



Utilities and Network Seminar

Amsterdam | April 30th, 2026

Groundwater: Making the invisible visible

From data to action

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Ministerie van Infrastructuur
en Waterstaat



WORLD
METEOROLOGICAL
ORGANIZATION

From DATA to INFORMATION for decision-making:

In many cases, management has been initiated with very **limited information**

What is the lowest level of data needed?

MONITORING

- Groundwater levels
- Groundwater abstraction rates
- Groundwater quality

Adapt groundwater management

Increase the knowledge base (Other studies)

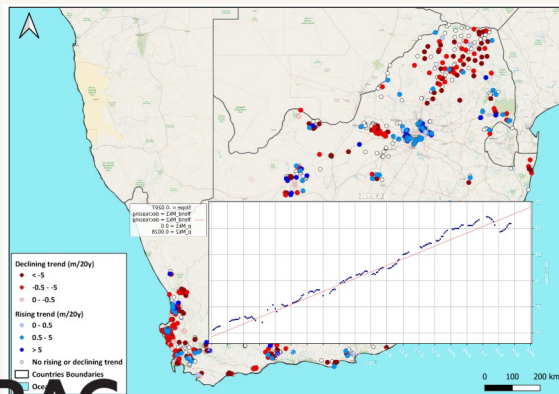
State of groundwater (quantity and quality)



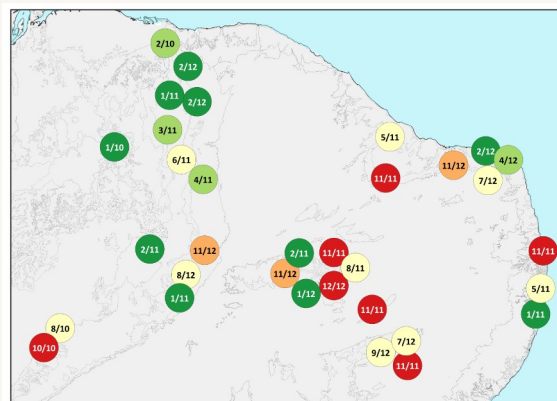
+ drought indicators

Groundwater status and trends indicators

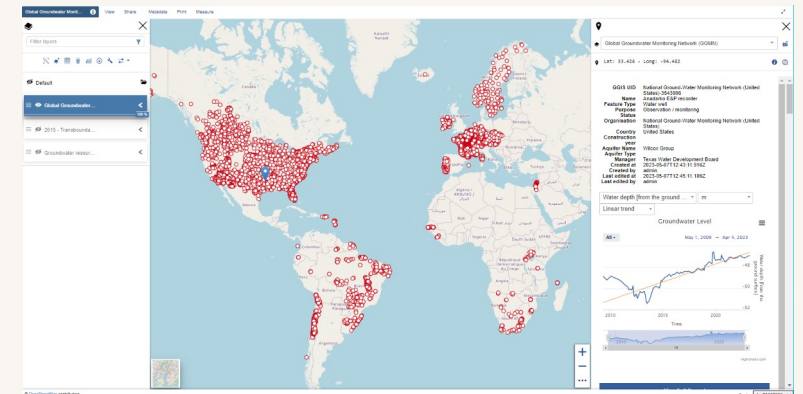
Groundwater level trends



Groundwater level ranking



Groundwater Information System



GROUNDWATER MONITORING WORLDWIDE

THE GLOBAL GROUNDWATER INFORMATION SYSTEM (GGIS)

The GGIS is an interactive portal for sharing data and information on groundwater resources around the world. It gives access to map layers, documents, and well and monitoring data. It also contains several thematic map viewers.

[Visit IGRAC Website](#)

[Hide this banner](#)

EXPLORE THE VIEWERS



Transboundary Aquifers of the World map

The global map of transboundary aquifers (TBAs) shows the surface delineation of aquifers extending over country borders. Such information is necessary to develop appropriate cooperation mechanisms for the management of shared groundwater resources. Yet, it is challenging to map transboundary aquifers due to the invisible nature of groundwater. The current version of the map (2021 edition) is in fact the result of over 20 years



Global Groundwater Monitoring Network (GGMN)

The Global Groundwater Monitoring Network (GGMN) is a collaborative initiative that collects and shares groundwater monitoring data, including groundwater levels, quality parameters, and other relevant data and metadata from national and sub-national authorities. The GGMN aims to provide reliable, comprehensive data to support groundwater research and enhance our understanding of global groundwater resources.



MAR Portal

The MAR Portal contains the Global MAR Inventory, an inventory of over 1200 sites where Managed Aquifer Recharge is or has been implemented. The Global MAR Inventory includes information on site name, MAR type, year of scheme deployment, the source of infiltration water, the final use of abstracted water, as well as the main objectives of the project.



Groundwater Observations Repository

The Groundwater Observations Repository is an initiative by IGRAC to disseminate groundwater data, including levels, quality, spring flow, and other observations, from research studies, local monitoring networks, and various other sources. It aims to complement the GGMN, which only includes groundwater monitoring data from active national monitoring networks, to provide the most comprehensive coverage of groundwater in situ



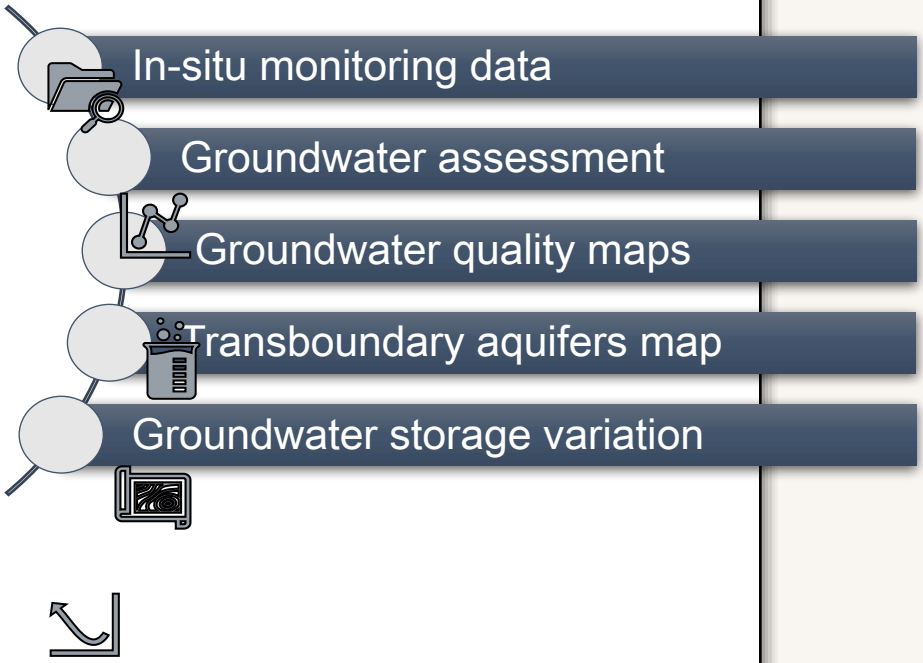
Global Groundwater Quality

The Global Groundwater Quality Portal by IGRAC is a dedicated platform for sharing global maps related to groundwater quality, featuring data from both IGRAC and external partners.



GroMoPo - Groundwater Model Portal

Groundwater models are crucial for understanding groundwater science and sustainability but they are not consistently and openly shared. You can explore or share groundwater model data, knowledge, and insights through this unique portal of regional and global numerical groundwater models. We've made it easy! Fly around the world on our map or grab a coffee and share your first model in less than 10 minutes!



GROUNDWATER MONITORING WORLDWIDE

Home Data Maps Dashboards GeoStories Users About

IGRAC Search Register Sign in English

All resources Resource View Contributors Data download

Filter layers

- Global Groundwater Monitoring Network... 100%
- GGMN Quality Data
- GGMN Springs
- GGMN data quality control

Search by location name

Global Groundwater Monitoring Network (GGMN)

Lat: -18.81 - Long: -53.56

Number of selected points : 10

| | |
|---|--|
| Original ID | 5200007147 |
| Name | Escola Municipal Francisco Rates Rodrigues |
| Feature Type | Water well |
| Purpose | Observation / monitoring |
| Status | |
| Organisation | Brazil - Geological Survey of Brazil (SGB) |
| Country | Brazil |
| Ground surface elevation | |
| DEM elevation based on the GLO_90m dataset | |
| Groundwater levels | yes |
| Groundwater quality data | no |
| Data quality | No flags |
| Last edited at | 2025-08-22T09:59:06.019Z |
| Last edited by | claudia |
| First measurement | 2012-08-19T00:00:00Z |
| Last measurement | 2023-10-27T00:00:00Z |

Water depth [from the ground s...] m

Linear trend

Groundwater Level

All Aug 19, 2012 - Oct 27, 2023

Water depth (from the ground surface)

Scale: 1:147914678

- 50 countries
- ~ 218 670 stations
- 18 Automatic Connections

<https://gmn.un-igrac.org/>

<https://doi.org/10.58154/6Z0Y-DA34>



THE CHALLENGE: KNOWLEDGE IS BURIED IN LITERATURE

Automated discovery, extraction and analysis of scientific knowledge

What is data mining

An automated pipeline that searches, reads, and extracts knowledge from thousands of papers consistently and reproducibly

Why data mining matters

Thousands of papers

Millions of scientific articles published each year — impossible to read manually

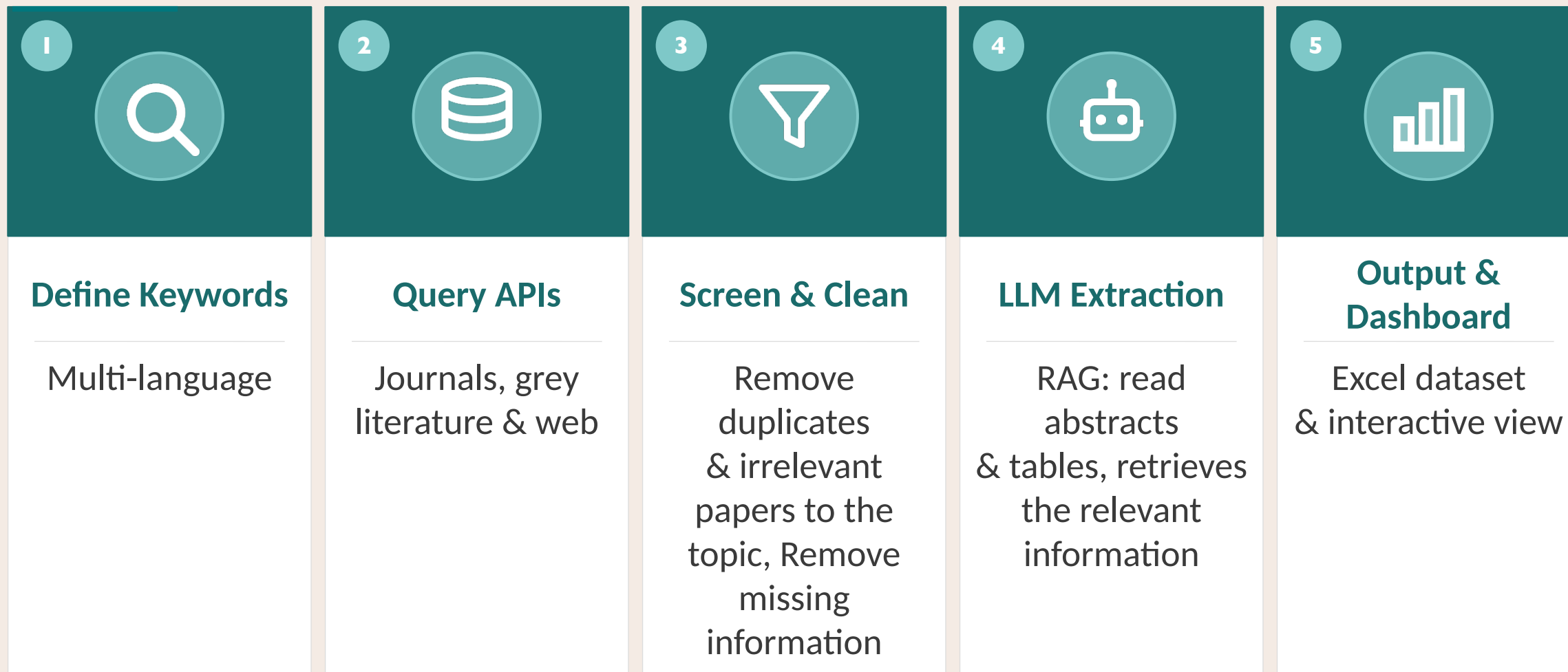
Multiple languages

Research exists in Spanish, French, Arabic and more. Manual translation is impractical

Scattered data tables

Groundwater data are buried inside PDF tables & figures

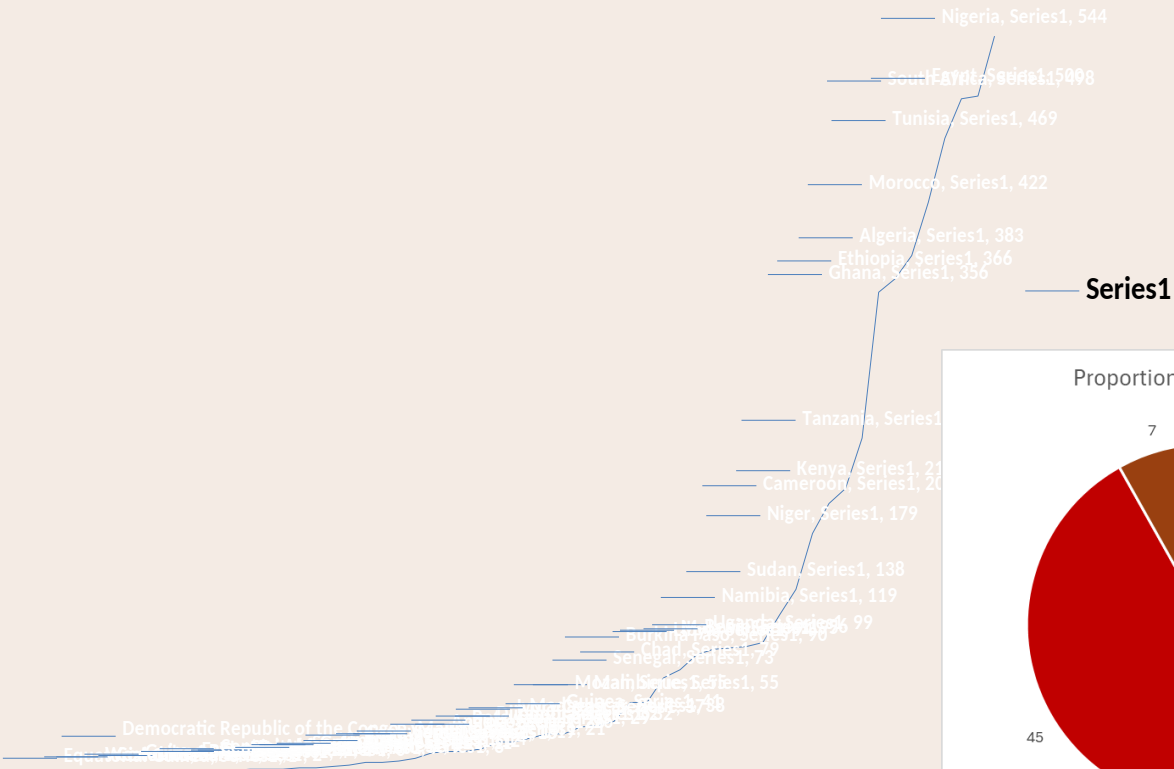
THE PIPELINE: 5 AUTOMATED STAGES



Orchestrated by Apache Airflow — each stage runs automatically in sequence as a scheduled DAG (Directed Acyclic Graph)

Interactive dashboard Groundwater in Africa

Groundwater Research Papers per African Country (n = 5168)

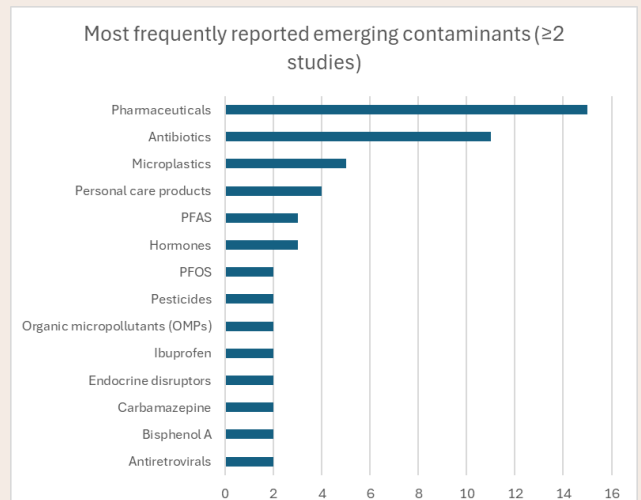
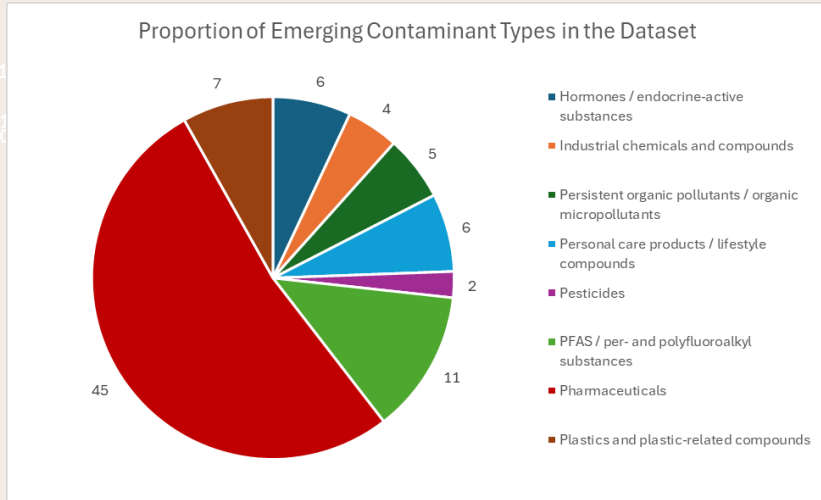
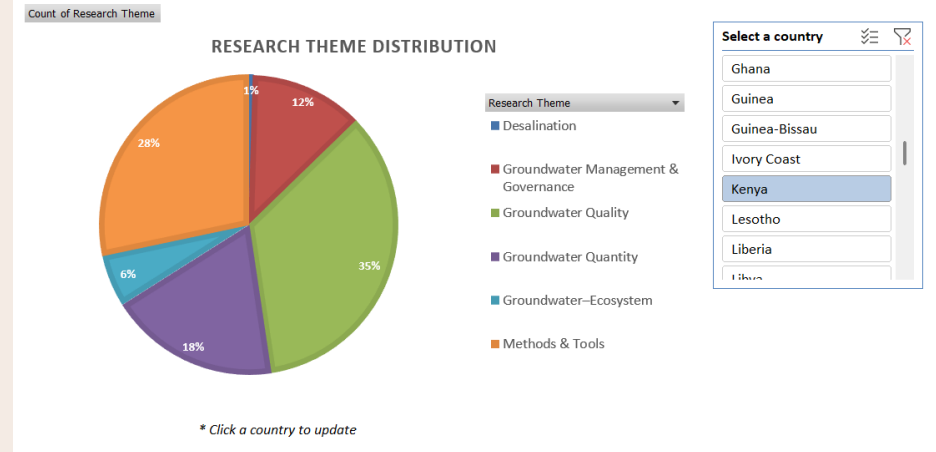


5,168

scientific papers identified

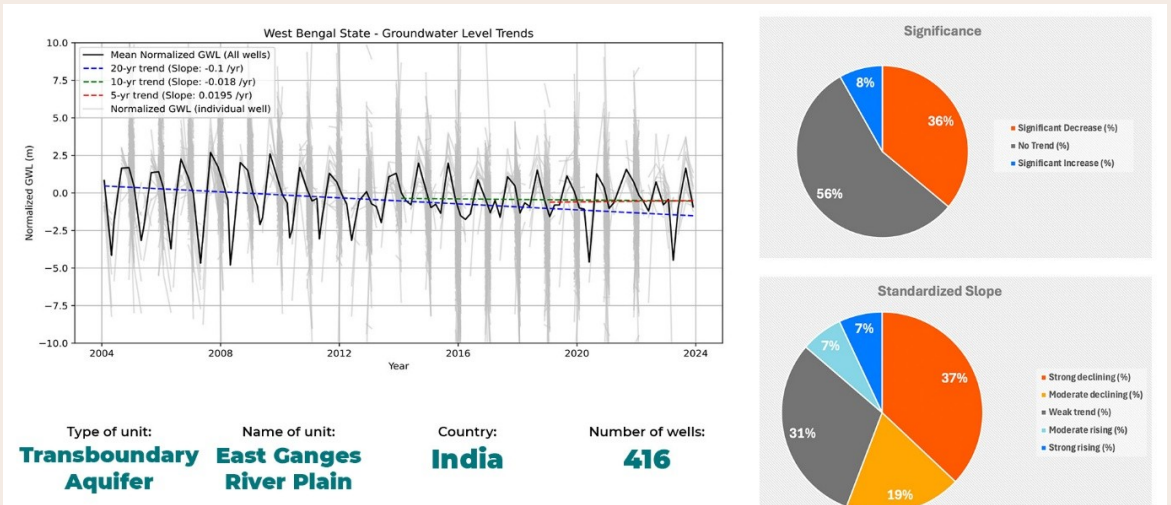
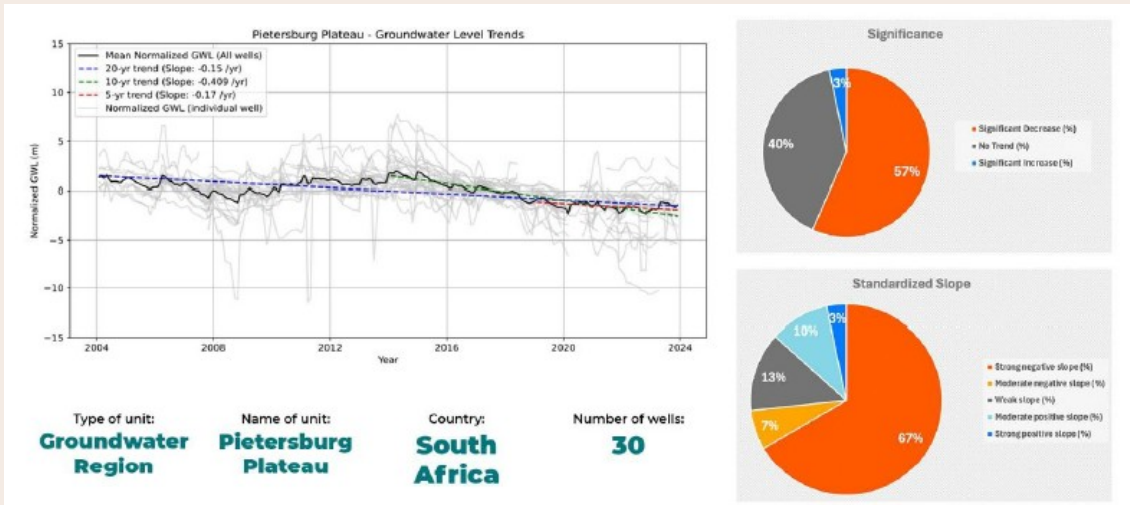
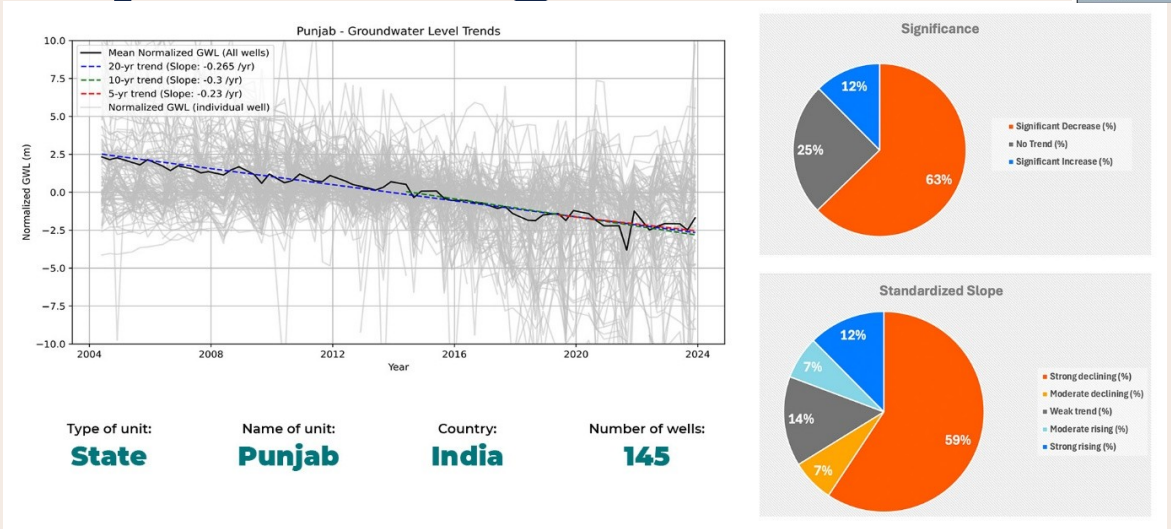
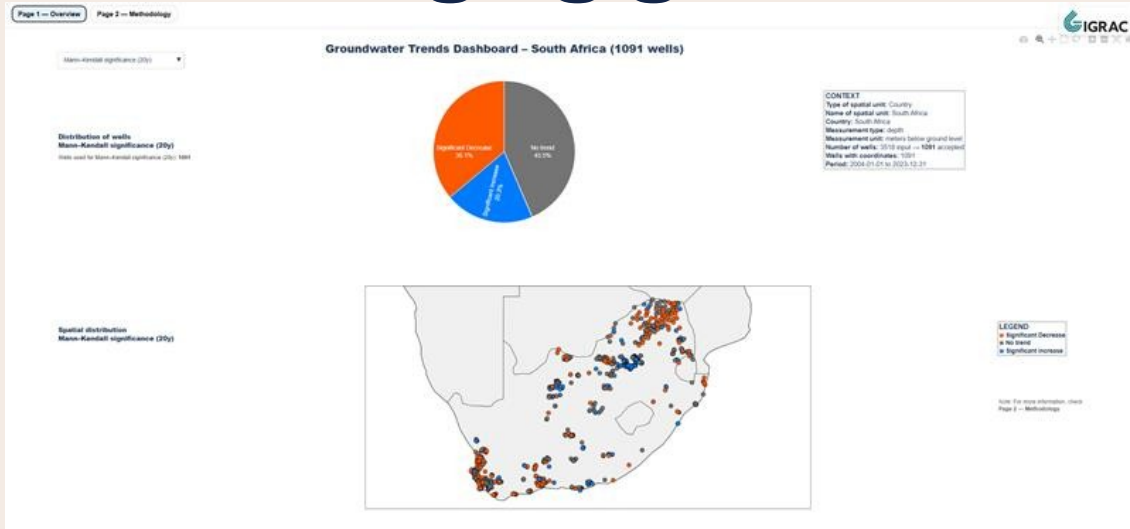
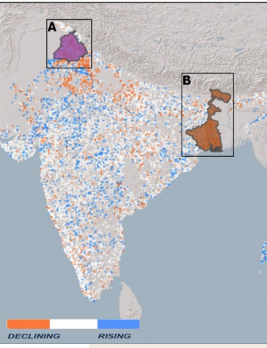
54

African countries covered



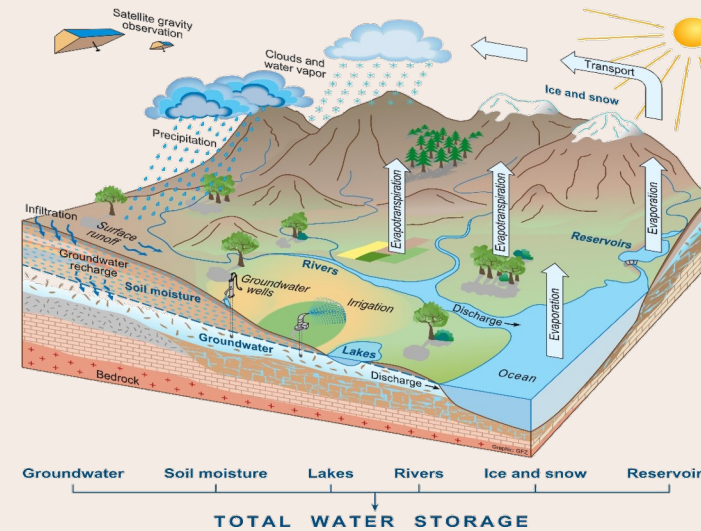
Interactive dashboard

Leveraging groundwater in political agendas



CAN WE MONITOR GROUNDWATER FROM SPACE?

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



Source: G3P project. Groundwater storage trend 2002-2016

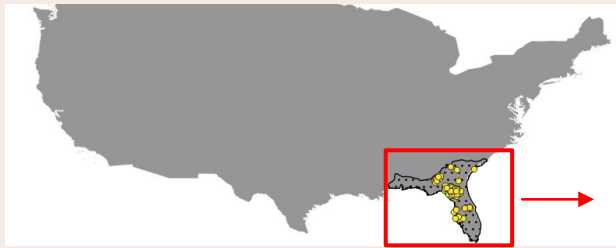
Groundwater = TWS - glaciers - snow - soil moisture - storage in surface water bodies



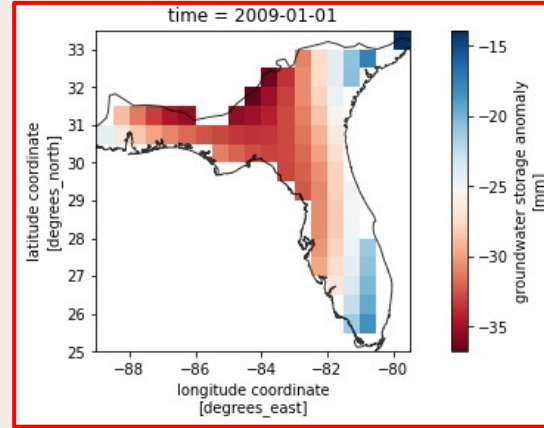
CAN WE MONITOR GROUNDWATER FROM SPACE?

Global Gravity-based Groundwater Product (G3P):

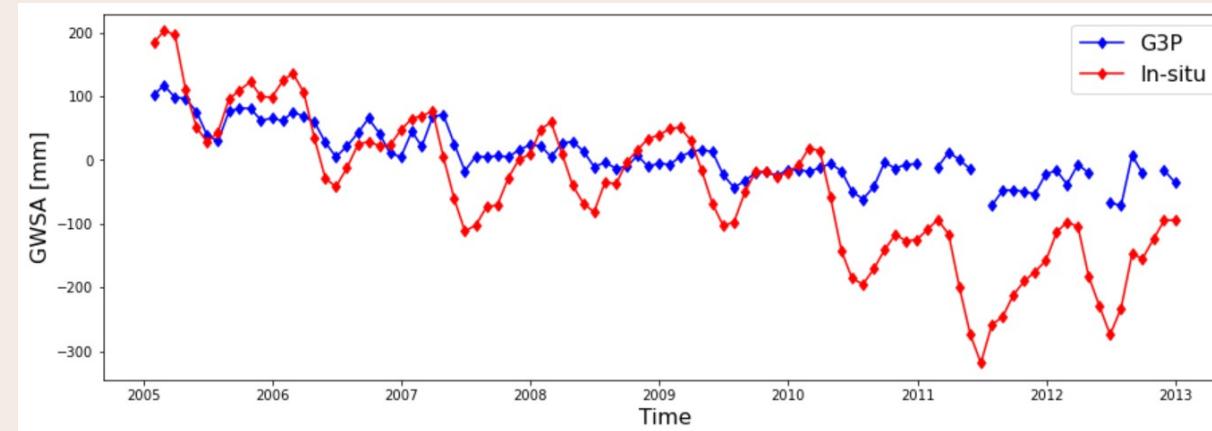
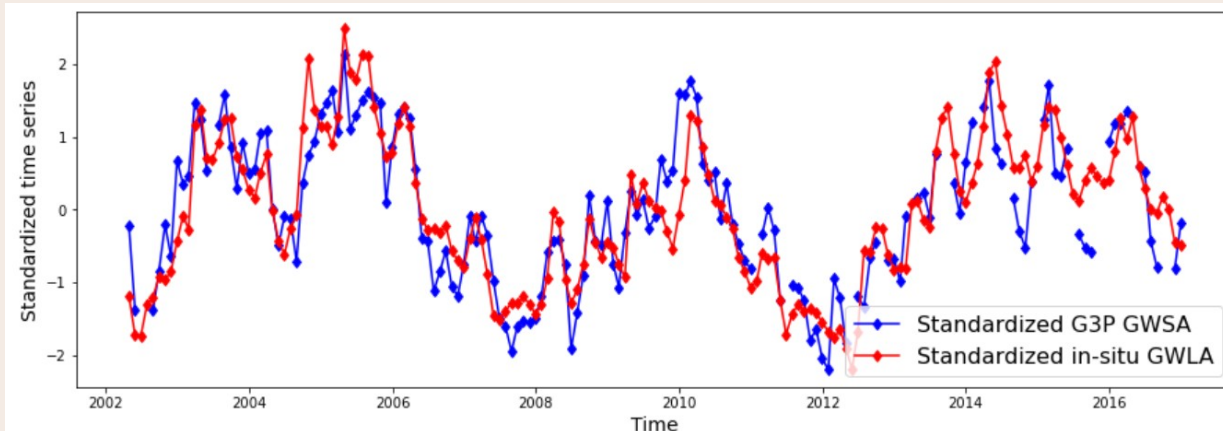
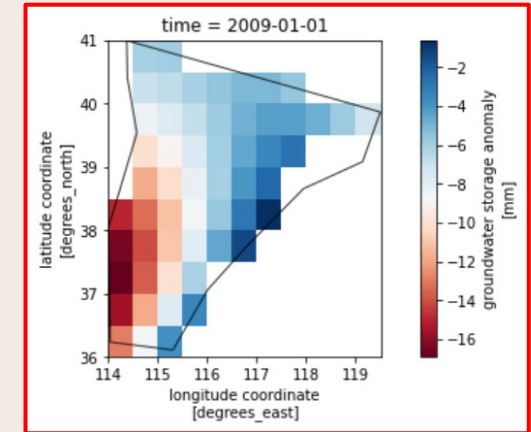
Validation with in-situ data



Floridian aquifer, USA



North China aquifer system



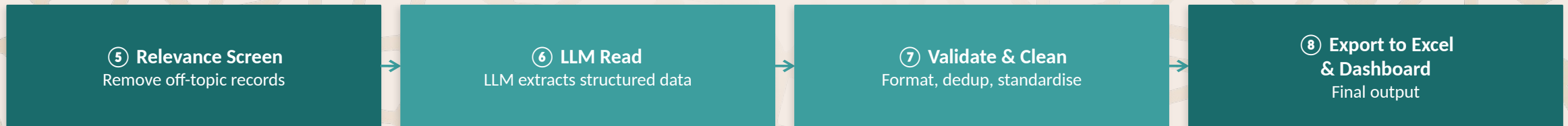
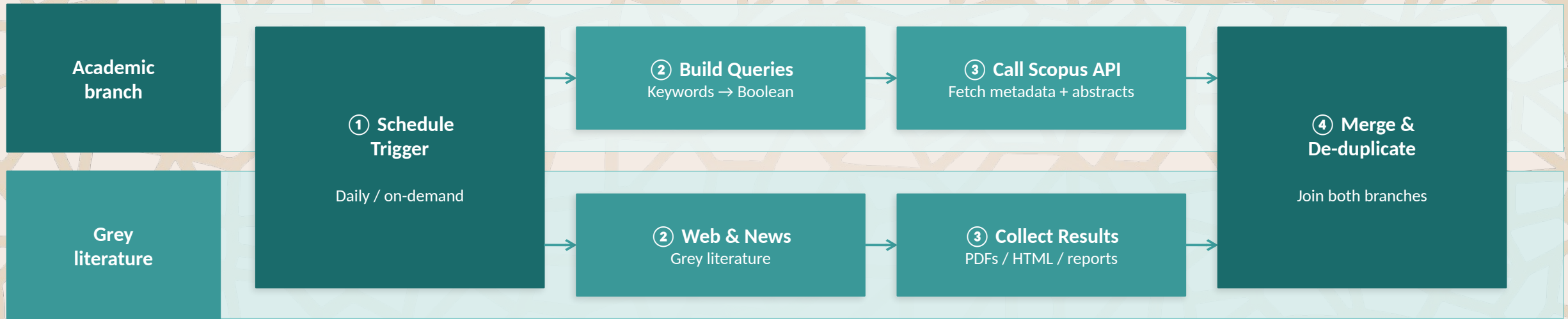
Thank you for your attention

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



How It Runs: Apache Airflow for MAR Project (Extra)



Each box is an independent Airflow task — if one fails, only that task re-runs, not the whole pipeline.

RAG Architecture: How It Works (used in G4DR and stage 6 in MAR) (Extra)

