Lima	**Eng. Pedro Luis Grados**, Lima Potable Water and Sewerage Service (SEDAPAL)
Building capacity for monitoring and evaluating groundwater data in Peru (El Agua nos Une)	**Javier Antiporta Peñaloza**, Hydrological Monitoring and Natural Infrastructure Specialist, CARE Peru
Rapid groundwater potential mapping for humanitarian contexts	**Marc-André Bünzli**, Head of WASH at Swiss Humanitarian Aid, SDC
Q&A, plenary discussion	
Conclusion and closing	**Dr. Daniel Maselli**

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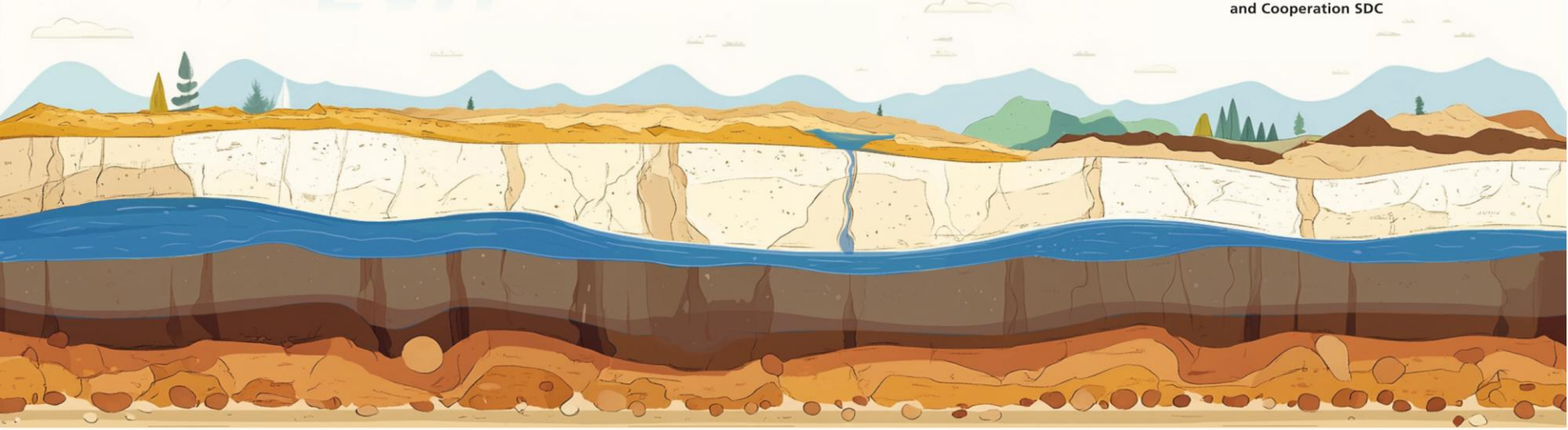


Groundwater data and monitoring

A global overview

Elisabeth Lictevout, Director, IGRAC

IGRAC

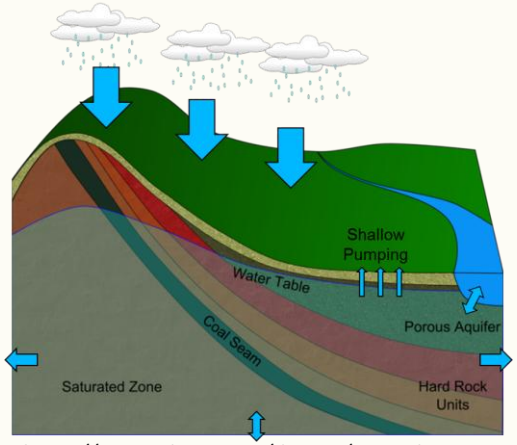
About IGRAC

- Global groundwater center, under the auspices of UNESCO and WMO, supported by Dutch government
- Data, research, knowledge transfer and awareness raising
- Focus on:
  - Global groundwater monitoring, status and management
  - Transboundary aquifers monitoring and assessment
- Contribution at different levels:
  - Global: international agendas, global reports, UN support
  - National: support to institutions in charge of groundwater
  - Local: raising awareness, linking local to global

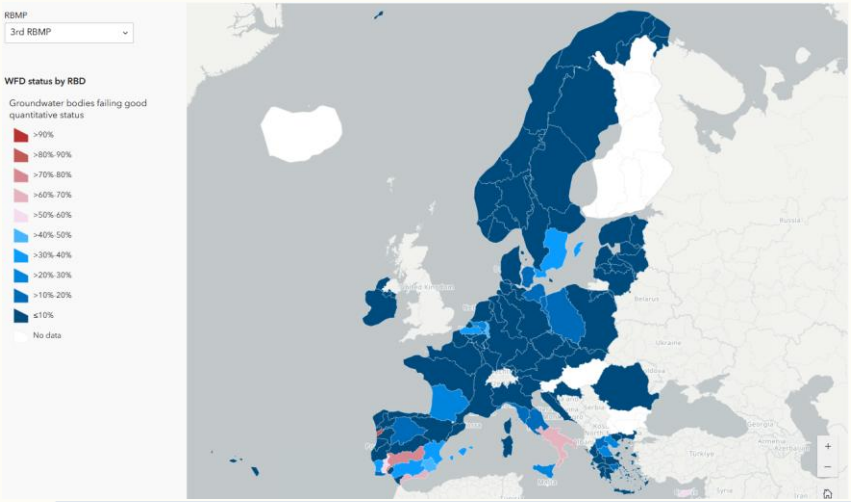
Why groundwater data & monitoring?

Objective of groundwater data acquisition and monitoring:

- To improve groundwater knowledge
- To assess and report on quantitative and qualitative status of groundwater



Source: https://research.csiro.au/data61/groundwater-modelling/



- To track extractions, contaminations
- Drought and flood "early" warning

Source https://water.europa.eu/freshwater/europe-freshwater/water-framework-directive/groundwater-quantitative-status

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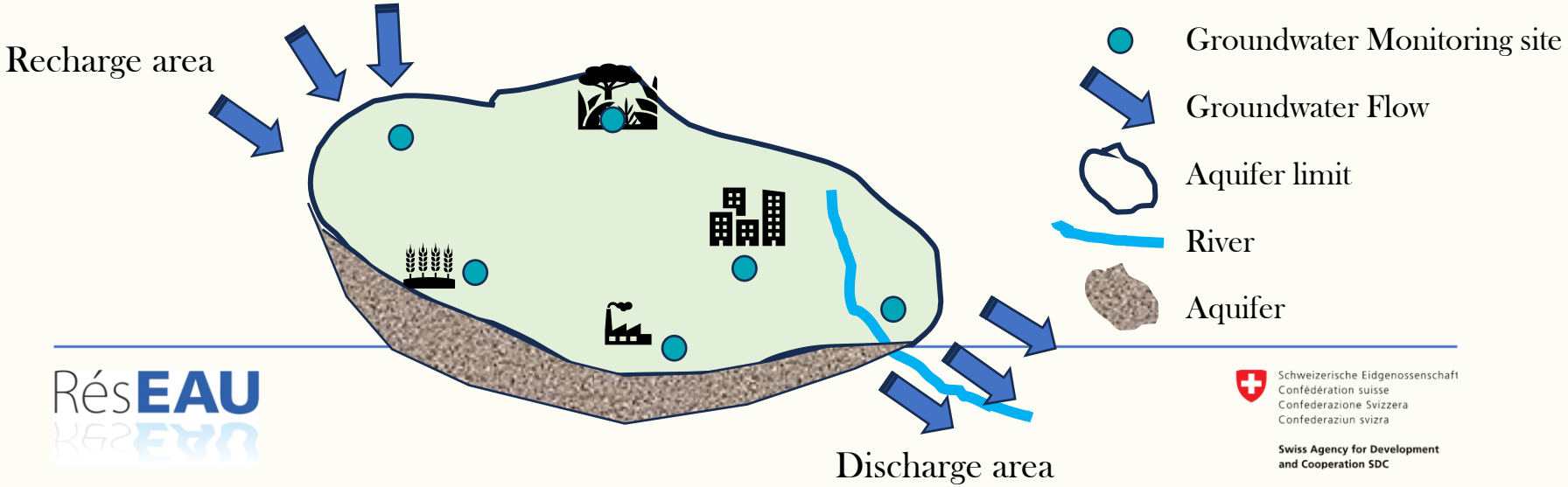
What do we need to know?

Features	Variables
• Aquifer limits • Lithology (and heterogeneities)	• Groundwater level • Extractions • Groundwater quality
• Natural recharge (cycles!) and discharge • Interactions with surface water and groundwater-dependant ecosystems	



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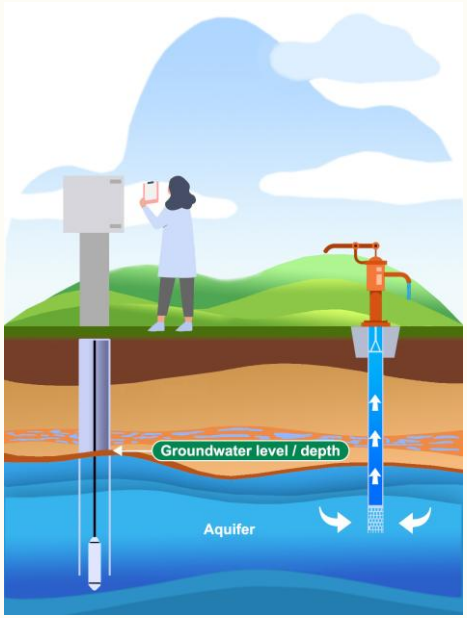
What do we need to monitor?

1- Groundwater levels



Modified from www.ysi.com/parameters/level

2- Groundwater quality

© E. Lictevout (2020)

3- Groundwater extraction

Source: https://dwr.colorado.gov/services/ well-metering

Where to monitor groundwater?

1- Wells and boreholes

https://wikiwater.fr

Source: https://microsites.wika.com/newscontentgeneric_ms.WIKA?AxID=472

2- Springs

Source: Lo Russo S., Suozzi E., Gizzi M. et al. (2021)

3- Wetlands

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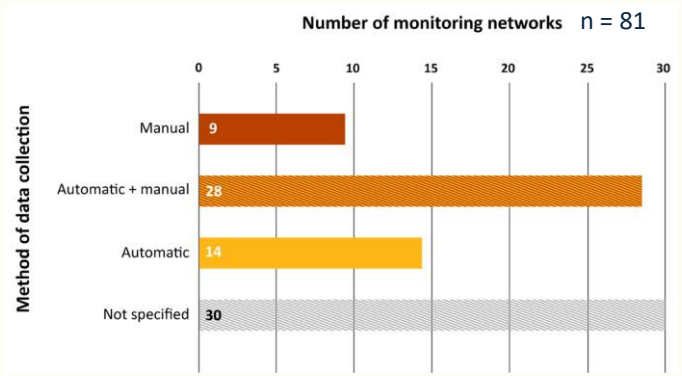
How do we monitor groundwater?

1- Manual monitoring



2- Sensors

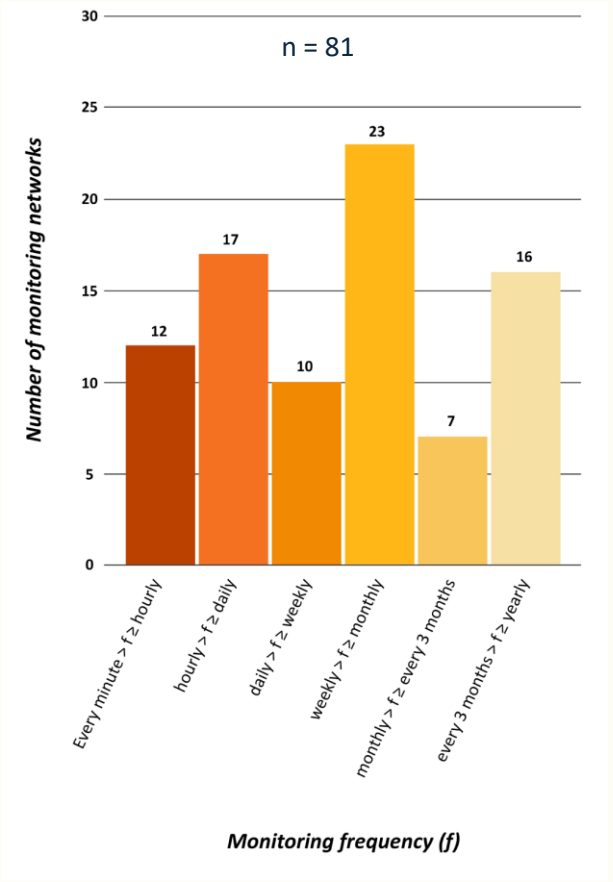
© IGRAC (2024) Rwanda

Source: IGRAC (2020) Global Overview of National Groundwater Monitoring Programmes

How do we monitor groundwater?

How frequent to monitor and for how long?

Groundwater: slower flow and long residence time.



Source: IGRAC (2020) Global Overview of National Groundwater Monitoring Programmes

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Alternative ways of monitoring groundwater

It is often challenging for national institutions to monitor remote and/or wide areas.

Therefore, it is key to integrate in the monitoring programme:

- Participatory monitoring by the local population
- Integration of local knowledge

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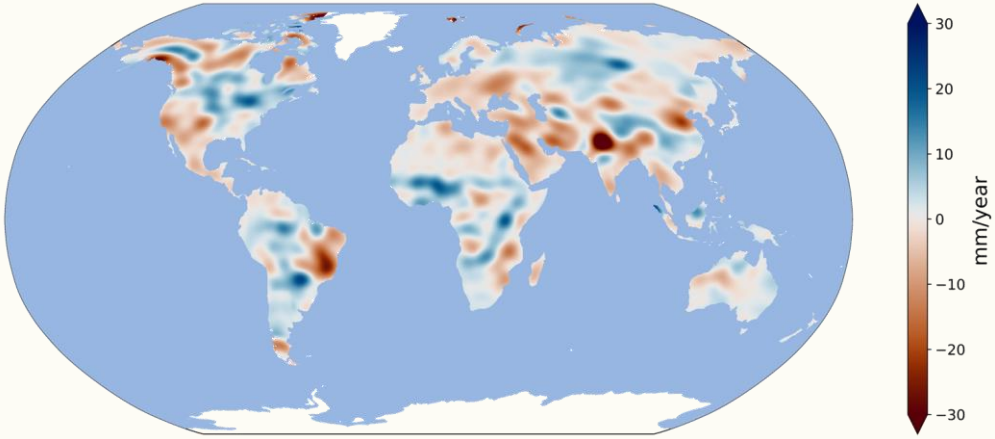
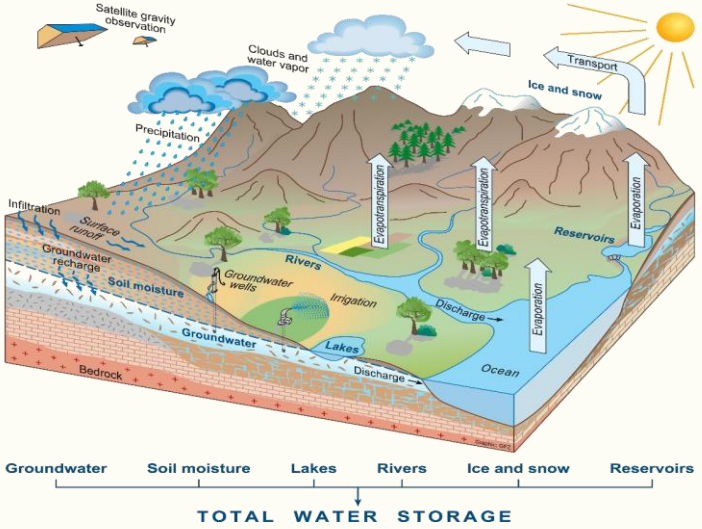
Can we monitor groundwater from space?

GRACE/GRACE-FO satellite gravity data: Total water storage



Source: G3P project. Groundwater storage trend 2002-2016



Groundwater = TWS - glaciers - snow - soil moisture - storage in surface water bodies

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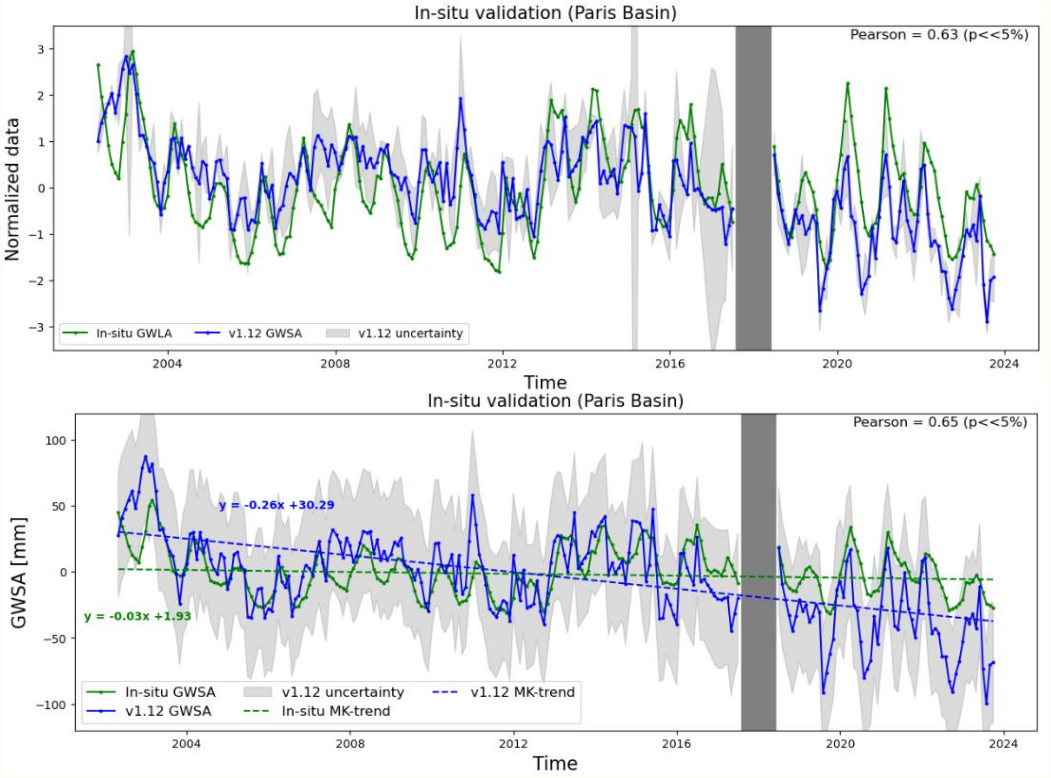

Paris basin, France

- Good overall correlation
- Both trends are decreasing

Source: IGRAC - Morlière S. (2024).

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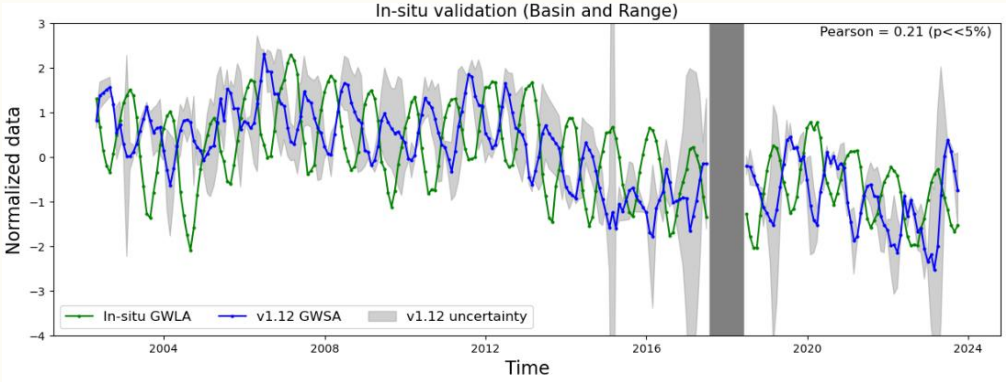
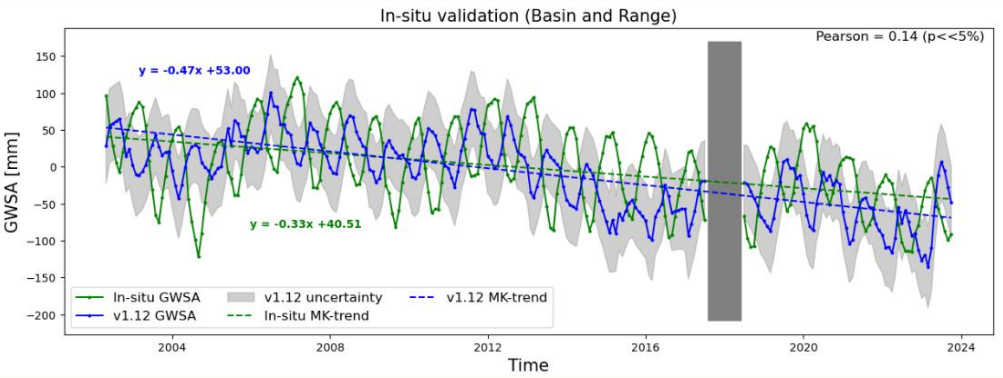
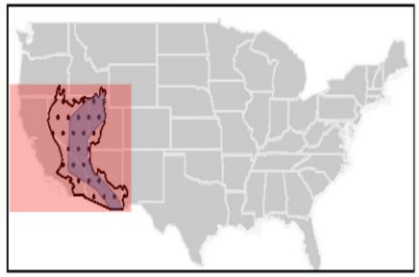
Can we monitor groundwater from space?

GRACE/GRACE-FO satellite gravity data: Total water storage





Basin and Range, USA



- Low overall correlation
- Strong signal dephasing
- But similar decreasing MK-trend

Source: IGRAC - Morlière S. (2024).

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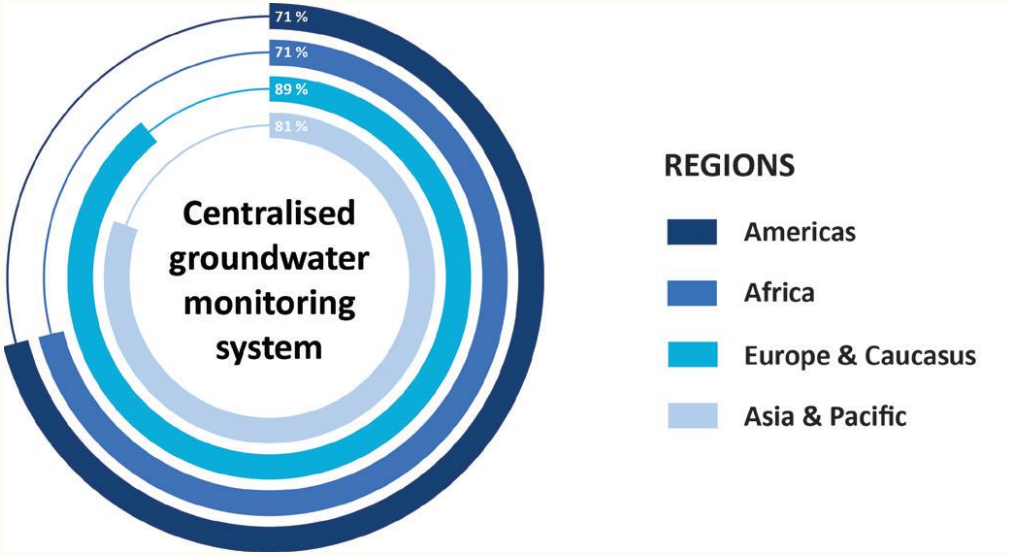
Who monitor groundwater?

- National or subnational institution in charge of groundwater
- Local networks set up for project or research purpose

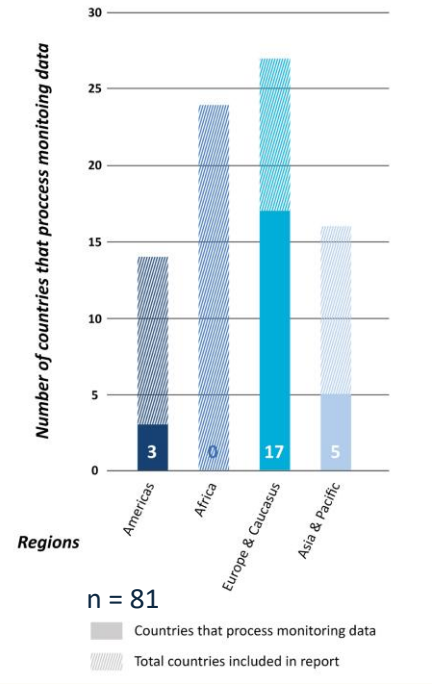


Source: IGRAC (2020) Global Overview of National Groundwater Monitoring Programmes

Countries with a centralised monitoring system, per region (in %). n = 81

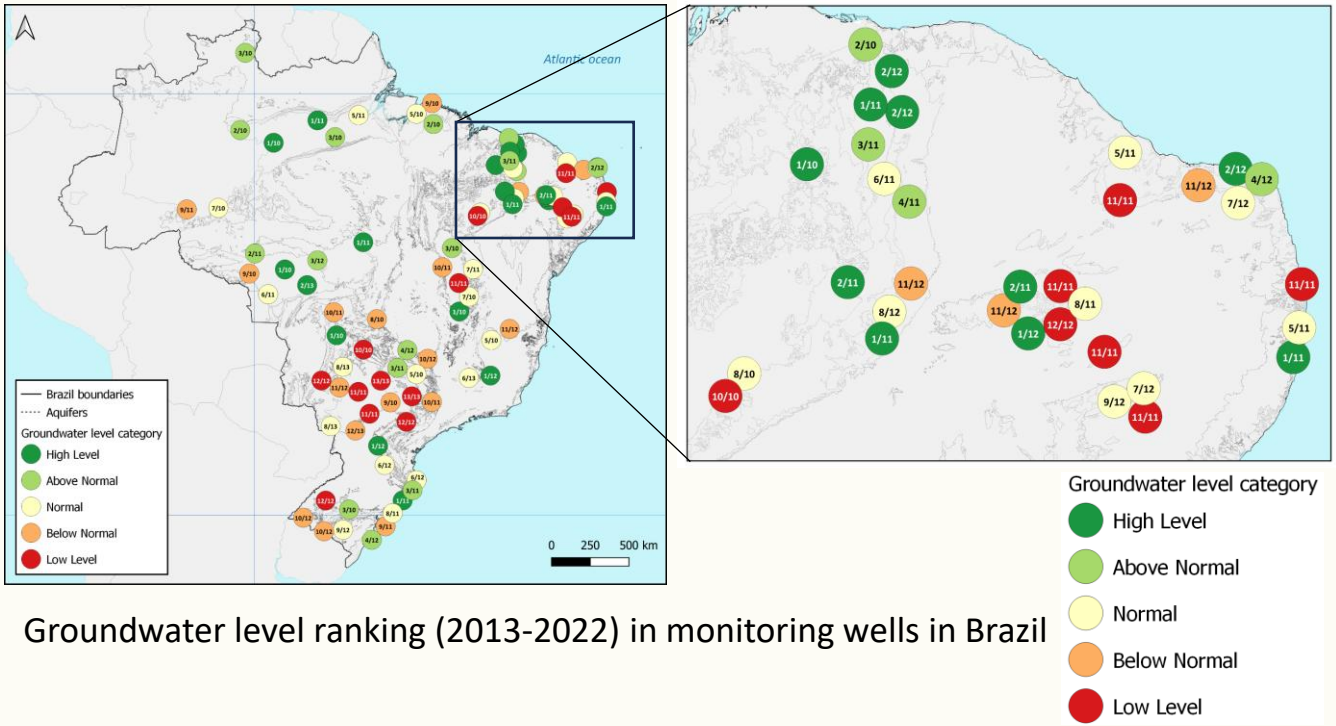
From monitoring to reporting

Key information for decision making



Source: IGRAC (2020) Global Overview of National Groundwater Monitoring Programmes

Indicator 1: Groundwater ranking (level and quality parameters)



Groundwater level ranking (2013-2022) in monitoring wells in Brazil

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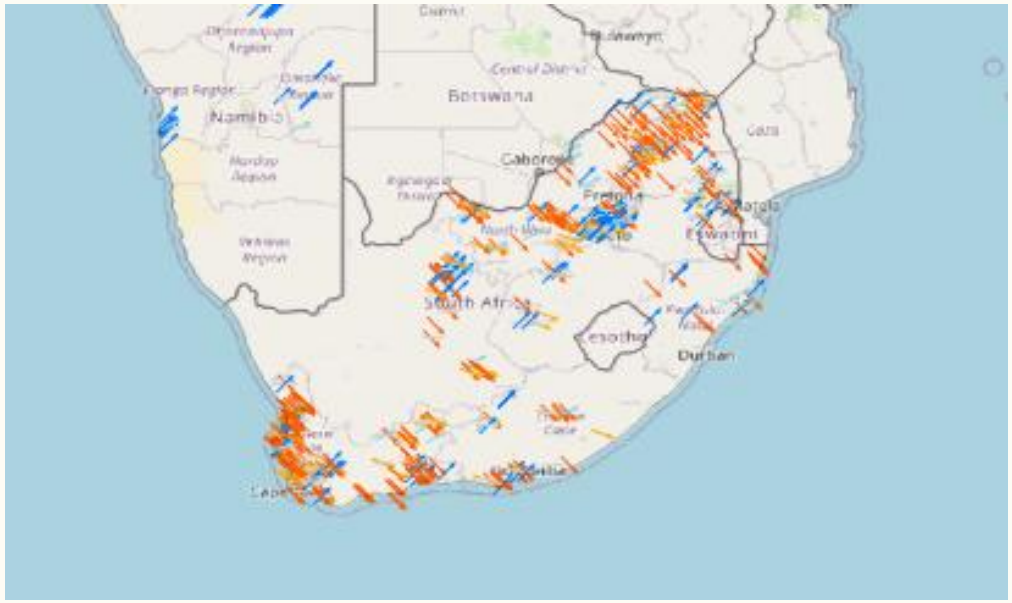
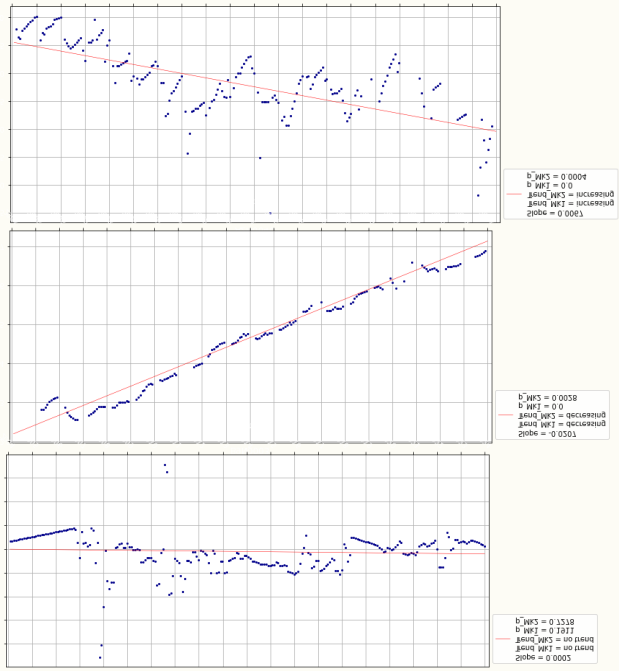
From monitoring to reporting

Key information for decision making

Indicator 2: Groundwater long term trends

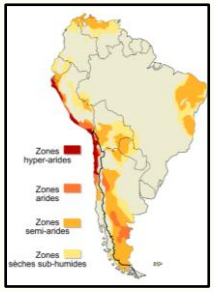


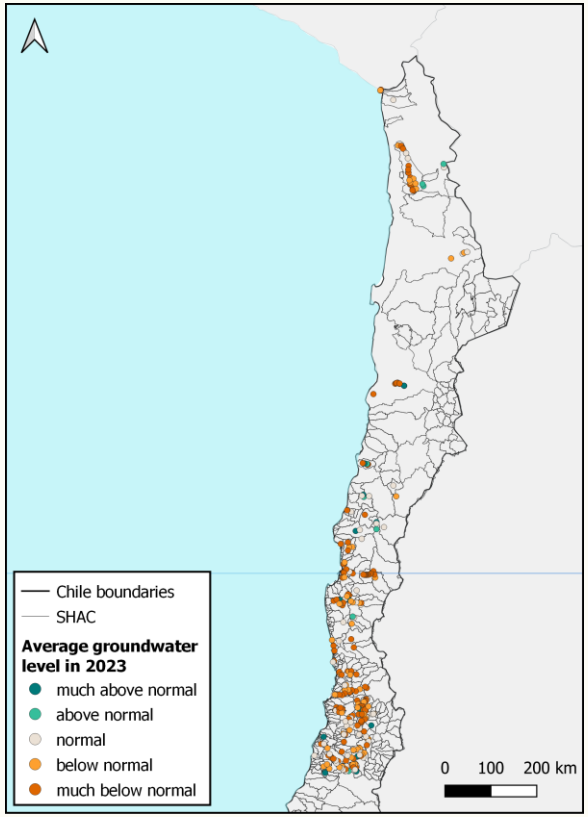


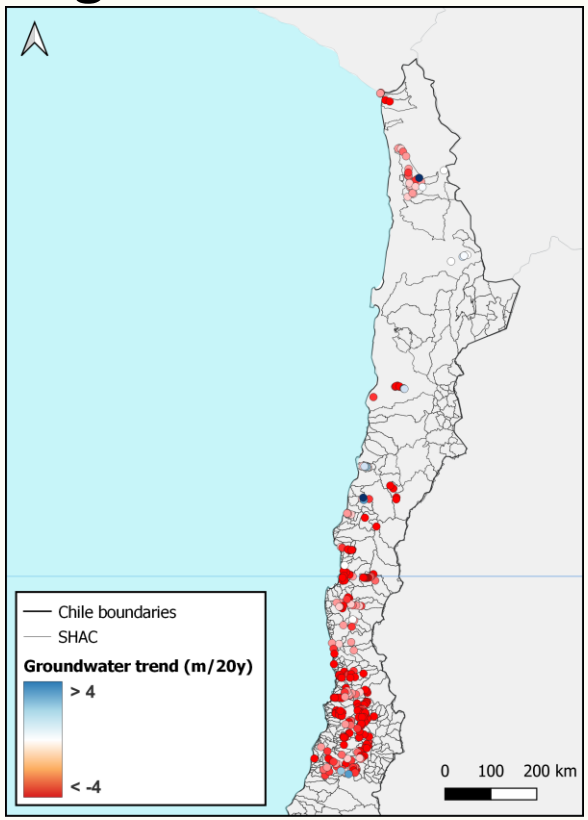
Groundwater level trends (2000-2020) in monitoring wells in South Africa

From monitoring to reporting

Key information for decision making







Groundwater level ranking and trends (2004-2023) in monitoring wells in Chile

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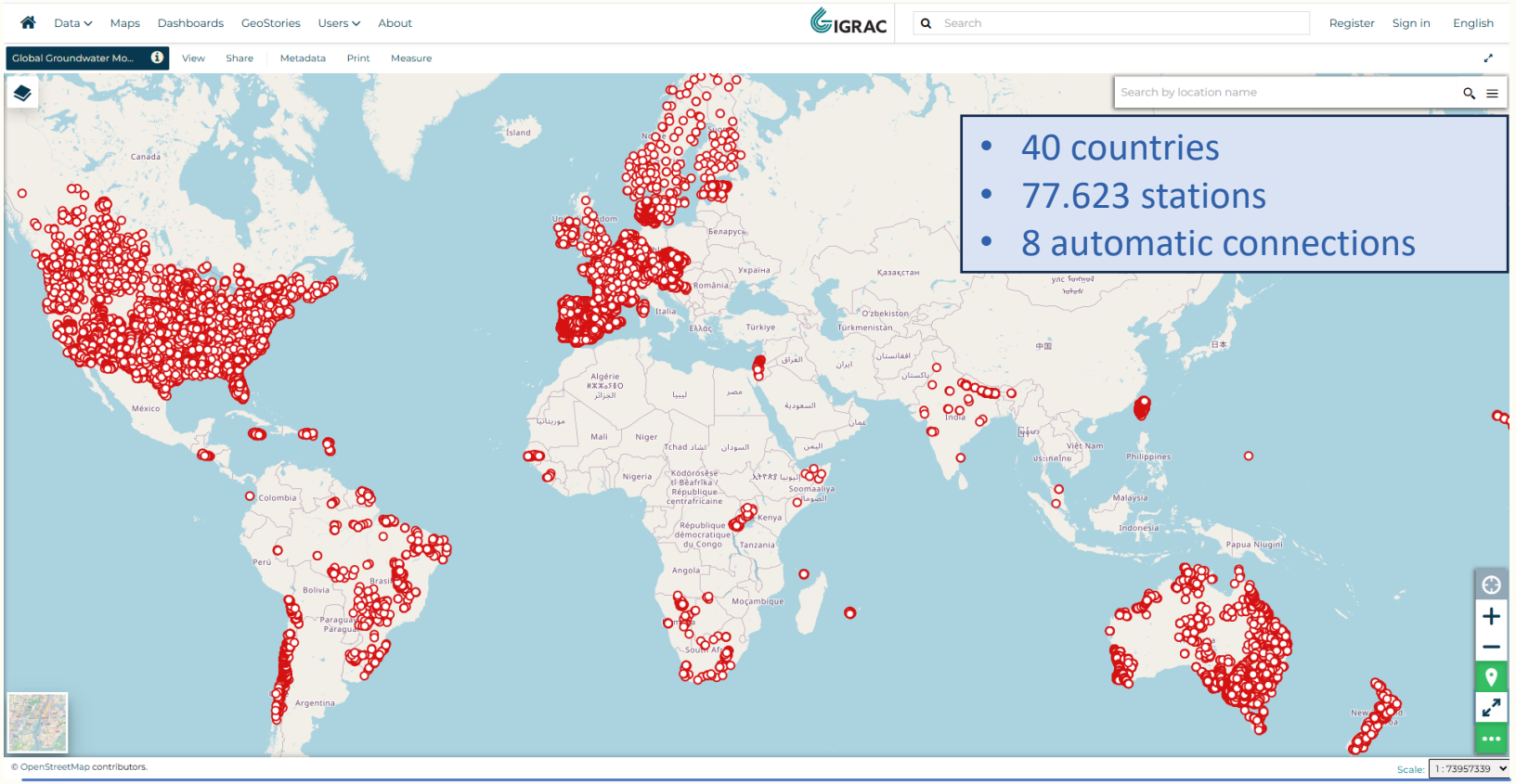
Groundwater monitoring worldwide

Global Groundwater Monitoring Network (GGMN)



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Groundwater monitoring worldwide

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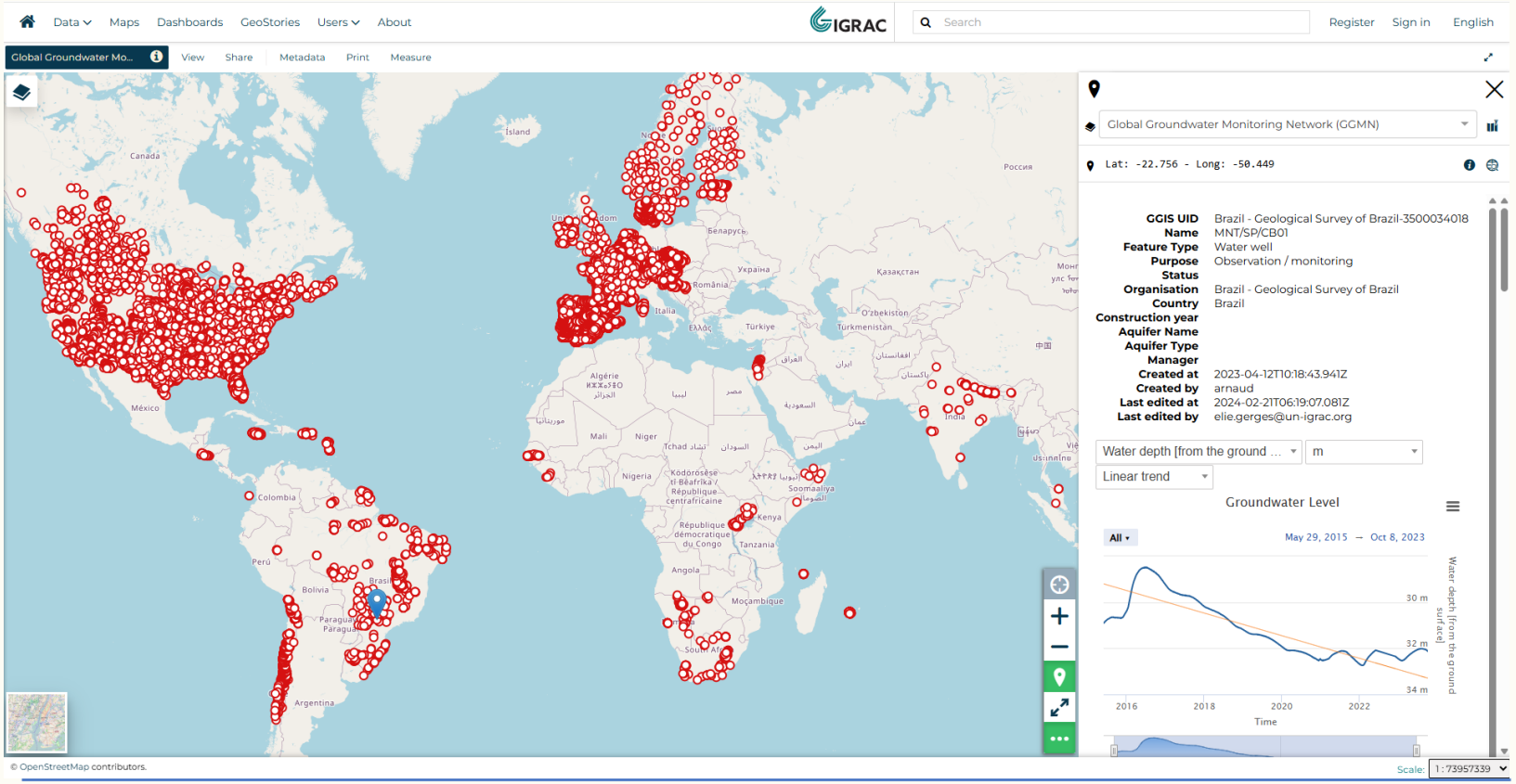

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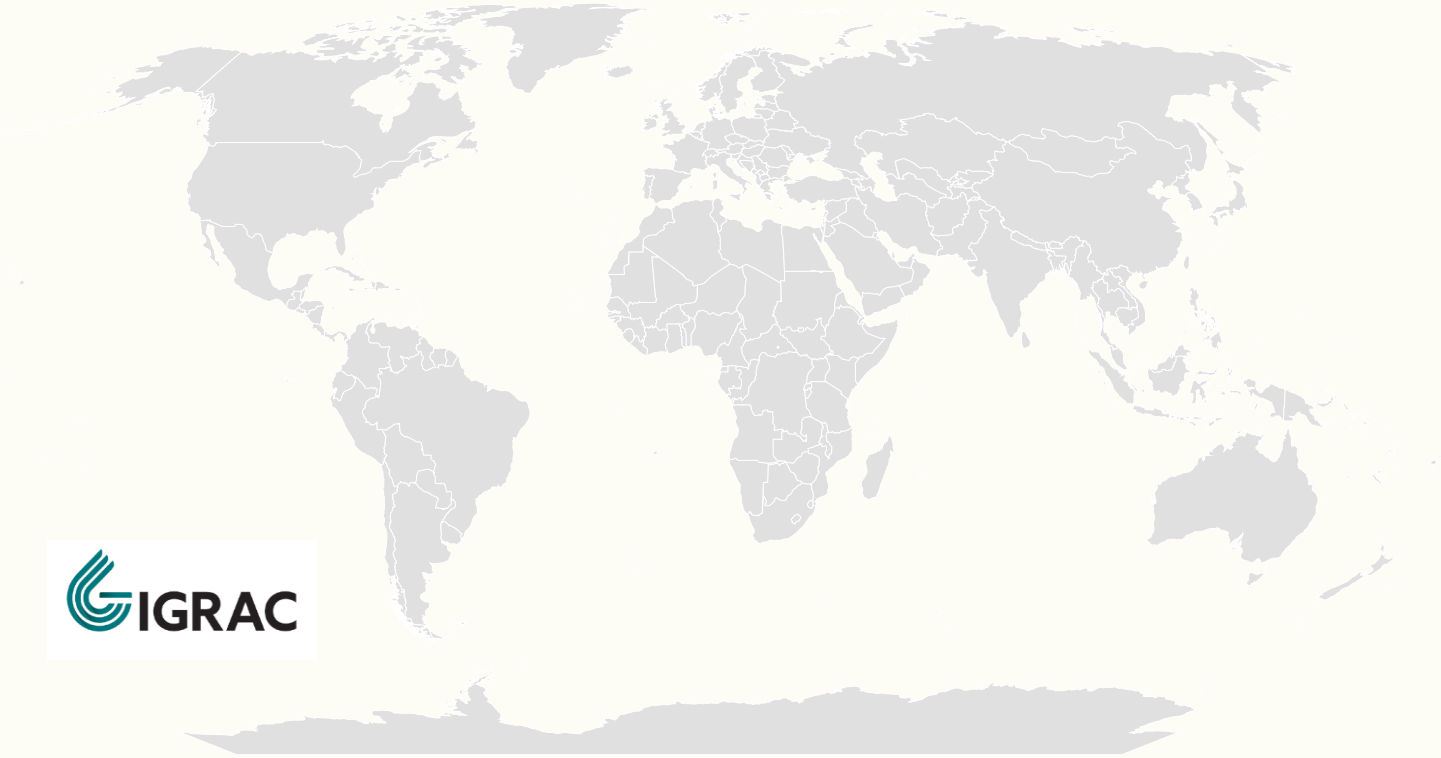
Groundwater monitoring worldwide

58 countries sharing groundwater level monitoring data



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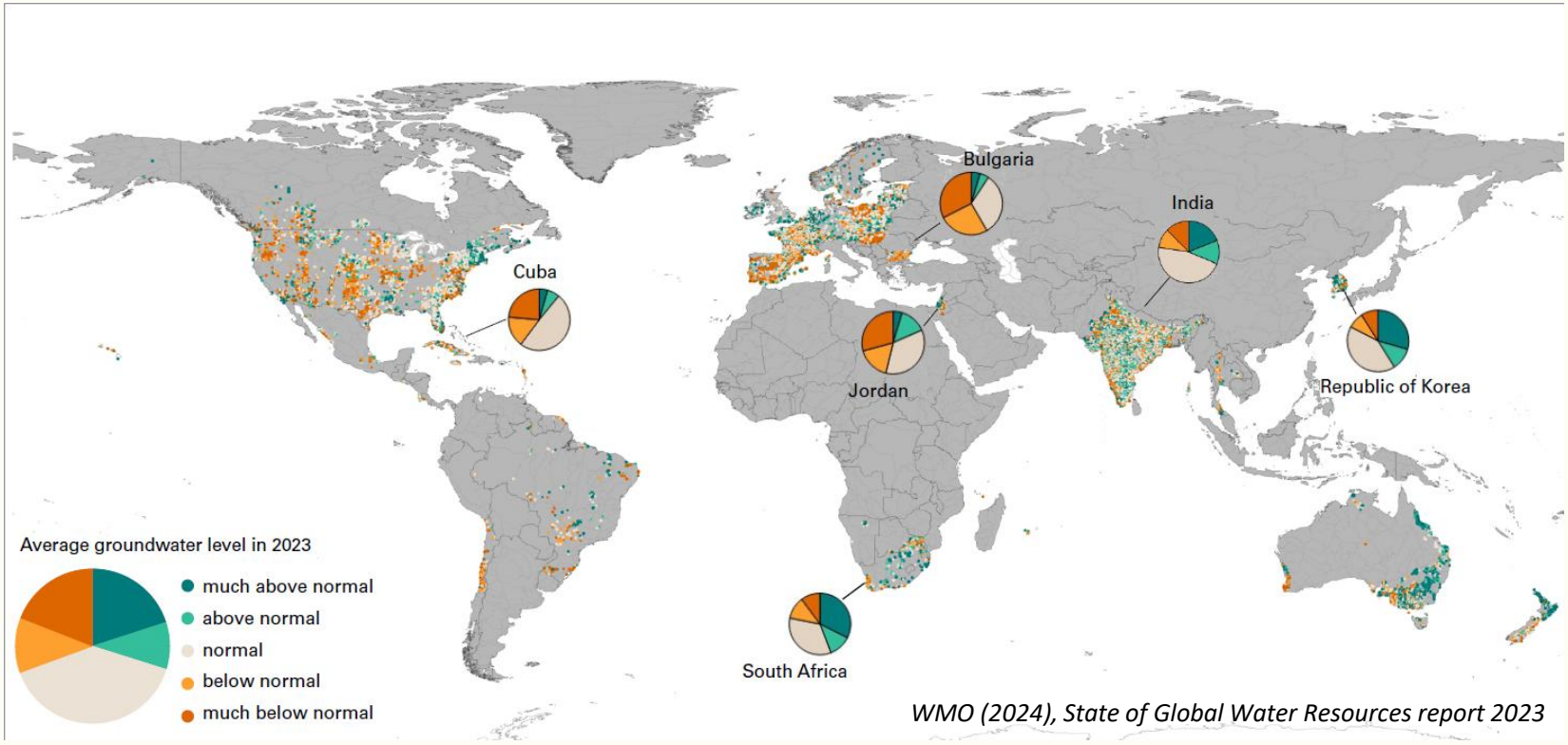
Groundwater monitoring worldwide

Historic groundwater level ranking for 2023: Data analyzed for 130.000+ wells, from 40 countries. 35.459 wells after filtering.



WMO (2024), State of Global Water Resources report 2023

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Conclusion

- Groundwater: a slow yet dynamic system
- Continuous studies and observations are required ➔ Long term investment
- In many examples, groundwater management has been initiated with very limited information, and improved over time
- Increase need for monitoring with accelerated changes affecting natural processes: recharge; discharge; quality
- Although, in countries with long monitoring programme, less monitoring over years
- More countries are monitoring groundwater, and sharing data

Thank you

Elisabeth.lictevout@un-igrac.org

https://un-igrac.org/

https://ggmn.un-igrac.org/

https://ggis.un-igrac.org/

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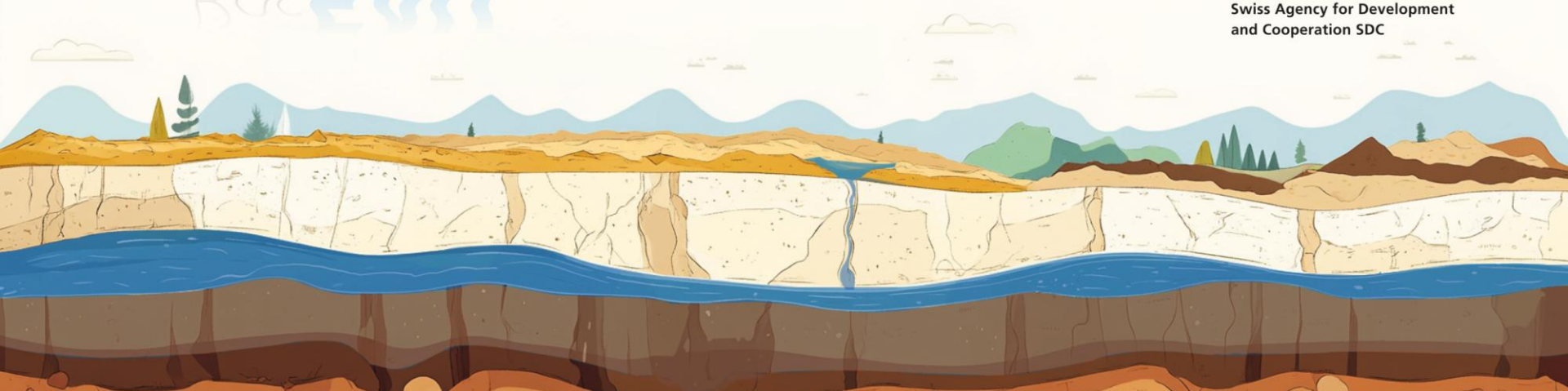

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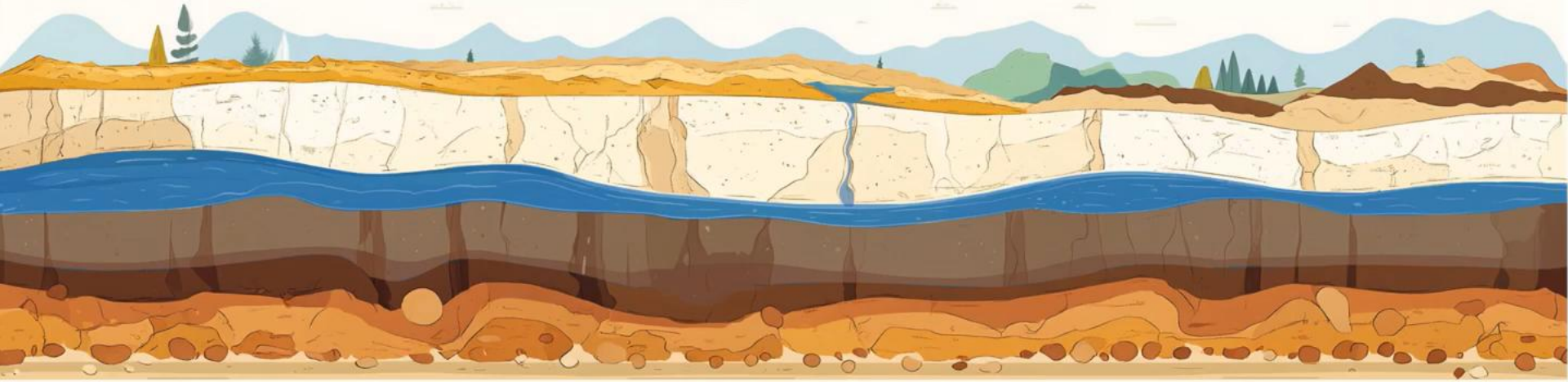

Emergency water

Case: Groundwater disaster risk management, 8.8 Earthquake alert in Lima

Pedro Luis Grados Chaw, Well Engineer, Team Grou
SEDAPAL

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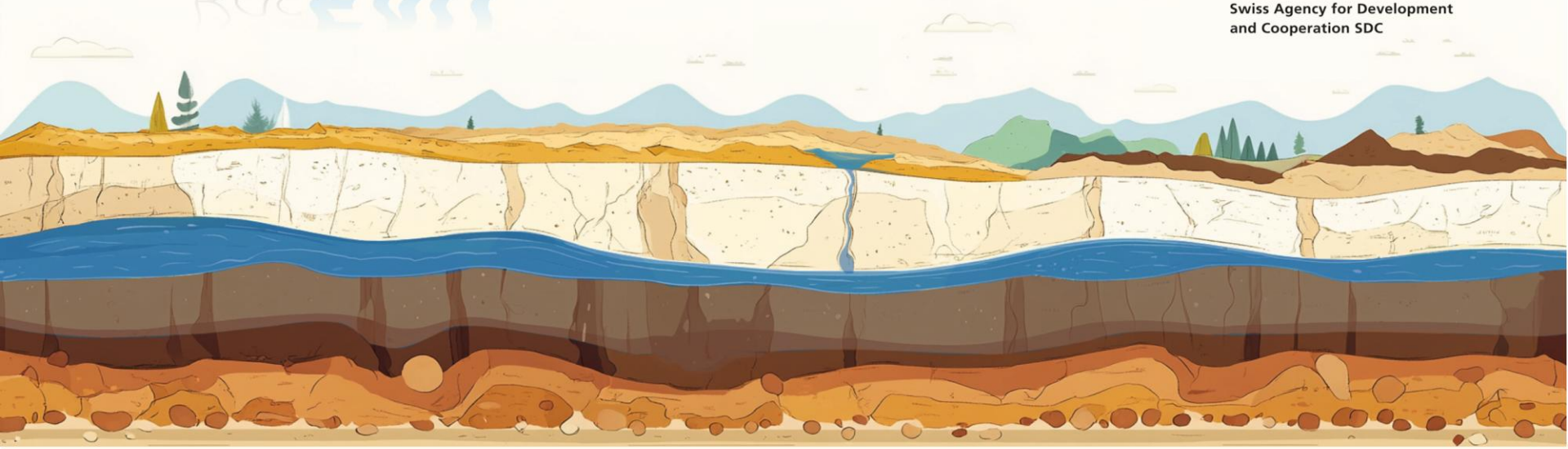


Building capacity for monitoring and evaluating groundwater data in Peru – El Agua Nos Une project

Peru case

Javier Antiporta, Hydrology monitoring specialist , CARE Perú

Water resources in Peru

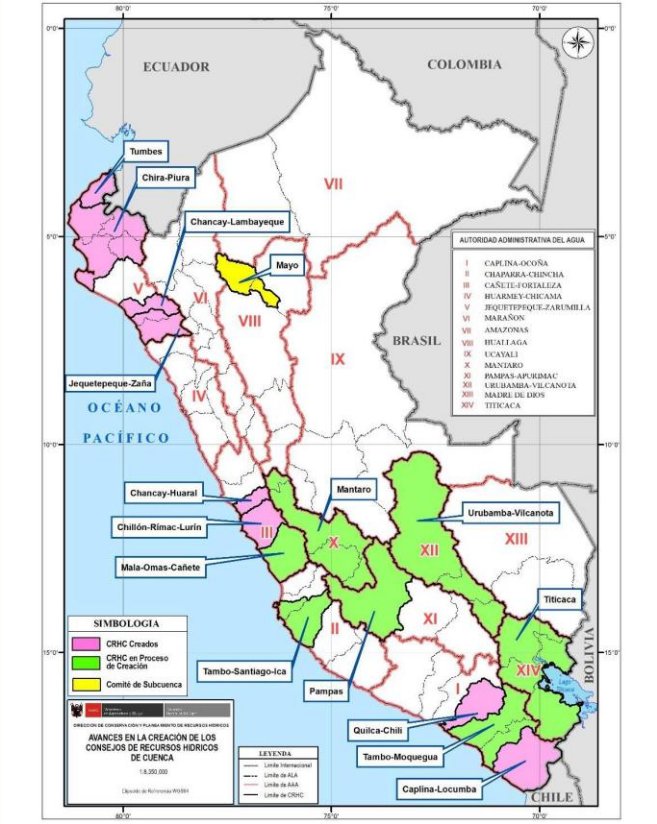
- Peru is the eighth water-richest country in the world in terms of freshwater volume and the third in Latin America, after Brazil and Colombia.

Hydrographic Region	Basins	Area (km^2)	% of Territory	Population	% of Population	Freshwater Availability (hm^3)	% of Total Water
Pacific	62	279700	21.8	18801417	65.0	34067	1.8
Amazon	84	958500	74.6	10018789	31.0	1895167	97.9
Titicaca	133	47000	3.7	1246975	4.0	6388	0.3
Total	**279**	**1285200**	**100.0**	**30067181**	**100.0**	**1935621**	**100.0**

Hydrographic Region	Groundwater disponibility (HMC)	% of Groundwater
Pacific	4844	0.9
Amazon	542998	99.0
Titicaca	615	0.1
Total	**548457**	**100**

Integrated water resources management in Peru

- In Peru, the IWRM is implemented through the National Water Resources Management System.
- The SNGRH is the set of institutions, principles and norms allowing for the articulation and co-ordination across public and private entities to meet water demands, avoid conflicts, carry out projects, etc.
- The National Water Authority (ANA) is the governing body of the SNGRH. It is a deconcentrated body, providing coverage to the 159 river basins in Peru. Its central headquearters is located in Lima.
- The ANA implemented the IWRM through its 14 regional offices, 71 local offices and 13 River Basin Councils. (OECD, 2021)



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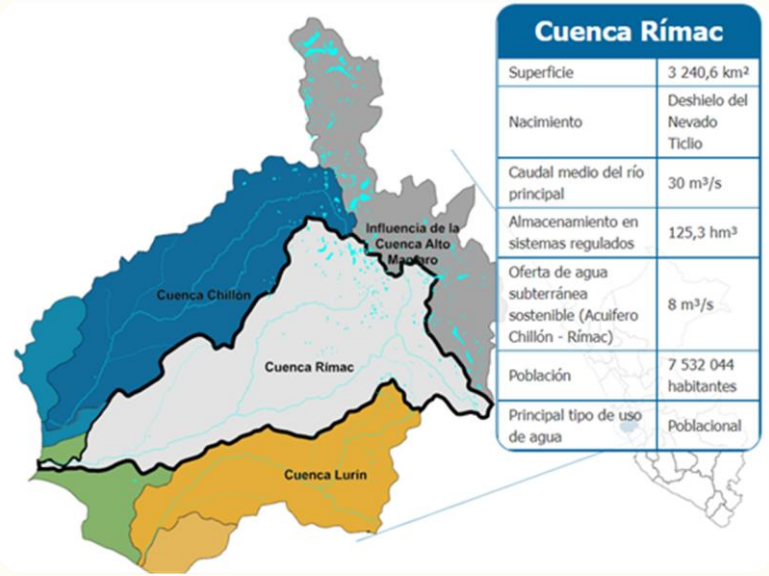
El Agua Nos Une Project in Peru

- El Agua Nos Une project aims to strengthen the implementation of public policies, multi-stakeholder alliances, and the participation of civil society and the private sector to promote leadership in a systemic change process toward responsible production and consumption, and enhance the value of water for society.
- The project is implemented in the Rimac River Basin.
- The project is carried out by CARE Peru and SAVAvida and is funding for the SDC.



Cuenca Rímac	
Superficie	3 240,6 km²
Nacimiento	Deshielo del Nevado Ticlio
Caudal medio del río principal	30 m³/s
Almacenamiento en sistemas regulados	125,3 hm³
Oferta de agua subterránea sostenible (Acuífero Chillón - Rímac)	8 m³/s
Población	7 532 044 habitantes
Principal tipo de uso de agua	Poblacional

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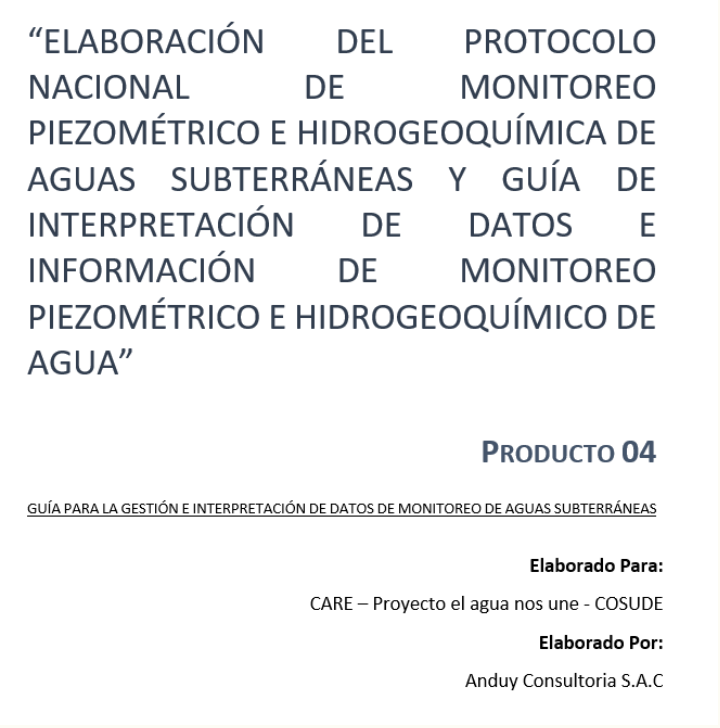
Building capacity for monitoring and evaluating groundwater

Data Collection

- In collaboration with the Directorate of Water Resources Quality and Evaluation (DCERH) of ANA, we have developed two tools that will standardize data collection in groundwater monitoring: the Monitoring Protocol for Piezometric Level and Hydrogeochemical Water Quality, and the Guide for Data Interpretation of Piezometric Level and Hydrogeochemical Water Quality Monitoring.
- These tools will streamline the data collection and reporting process for the specialized technical areas of the Administrative Water Authorities responsible for these tasks.



"ELABORACIÓN DEL PROTOCOLO NACIONAL DE MONITOREO PIEZOMÉTRICO E HIDROGEOQUÍMICA DE AGUAS SUBTERRÁNEAS Y GUÍA DE INTERPRETACIÓN DE DATOS E INFORMACIÓN DE MONITOREO PIEZOMÉTRICO E HIDROGEOQUÍMICO DE AGUA"

PRODUCTO 04

GUÍA PARA LA GESTIÓN E INTERPRETACIÓN DE DATOS DE MONITOREO DE AGUAS SUBTERRÁNEAS

Elaborado Para:

CARE – Proyecto el agua nos une - COSUDE

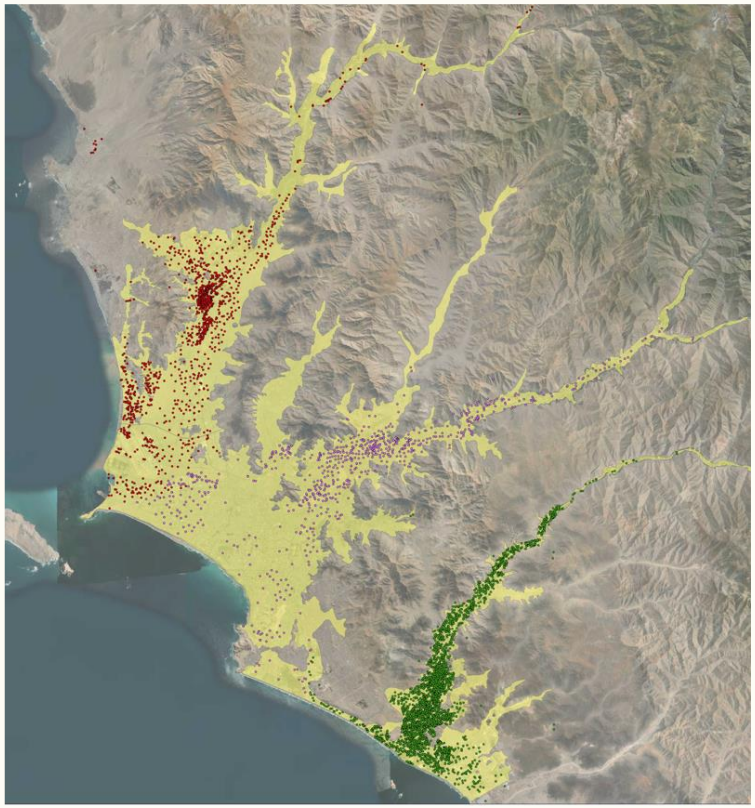
Elaborado Por:

Anduy Consultoria S.A.C

Building capacity for monitoring and evaluating groundwater

Data Systematization

- In 2024, we systematized the inventory of groundwater sources from 4 aquifers: Chillón, Rímac, Lurín, and Chilca.
- Currently, we are working in the systematization of the inventory of groundwater sources from 8 aquifers: Topará, Pativilca, Mala, Huaura, Fortaleza, Supe, Asia – Omas, and Cañete, in 2025.



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Data Systematization - Methodology

Data Collection:

- Inventory of groundwater sources from the Chillón, Rímac, and Lurín aquifers provided by the Cañete Fortaleza Water Administrative Authority.
- List of Directoral Resolutions for water use licenses granted during the 2019–2024 period within the scope of the Chillón, Rímac, and Lurín aquifers, provided by the Cañete Fortaleza Water Administrative Authority.
- Inventory of supplementary groundwater sources provided by the Directorate of Water Resources Quality and Evaluation.
- Database of groundwater sources from wells inventoried by SEDAPAL.

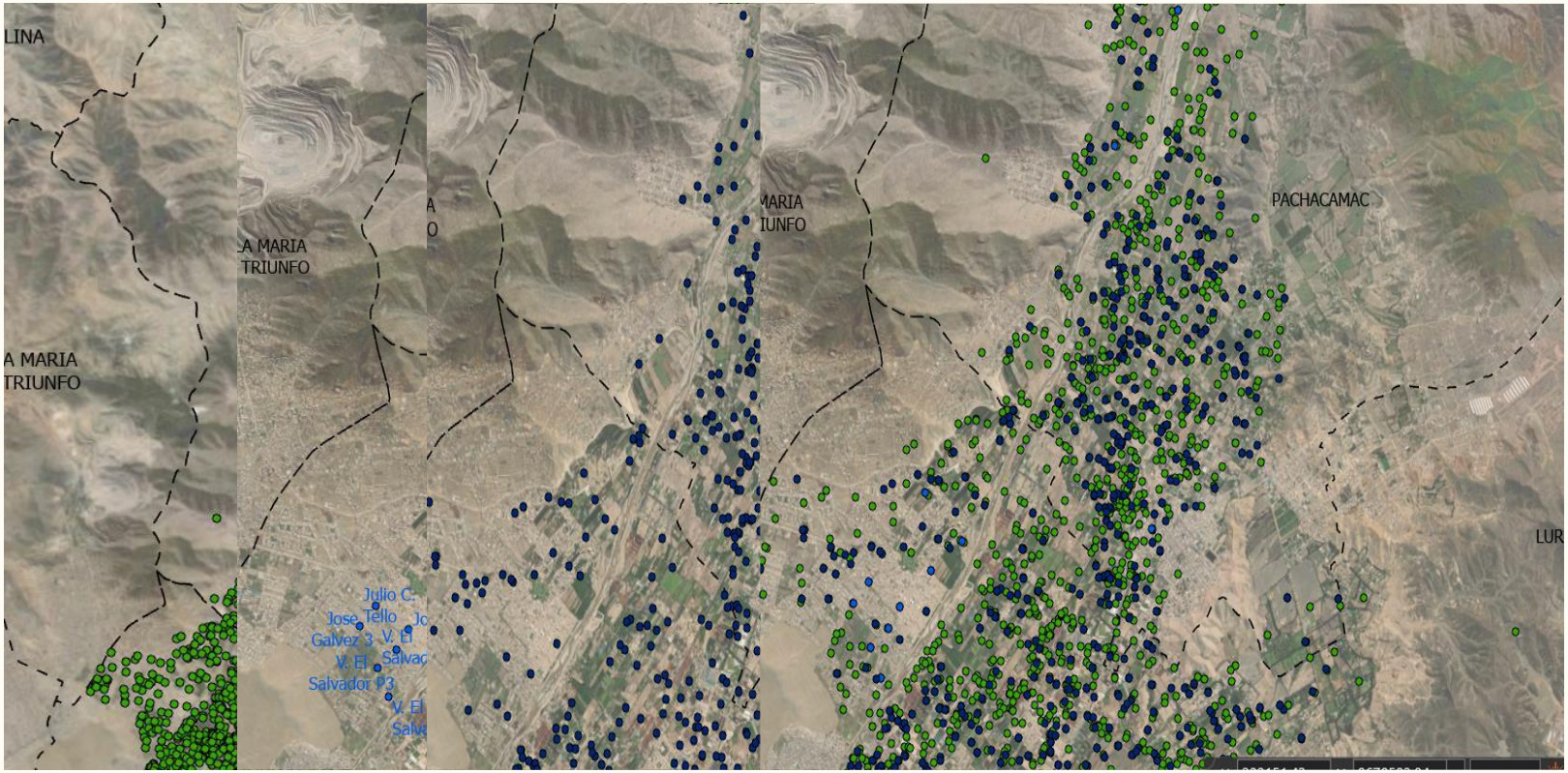
Building capacity for monitoring and evaluating groundwater

Data Systematization - Methodology

Data Analysis:

- Mapping of the provided and obtained databases.
- Cross-referencing of groundwater source locations.
- Verification of data consistency.
- Verification of information through data sheets and photographs.
- Verification of licensed water use sources through directoral and/or administrative resolutions.

Building capacity for monitoring and evaluating groundwater



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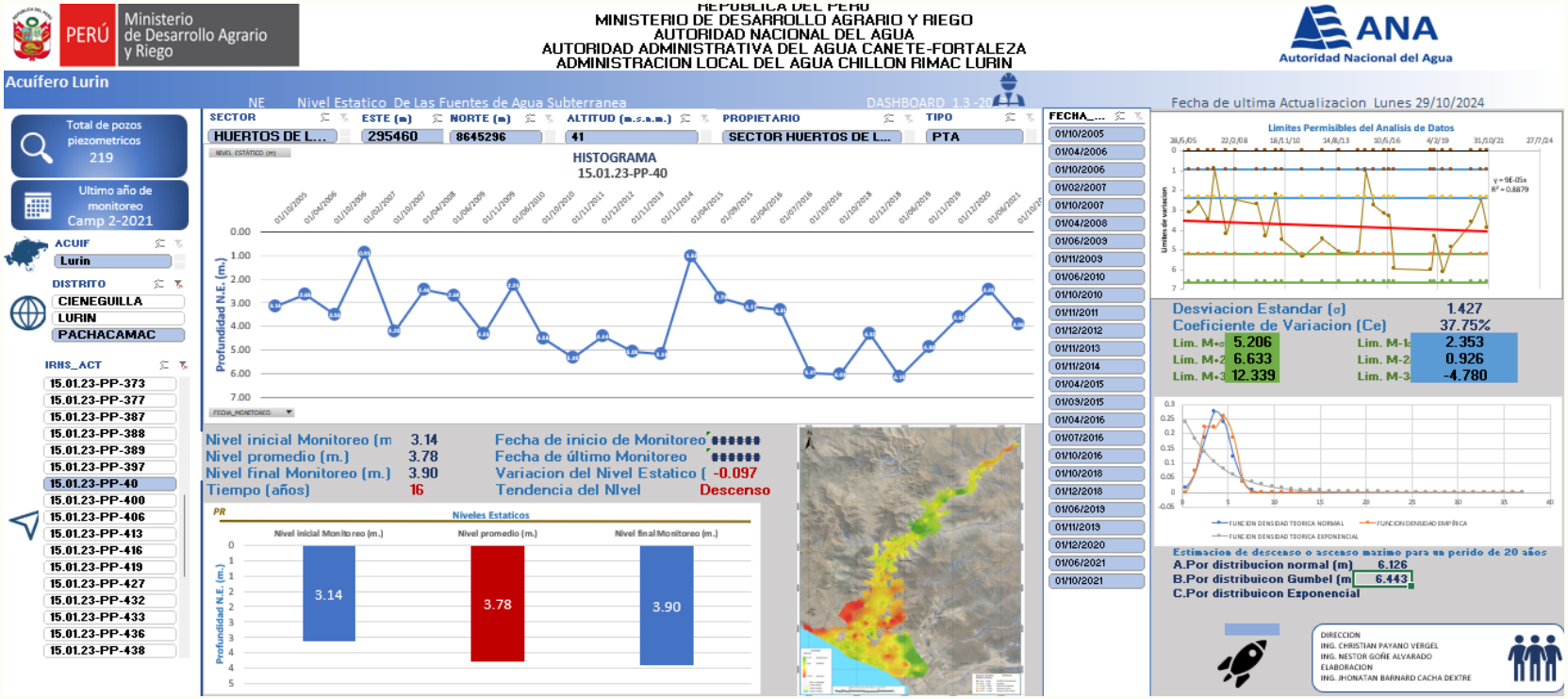

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Data Systematization - Challenges

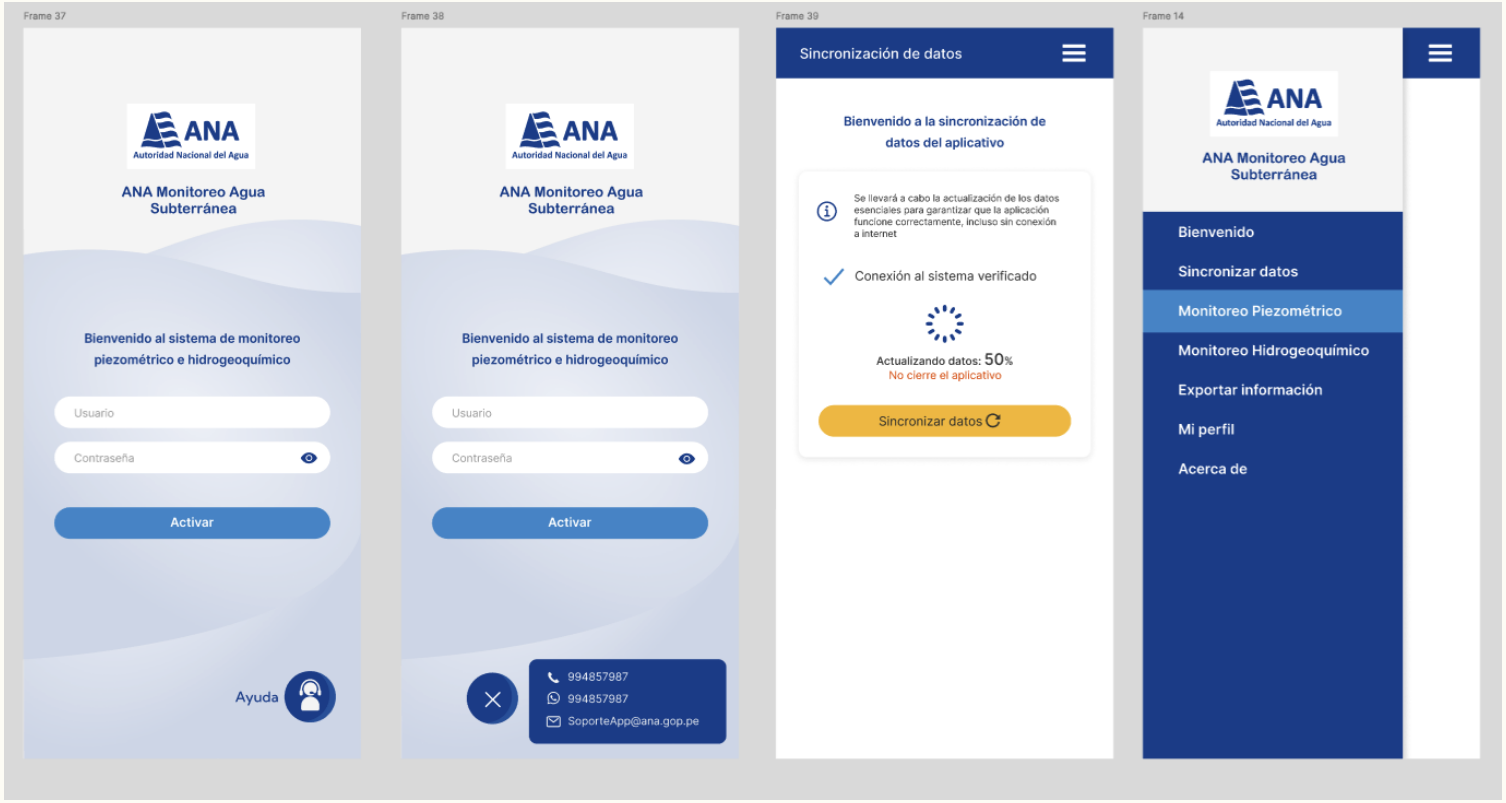
- The coding of wells between the AAA Cañete Fortaleza inventory and the SEDAPAL inventories is not the same.
- The inventories contained information referring to the same well but showing different locations.
- It was necessary to review the technical characteristics of the wells, as well as the ownership of the sources, to determine whether they referred to the same well.
- The unidentified wells that were found were added to the inventory, following the coding system of AAA Cañete Fortaleza.

Building capacity for monitoring and evaluating groundwater

Information Management

- In coordination with the Directorate of Water Resources Quality and Evaluation (DCERH) and the Directorate of the National Water Resources Information System (DSNIHR), activities have been carried out for the management of groundwater monitoring data.
  - A mobile application was developed for data collection related to the inventory of groundwater sources, piezometric monitoring, and field hydrogeochemical monitoring.
  - The application is available for download on the Play Store for devices with the Android operating system. Each specialist requires a unique username and password to access the system.
  - This will allow field specialists to collect data using mobile devices, and the collected data can be stored in a digital database.
  - During the development of the application, DSNIRH was responsible for providing technical assistance in programming, while DCERH, as the user area, was in charge of verifying the functionality of the modules.

Building capacity for monitoring and evaluating groundwater



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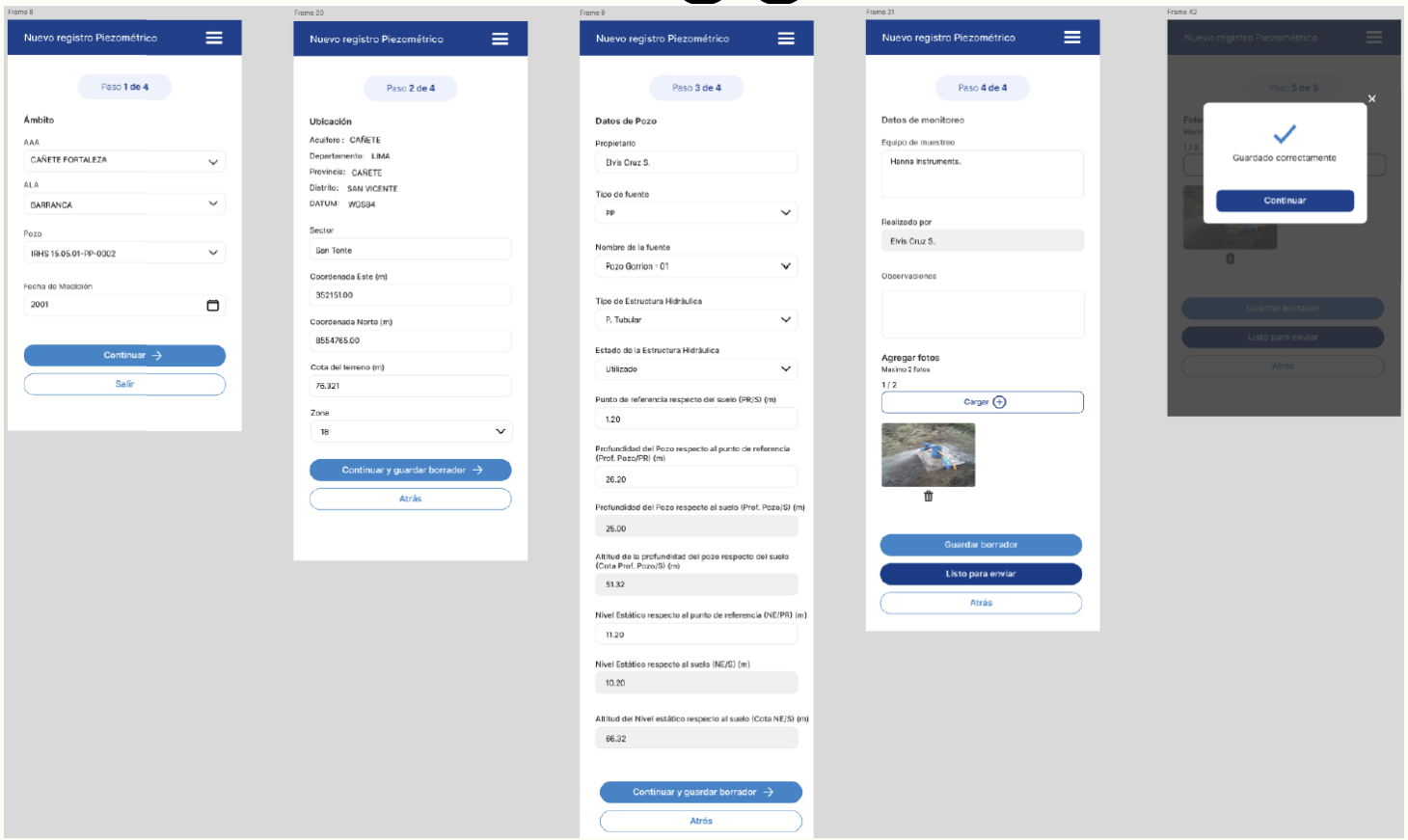

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Building capacity for monitoring and evaluating groundwater

Information Management

- In coordination with the Directorate of Water Resources Quality and Evaluation (DCERH) and the Directorate of the National Water Resources Information System, activities have been carried out for the management of groundwater monitoring data.
  - Two web modules were improved: the groundwater inventory module and the piezometric level monitoring module. Additionally, two new web modules were developed: the field hydrogeochemical monitoring module and the laboratory hydrogeochemical monitoring module.
  - This will allow the collected information to be organized and processed in an orderly and efficient manner, facilitating information management by ANA specialists.
- During the development of the modules, DSNIRH was responsible for providing technical assistance in programming, while DCERH, as the user area, was in charge of verifying the functionality of the modules.
- The specialists from the AAAs and DCERH are responsible for operating the modules, while the specialists from DSNIRH are in charge of its maintenance.

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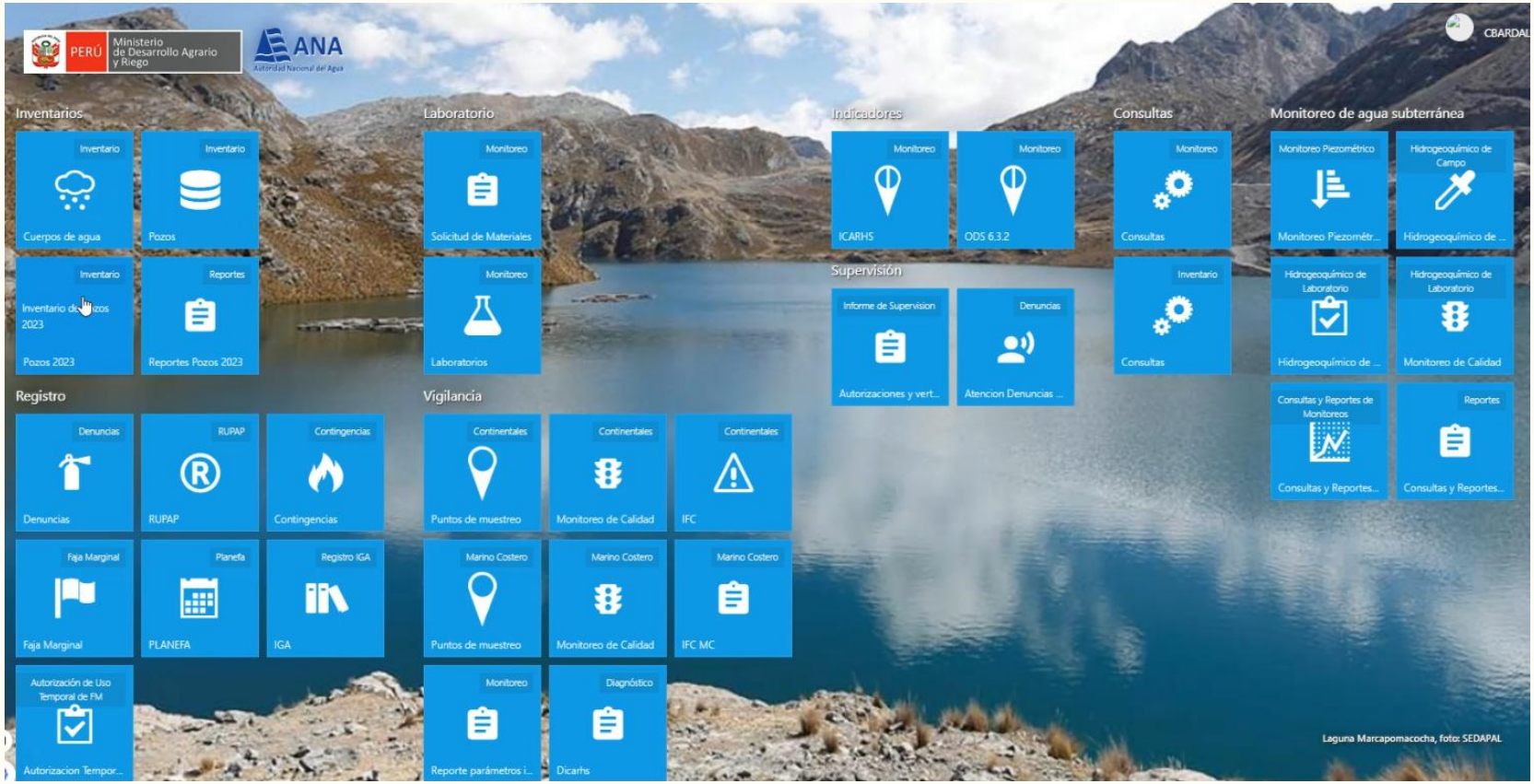

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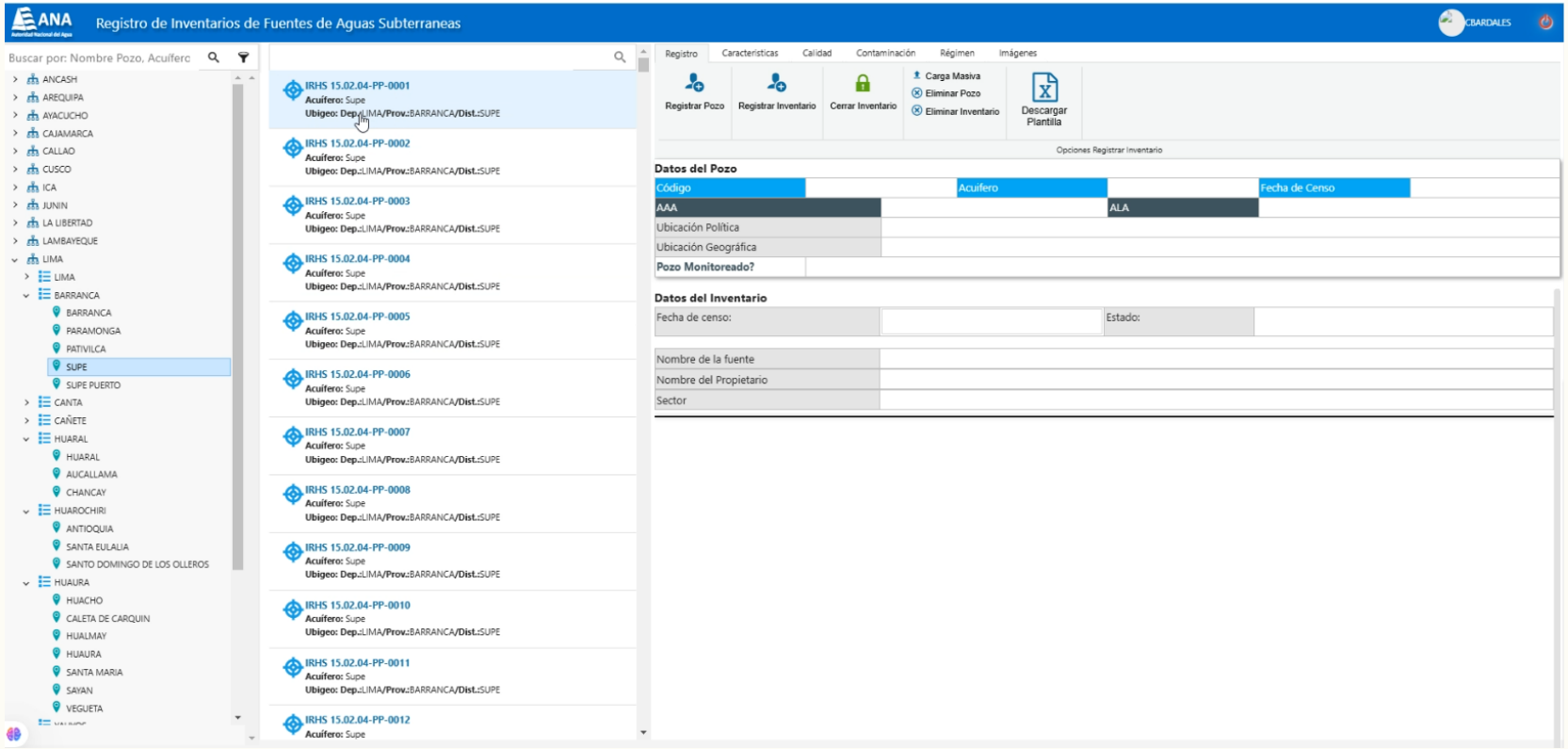

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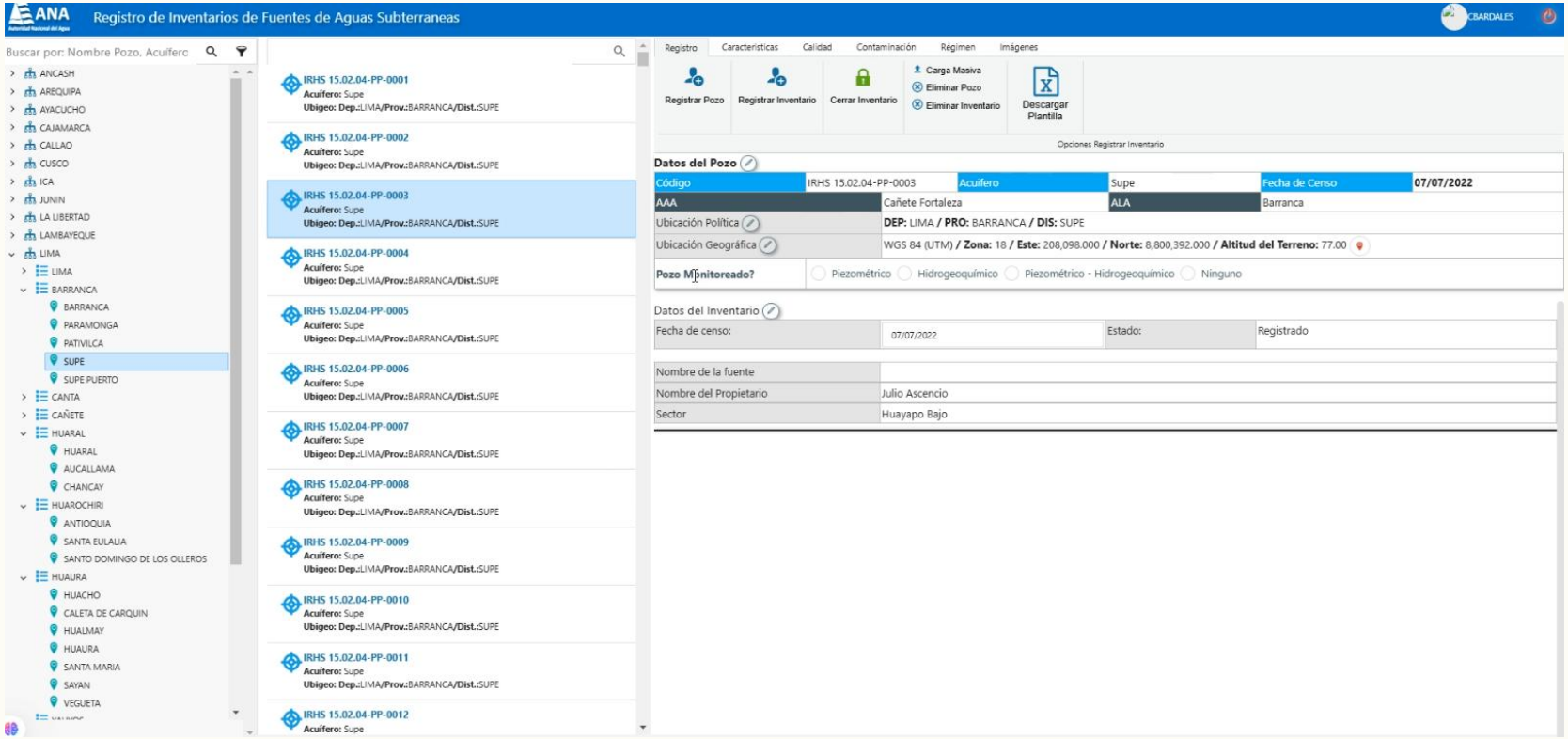

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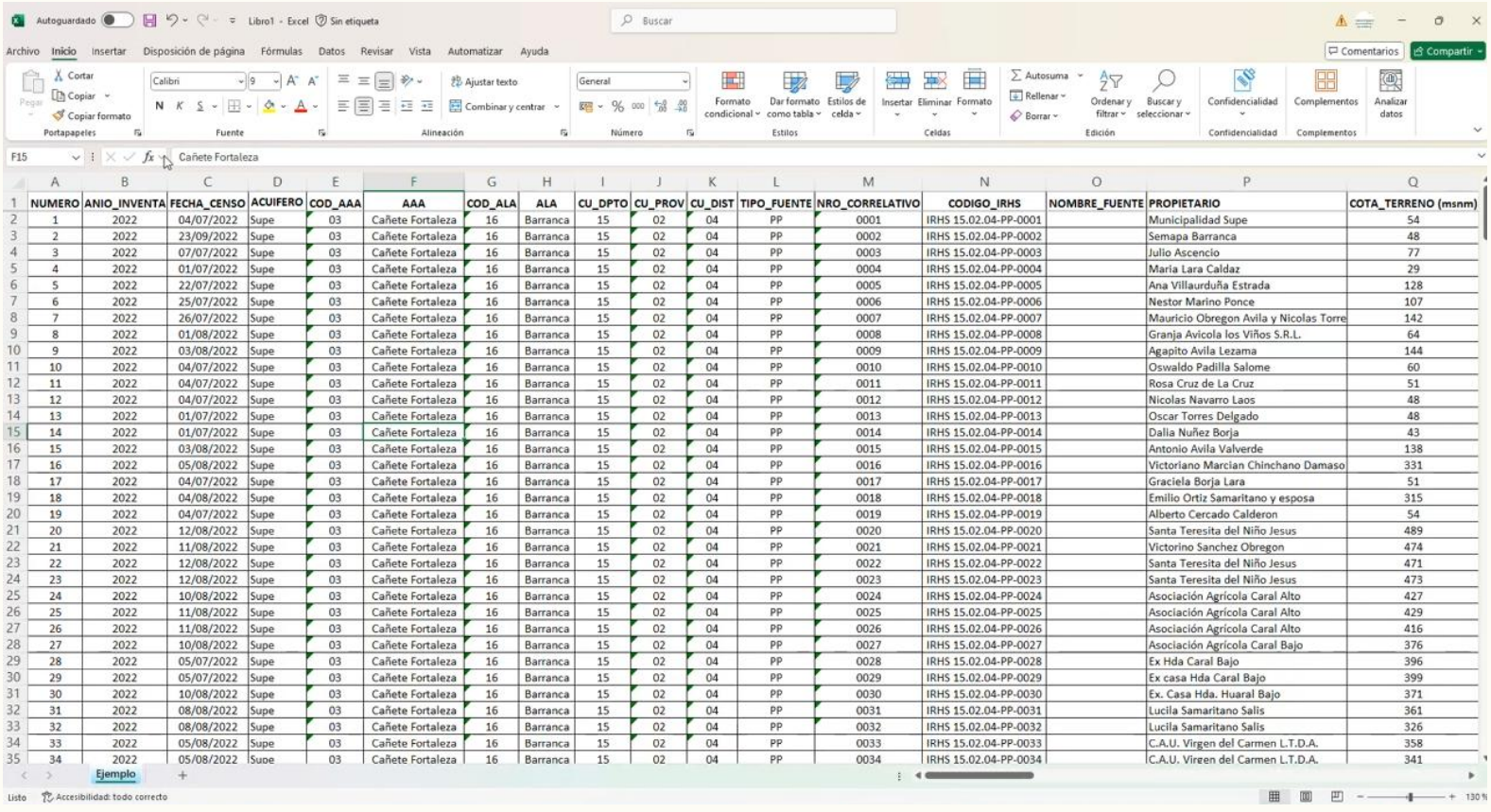

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	NUMERO	ANIO_INVENTA	FECHA_CENSO	ACUIFERO	COD_AAA	AAA	COD_ALA	ALA	CU_DPTO	CU_PROV	CU_DIST	TIPO_FUENTE	NRO_CORRELATIVO	CODIGO_IRHS	NOMBRE_FUENTE	PROPIETARIO	COTA_TERRENO (msnm)
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3	2	2022	23/09/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0002	IRHS 15.02.04-PP-0002		Semapa Barranca	48
4	3	2022	07/07/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0003	IRHS 15.02.04-PP-0003		Julio Ascencio	77
5	4	2022	01/07/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0004	IRHS 15.02.04-PP-0004		Maria Lara Caldaz	29
6	5	2022	22/07/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0005	IRHS 15.02.04-PP-0005		Ana Villaurduña Estrada	128
7	6	2022	25/07/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0006	IRHS 15.02.04-PP-0006		Nestor Marino Ponce	107
8	7	2022	26/07/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0007	IRHS 15.02.04-PP-0007		Mauricio Obregon Avila y Nicolas Torre	142
9	8	2022	01/08/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0008	IRHS 15.02.04-PP-0008		Granja Avicola los Viños S.R.L.	64
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24	23	2022	12/08/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0023	IRHS 15.02.04-PP-0023		Santa Teresita del Niño Jesus	473
25	24	2022	10/08/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0024	IRHS 15.02.04-PP-0024		Asociación Agricola Caral Alto	427
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30	29	2022	05/07/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0029	IRHS 15.02.04-PP-0029		Ex casa Hda Caral Bajo	399
31	30	2022	10/08/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0030	IRHS 15.02.04-PP-0030		Ex. Casa Hda. Huaral Bajo	371
32	31	2022	08/08/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0031	IRHS 15.02.04-PP-0031		Lucila Samaritano Salis	361
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35	34	2022	05/08/2022	Supe	03	Cañete Fortaleza	16	Barranca	15	02	04	PP	0034	IRHS 15.02.04-PP-0034		C.A.U. Virgen del Carmen L.T.D.A.	341

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Implementation strategy

- Development of an annual work plan, coordinated and validated by ANA's directorates and endorsed by the Head of ANA. This work plan defined the joint activities to be carried out, their timelines, and the responsibilities of each ANA directorate as well as those of the El Agua Nos Une project. In addition, a budget was established for each activity.
- Focal points were identified within each directorate, enabling faster and more efficient communication for the implementation of activities.
- Close coordination with line directorates and in-person meetings were also carried out.

Thank you

Javier Antiporta
jantiporta@care.org.pe

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Rapid groundwater potential mapping in data-scarce regolithic landscapes: a contribution to hydrogeology in humanitarian contexts

Cyrille Scherer, PhD thesis defence, 7th December 2022, Applied research project (SDC, UNHCR, CHYN)

Presented by Marc-André Bünzli, Head of WASH at Swiss Humanitarian Aid, SDC

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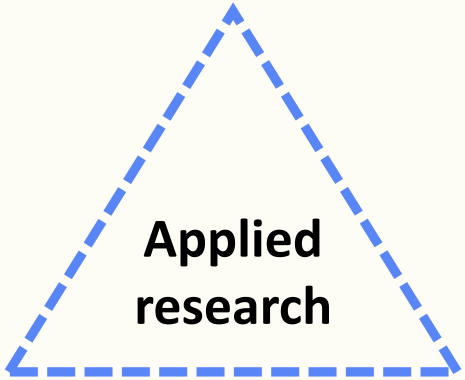
Direction du développement et de la coopération Suisse



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Centre d'hydrogéologie et de géothermie

UNHCR
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Unies pour les réfugiés

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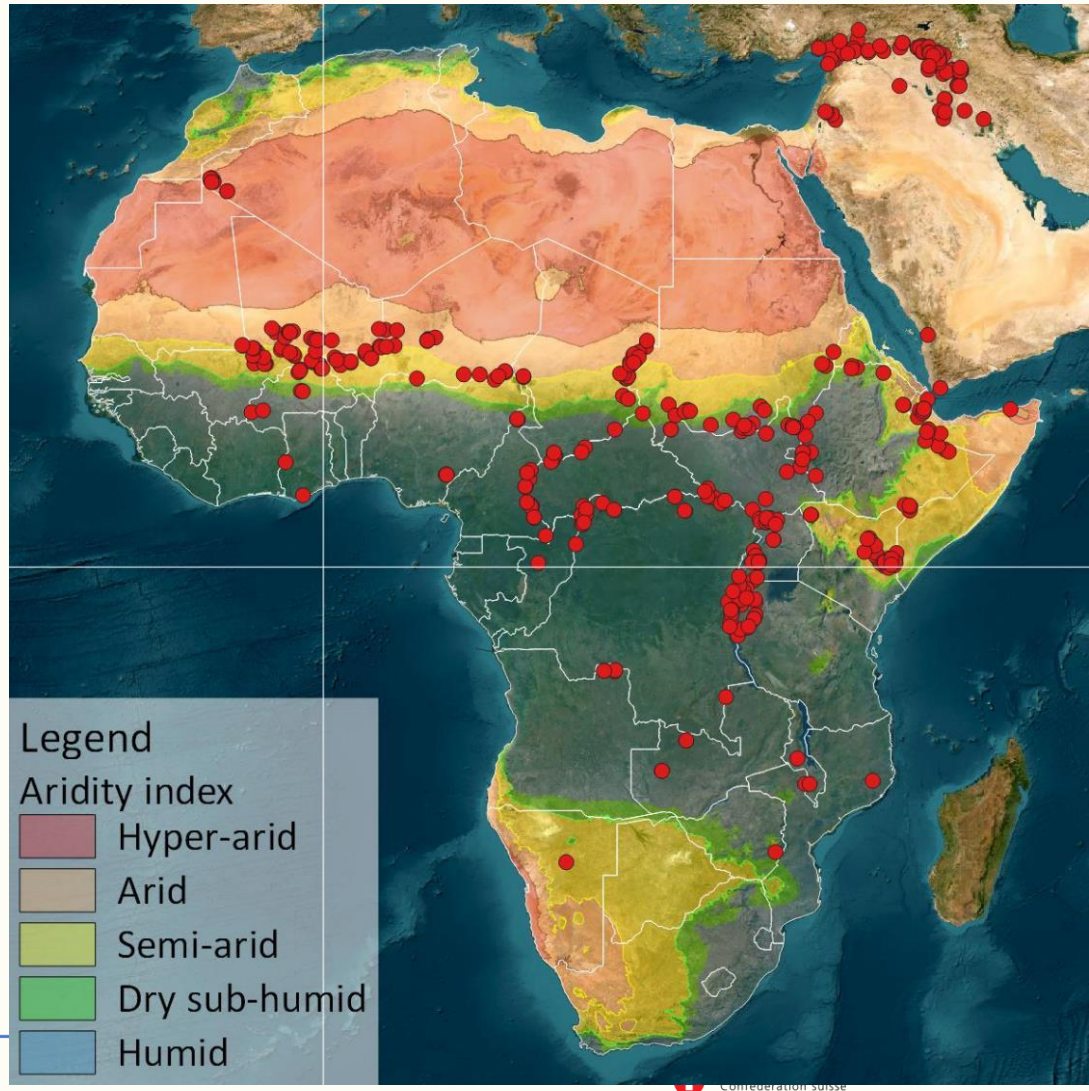
Where are refugee camps situated in Africa ?

Sub-saharan Africa is situated south of the hottest and largest desert in the world



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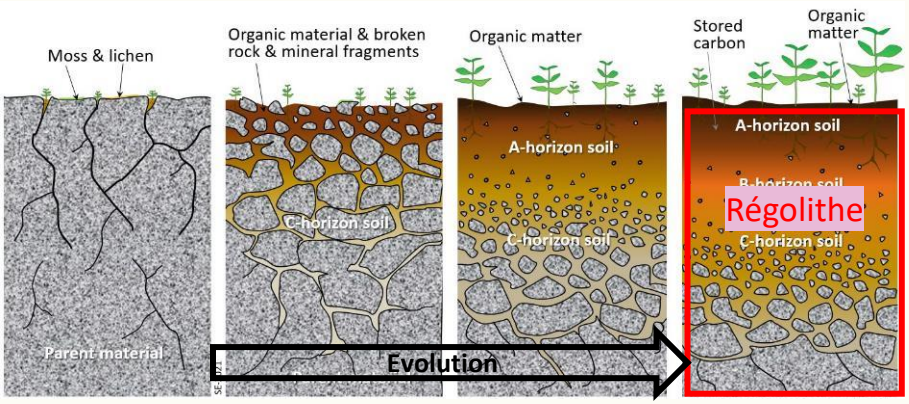
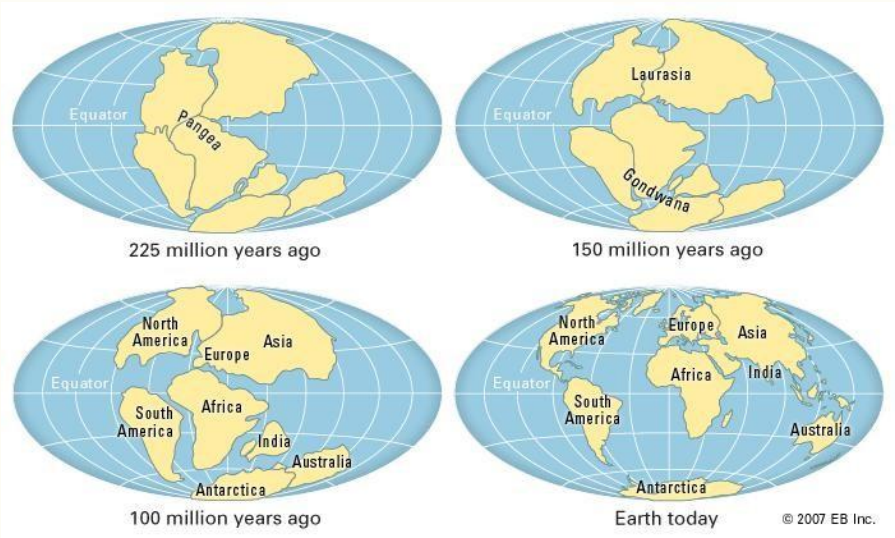
What is a regolith?

Formation →

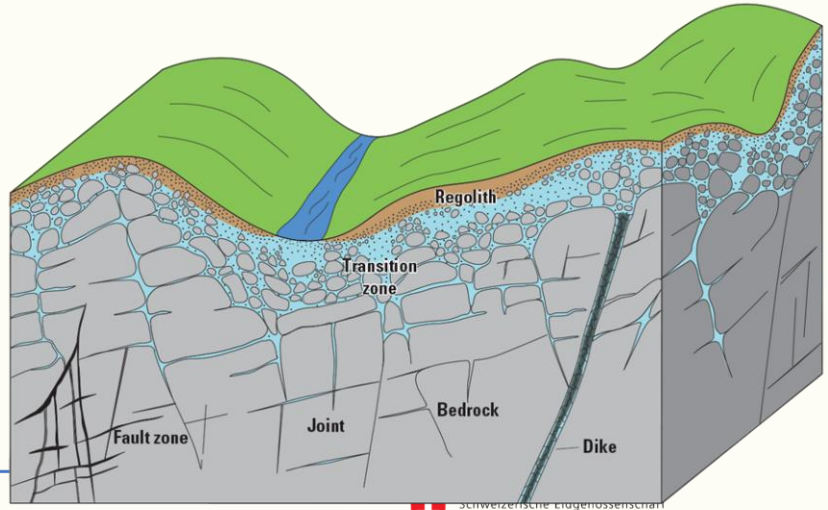
Rock weathering since million of years





Landscapes and environment

A smooth topography with a deeply weathered rock



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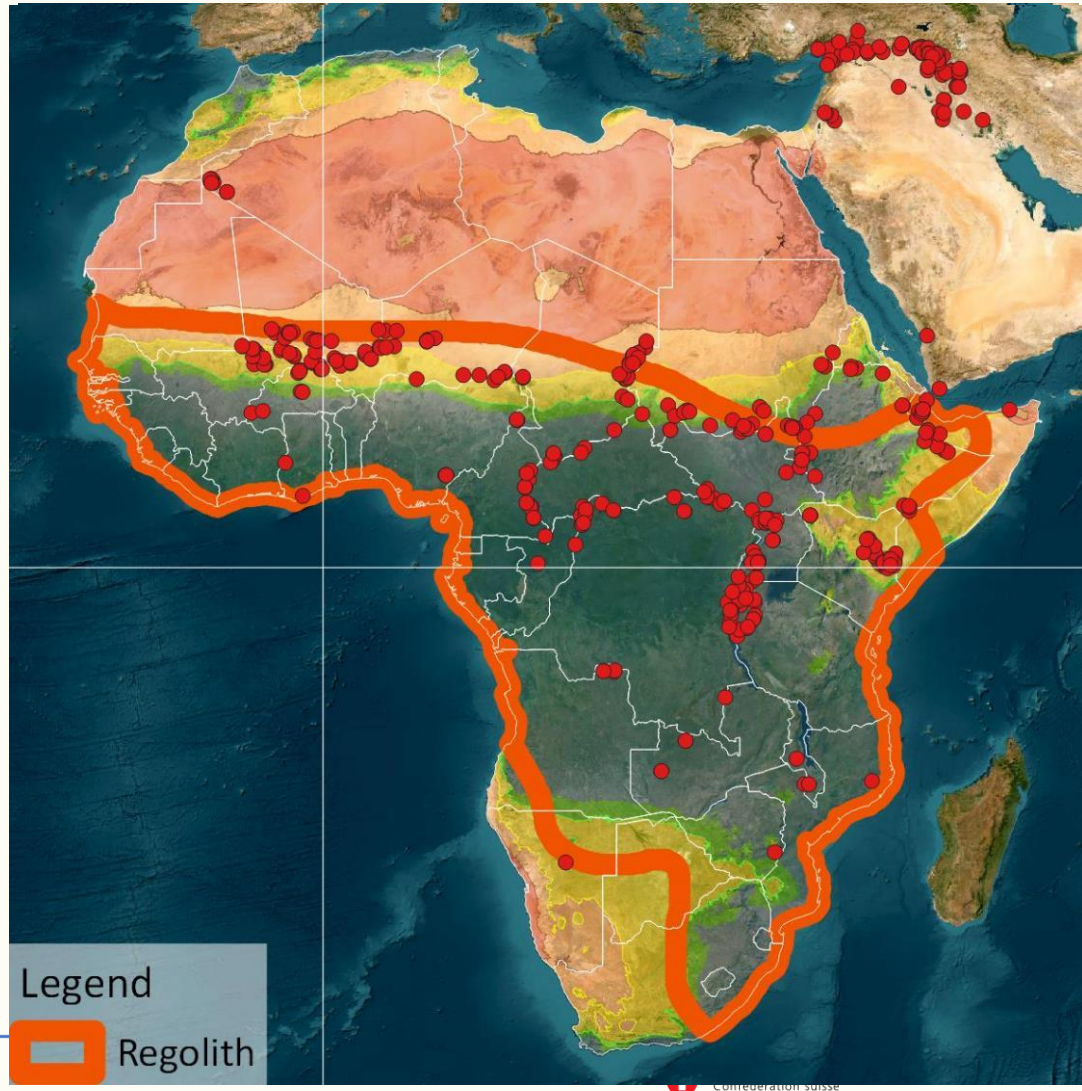
Refugee camps and regolith

Most refugee camps are situated on a regolith



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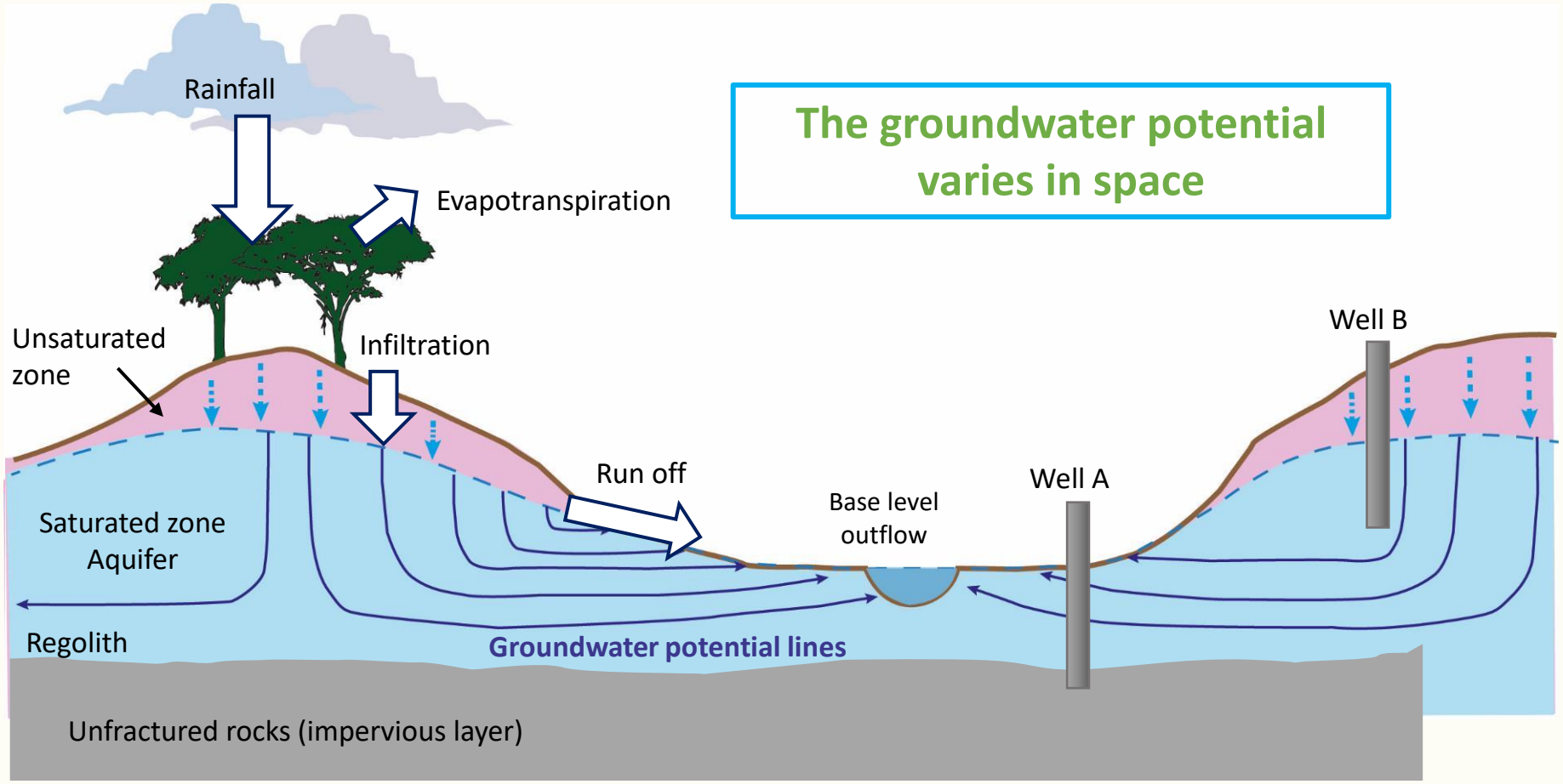
Groundwater potential in a regolith



Exploitation yields and pumping systems

Pump type

- Hand pump
- Submersible electrical pumps

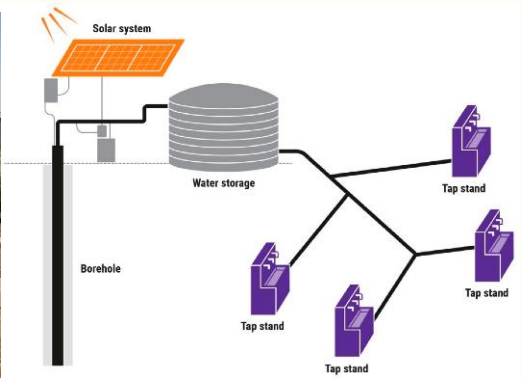
Low ← exploitation yield → High

Hand pump
0.5 m³/h

Little systems
5 m³/h

Intermediary systems
50 m³/h

Large systems
> 50 m³/h



Humanitarian contexts

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Towards strategic well implementation: RGWPM Rapid groundwater potential mapping methodology

Initial RGWPM methodology is based on mapping two variables:

1. **Water availability (WA)**: mapping of landscape units (hydrogeomorphological analysis)
2. **Reservoir capacity (RC)**: proxy of hydraulic conductivity, transcribing geological properties and features in terms of estimated hydraulic properties

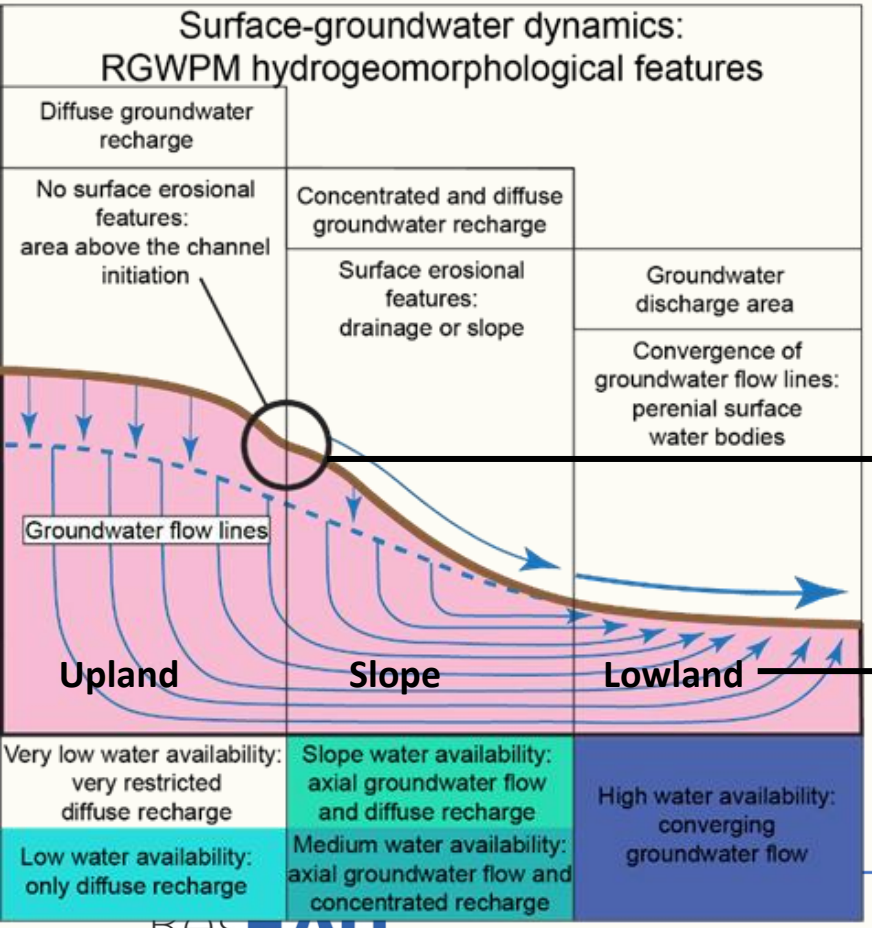
WA and RC are mapped in a classified way and assimilated to yield ranges, corresponding to water supply options:

RGWPM unit	Very low	Low	Medium	High
Water supply option	No groundwater	Hand pump	Small motorized systems	Large motorized systems
Yield range (m^3/hour)	< 0.5	0.5 - 5	5 - 50	> 50

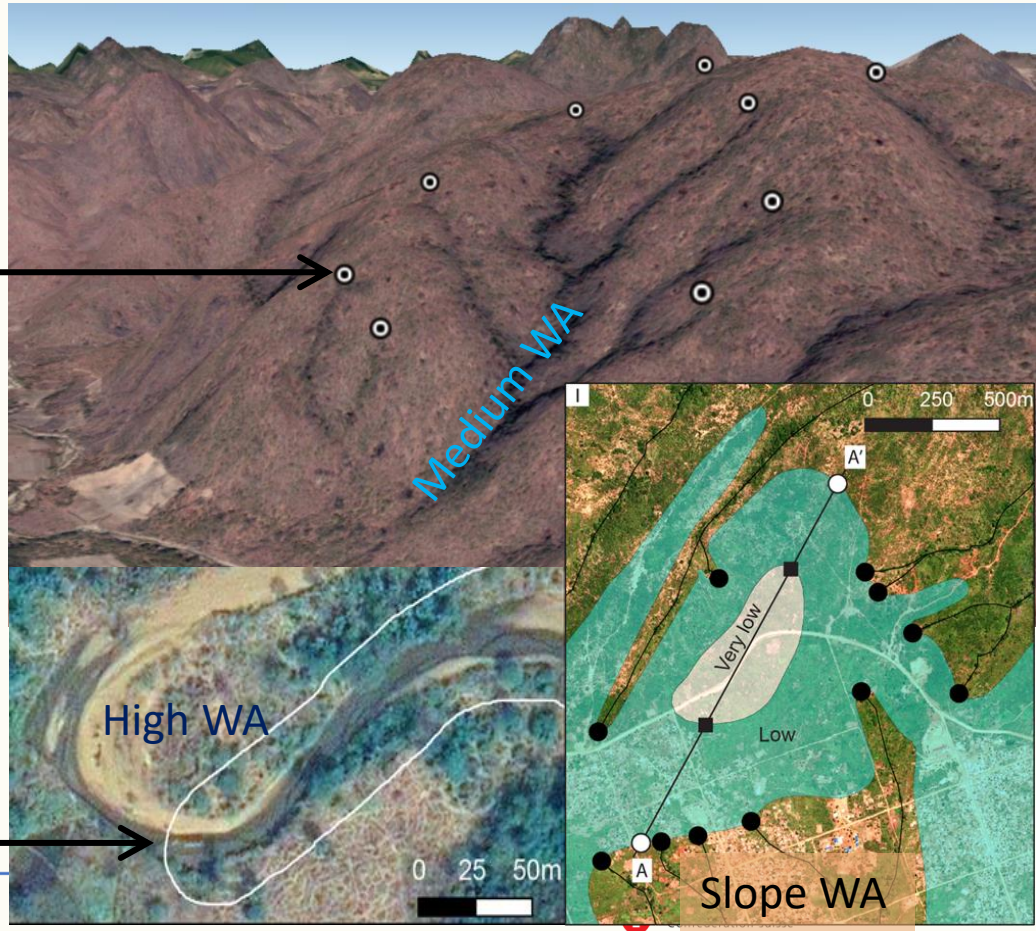
→ Through overlay of the WA and RC, the **lowest** is retained, defining the groundwater potential (GWP).

Water availability (WA) mapping

Conceptual framework



Real world corresponding WA/HGM features



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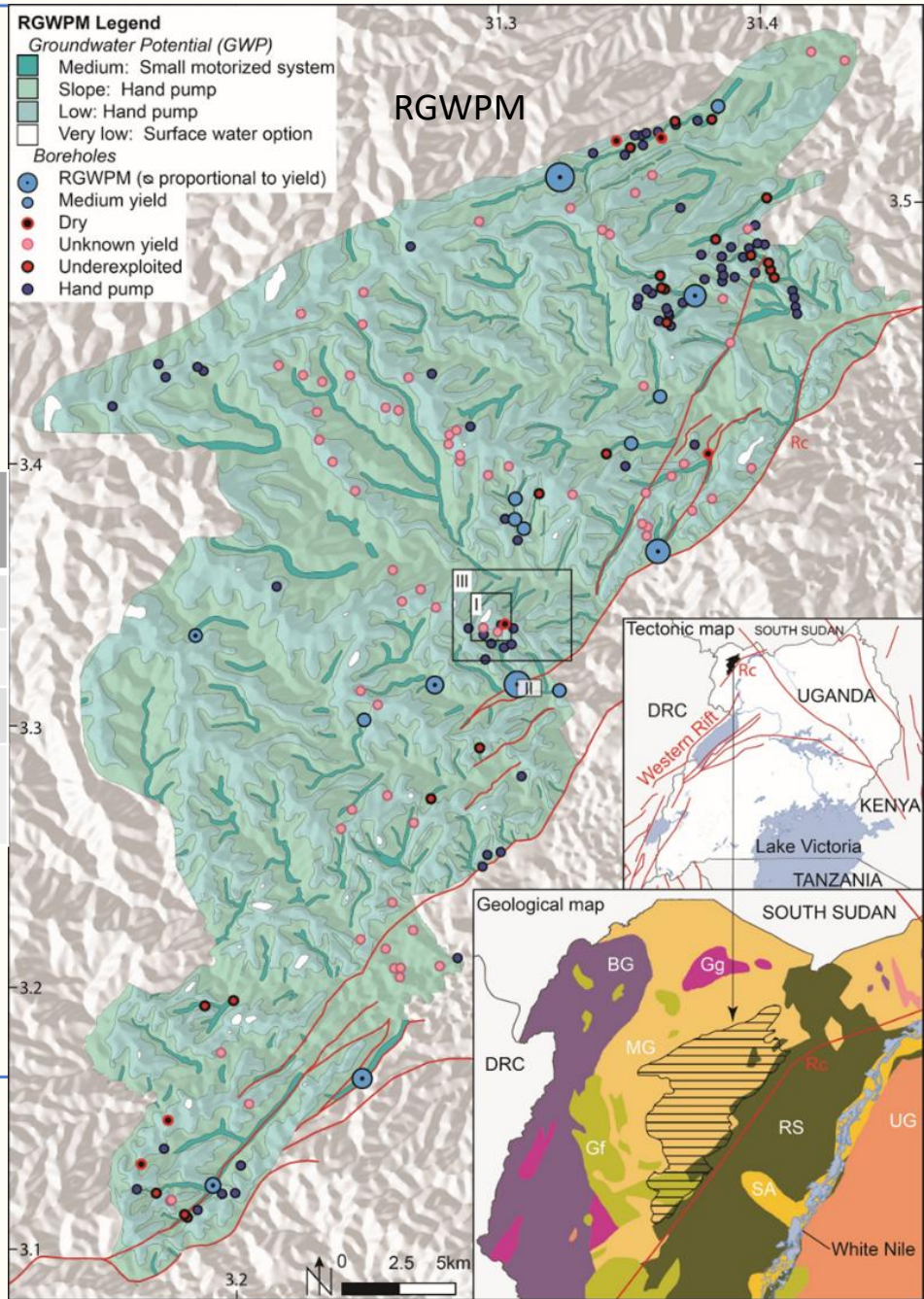
Cross-validation of RGWPM Bidibidi with field data

Comparative statistics of borehole sites with and without RGWPM

	Existing boreholes	RGWPM boreholes
Number of boreholes	92	8
Cumulated yield [m^3/h]	272	283
Average yield [$m^3/h/BH$]	3	35
Specific BH depth-yield [$m_{BH}/m^3/h$]	27	3

«drill where people are» to «drill where water is»



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Quantify groundwater through a water balance

Water balance:

$$\boldsymbol{P = ET + R + Q_i} \quad (1)$$

Solving the equation gives:

$$\boldsymbol{Q_i = P - ET - R} \quad (2)$$

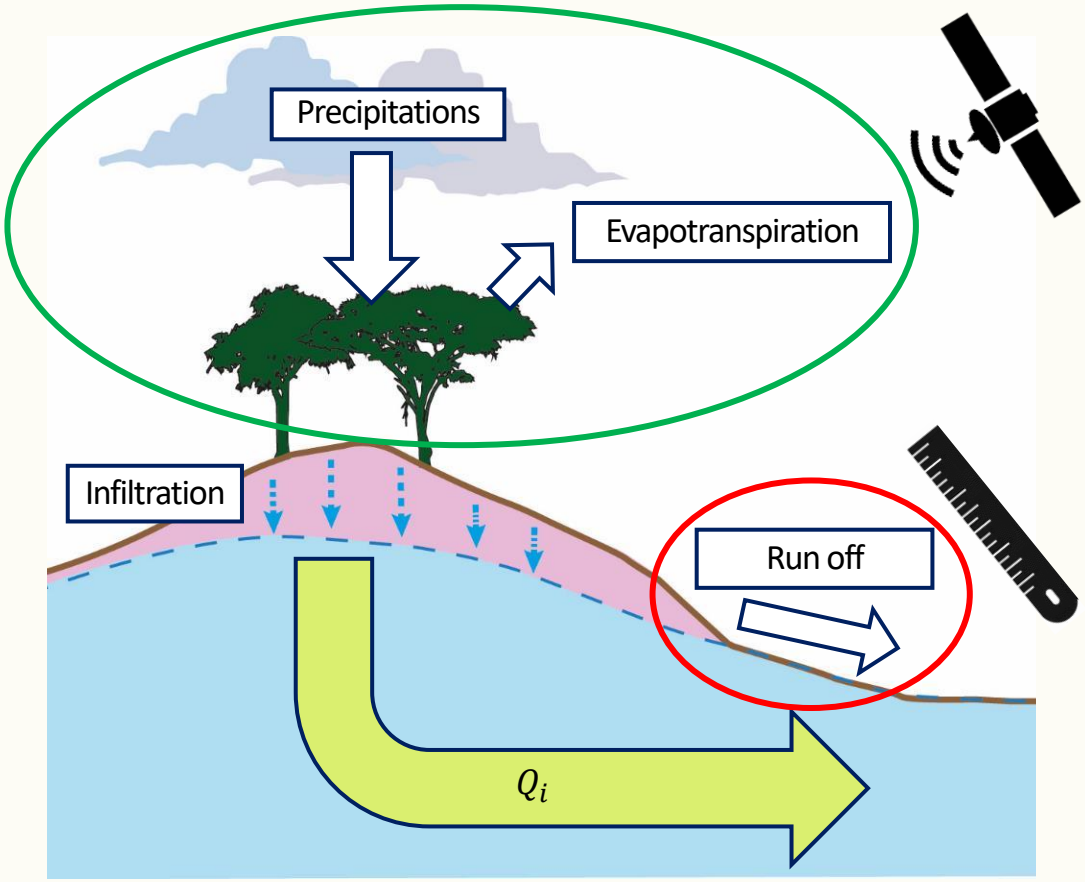
Water balance elements :

Precipitations ($\boldsymbol{P}$)

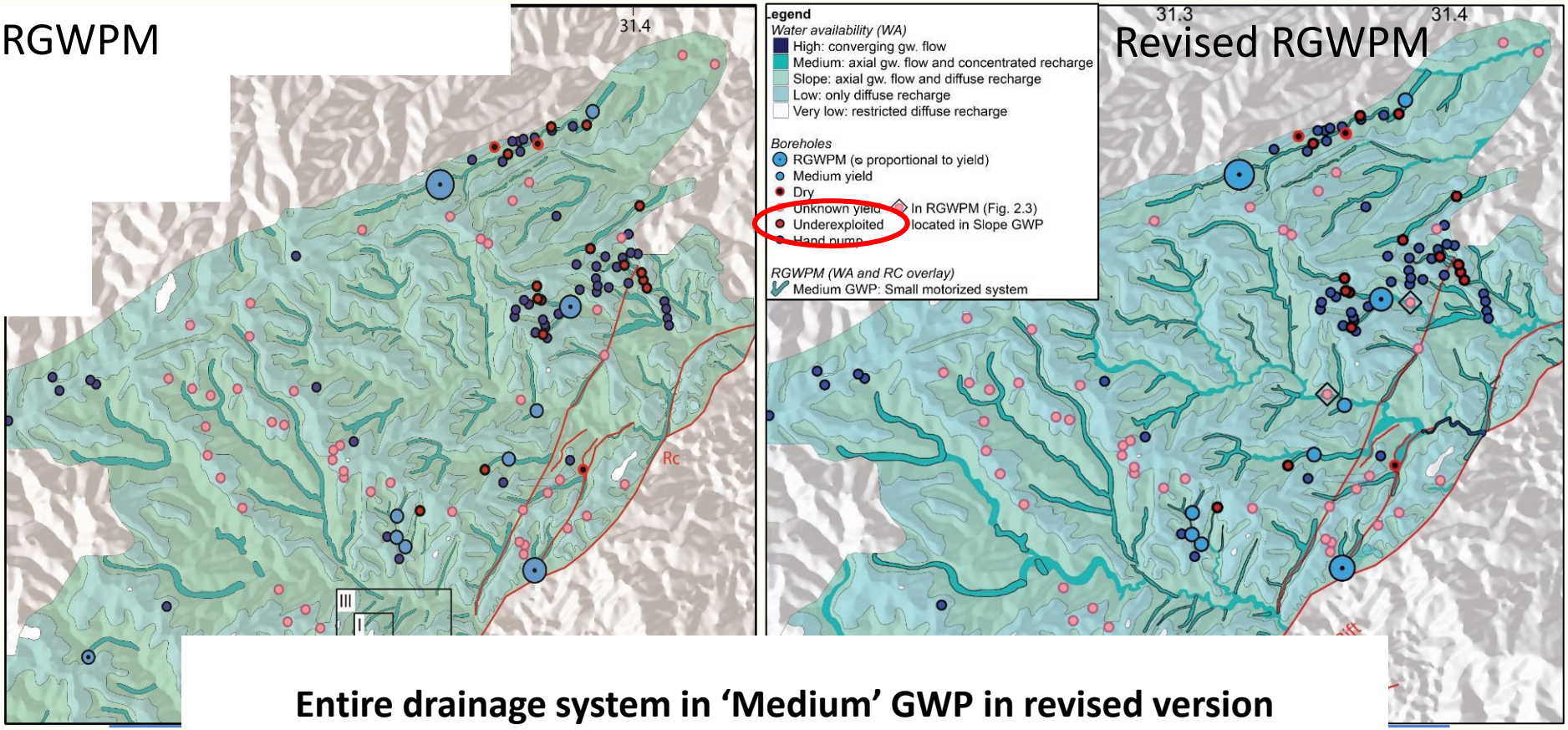
Evapotranspiration ($\boldsymbol{ET}$)

Run off ($\boldsymbol{R}$)

Groundwater infiltration ($\boldsymbol{Q_i}$)



From RGWPM to revised RGWPM (Bidibidi, Uganda)



Entire drainage system in 'Medium' GWP in revised version

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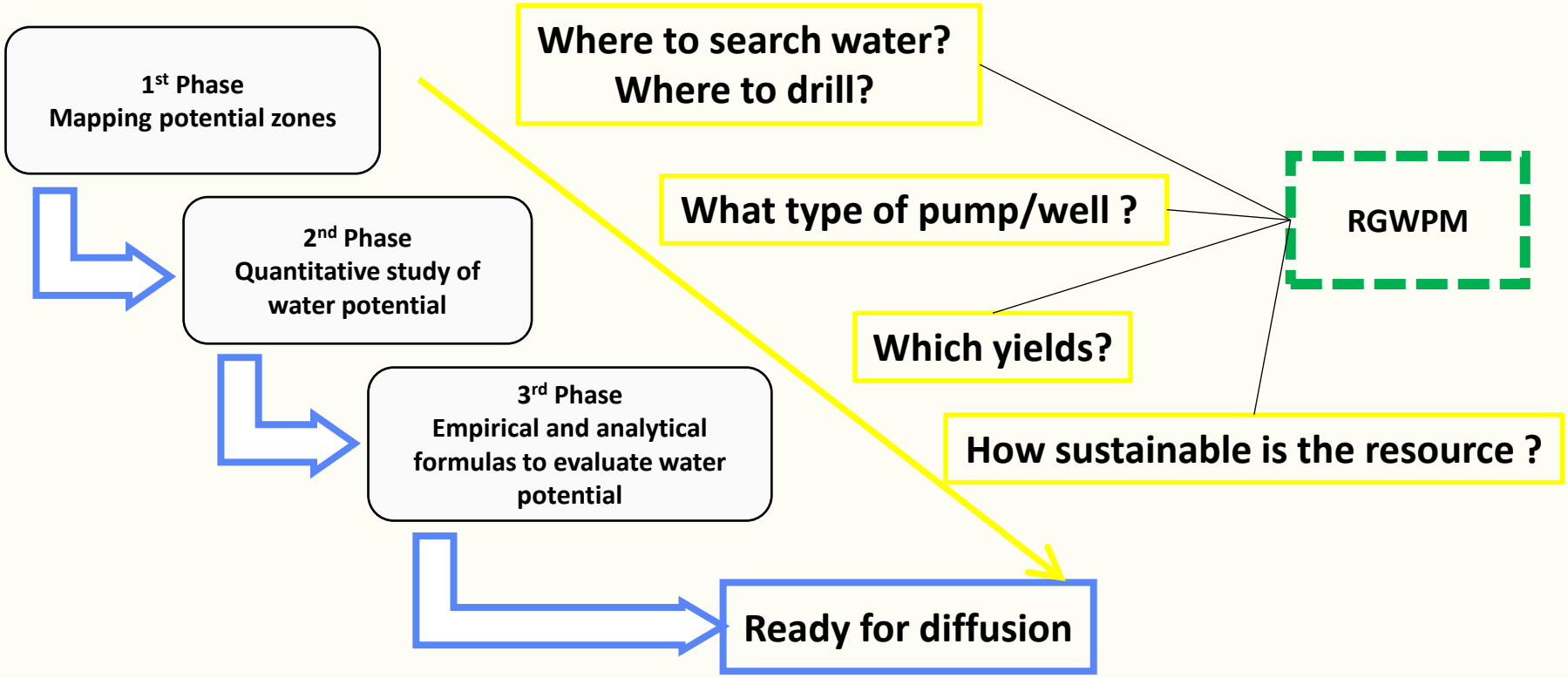
Conclusion: RGWPM as groundwater exploration tool



References

Scherrer, C., Schweitzer, R., Bünzli, MA. *et al.* Rapid groundwater potential mapping in humanitarian contexts: improving borehole implementation in basement environments. *Hydrogeol J* **29**, 2033–2051 (2021). https://doi.org/10.1007/s10040-021-02352-w

Q&A / Discussion

Q&A – Mad Tea Chat

- Something that has been mentioned which triggered my interest and I would like to know more about is …

- Something important that has been missing from my point of view is …

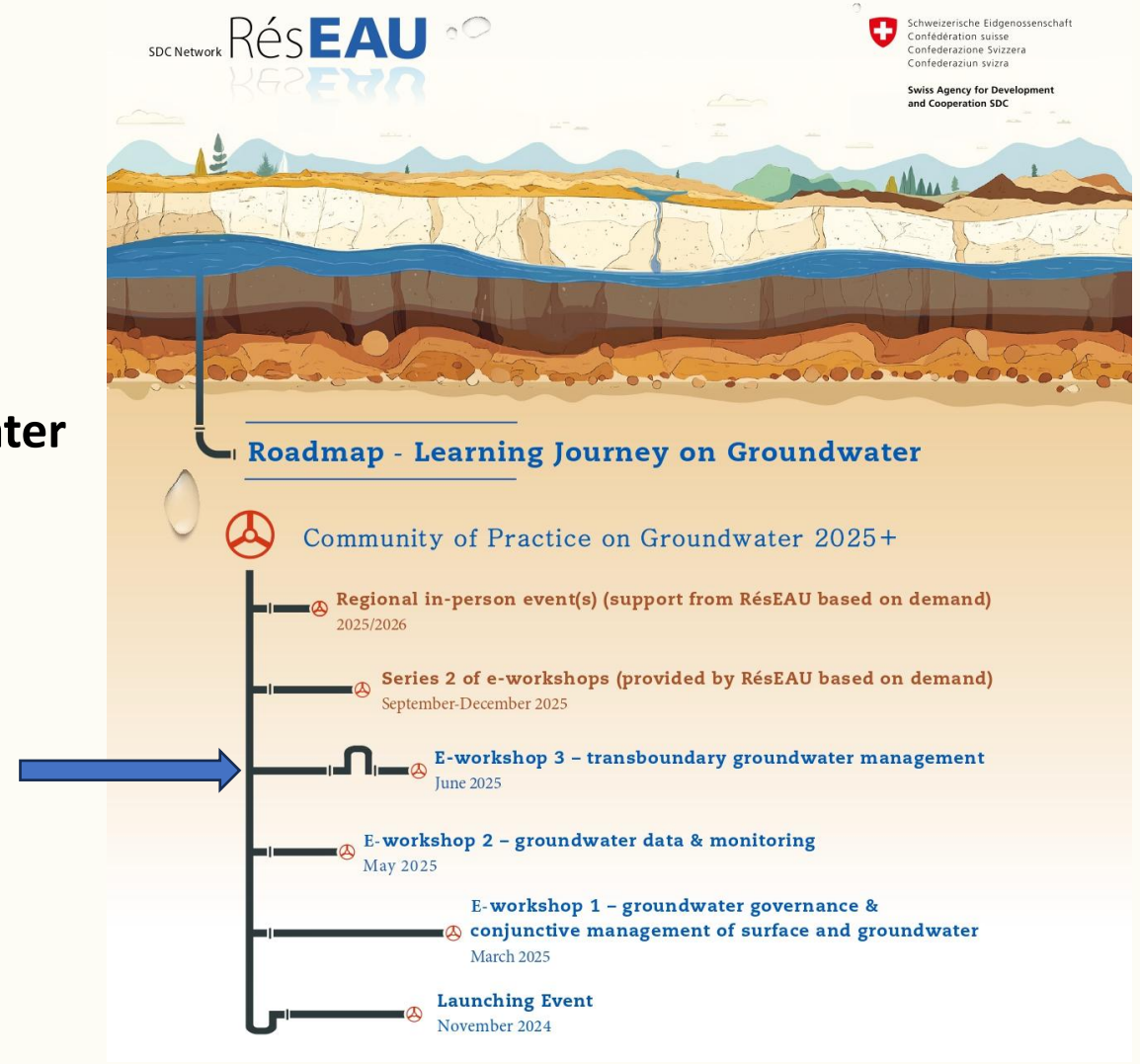
- My main take-home message from today's webinar in three keywords is ...

Quick survey

- https://us06web.zoom.us/survey/aZseFXW3_FKWrY2mZOcoUlA_s9kSVak_5zdaUEezRai3fVqCwQc.JeMVICl9bnd4fQYX/view?id=-ru6hTphQ-GZQnwItvnkCA#/sharePreview

Up next

12 June 2025,
Transboundary Groundwater Management



Thank you

For follow-up questions about this webinar, please contact frank.wiederkehr@skat.ch

Don‘t forget to join the RésEAU community to stay up to date about this Learning Journey and other news & activities: https://dgroups.org/sdc/reseau

This event has been recorded and will be made available on https://www.sdc-water.ch/

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