

Assessing Groundwater Quality: A Global Perspective

Importance, methods and potential data sources

presented by

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on behalf of the “Friends of Groundwater”

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ASSESSING
GROUNDWATER QUALITY:
A GLOBAL PERSPECTIVE

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Friends of Groundwater in the World Water Quality Alliance (WWQA)

Institutions & organisations represented through the “Friends of Groundwater”



British Geological Survey



Bundesanstalt für Geowissenschaften und Rohstoffe

eawag
aquatic research



International Association of Hydrogeologists
the World-wide Groundwater Organisation



International Groundwater Resources Assessment Centre



RESEARCH PROGRAM ON Water, Land and Ecosystems

LED BY: IWM
International Water Management Institute

KWR



NATIONAL CENTRE FOR GROUNDWATER RESEARCH AND TRAINING

RUHR UNIVERSITÄT BOCHUM

RUB



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

UMVOTO
EARTH | WATER | SCIENCE | LIFE



United Nations Educational, Scientific and Cultural Organization



Intergovernmental Hydrological Programme



UNITED NATIONS UNIVERSITY

UNU-INWEH

Institute for Water, Environment and Health



UF UNIVERSITY OF FLORIDA

UNLV



UNIVERSITY OF KWAZULU-NATAL

INYUVESI YAKWAZULU-NATALI



Centre for Water Resources Research

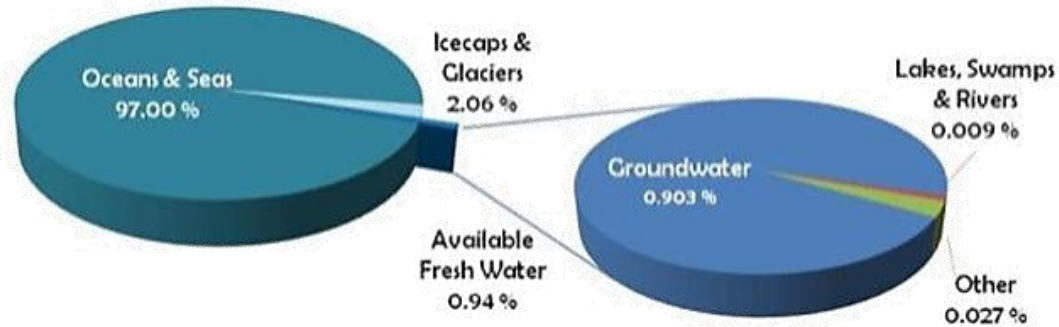


GRIPP

GROUNDWATER SOLUTIONS INITIATIVE FOR POLICY AND PRACTICE

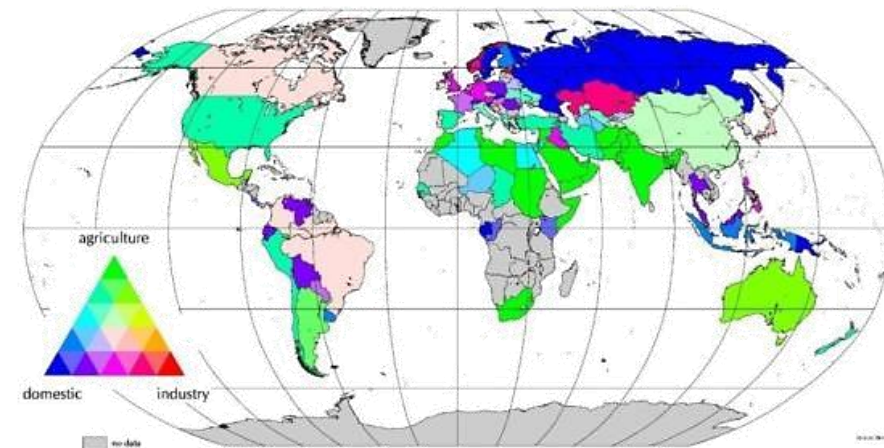
www.groundwater-quality.org

Groundwater: From a global perspective & Why a global groundwater quality assessment is needed



- About **50% of people globally** obtain drinking water from GW
- GW provides over **40% of world's irrigation water**
- Access to (good quality) GW for drinking and irrigation is impacted by **economic status**
- Meeting **SDGs will increase demand** for GW
- GW **sustains important ecosystems** such as wetlands, **keeps our rivers flowing** during droughts
- Aquifer systems offer **potential buffer** against impacts of **climate change**

- **Human activities** (e.g. growth of population, wealth), **climate variability** are **increasing pressures** on GW resources
- Protection of GW resources necessary for **protecting human health, maintaining food supplies and conserving ecosystems**
- GW is **poorly understood and often poorly managed**: vital resource needs to be protected from impacts of overexploitation and pollution



Global groundwater consumption per sector

Threats to groundwater quality

Groundwater is facing many threats from the effects of **agricultural intensification**, **urbanisation**, **population growth** and **climate change**:

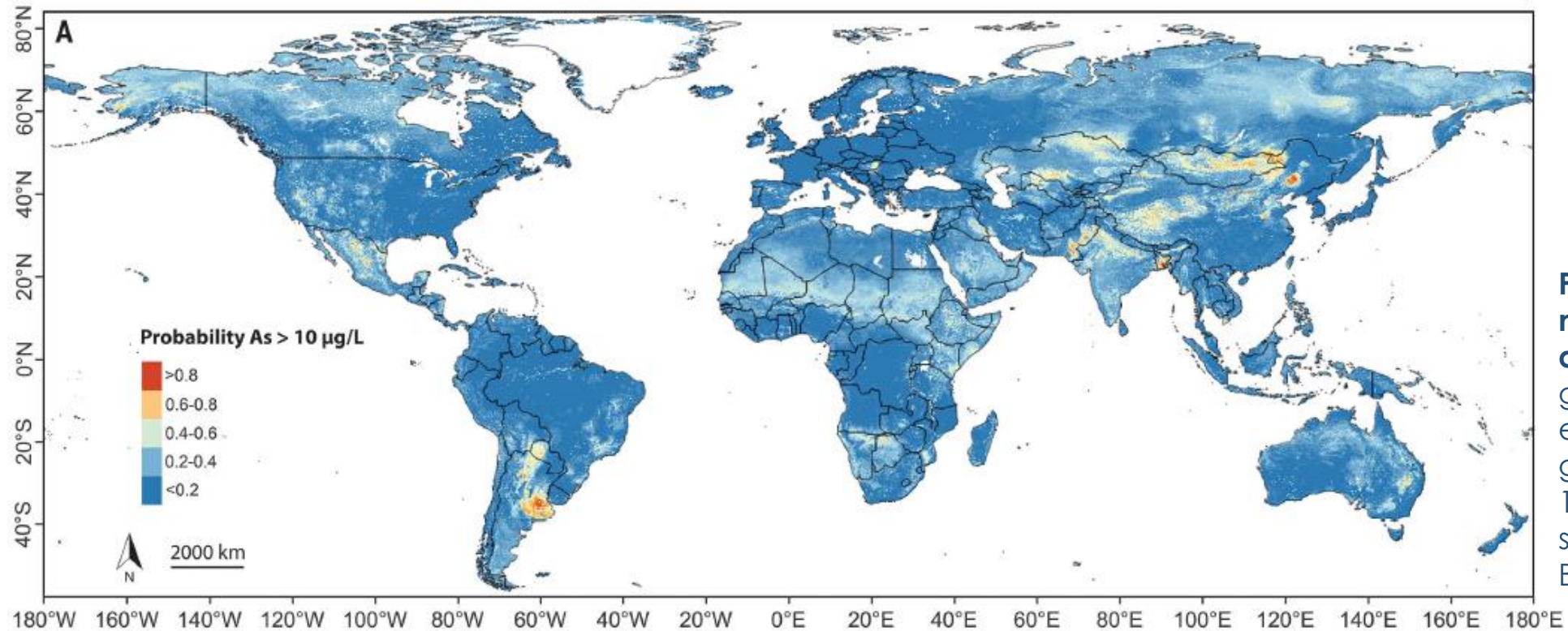
- Groundwater **salinization** from **irrigated agriculture**, over-pumping drawing in **old saline water**, and **sea water intrusion** into coastal aquifers
- **Nitrate** and **pesticide** pollution
- **Microbial** contaminants
- Groundwater contamination from **industry**, **mining**, **sanitation** and **urbanisation**
- **Emerging contaminants** associated with industrial activities, urbanisation and agriculture



Contaminants can occur naturally in groundwater

Several **naturally-occurring (geogenic) contaminants** can lead to serious health problems if present at high concentrations in groundwater supplies.

Notable examples: **arsenic, fluoride** and **radionuclides (U, Ra, Rn)**



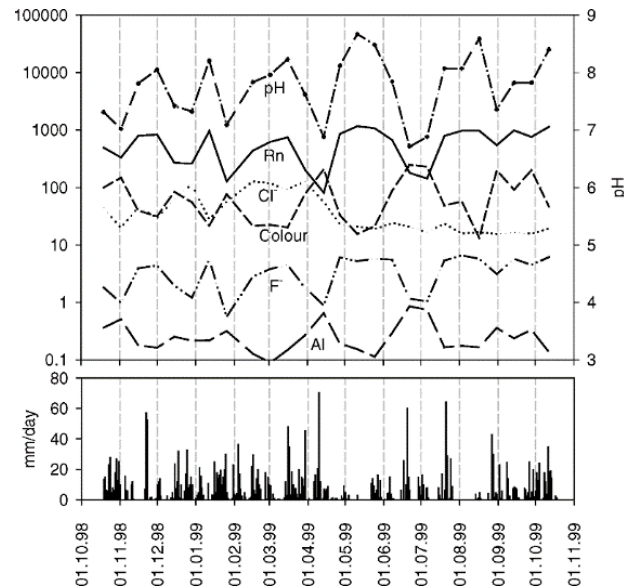
Probability of naturally occurring arsenic in groundwater exceeding WHO guideline of 10 µg/L at global scale (Podgorski & Berg, 2020)

Challenges for a global groundwater quality assessment

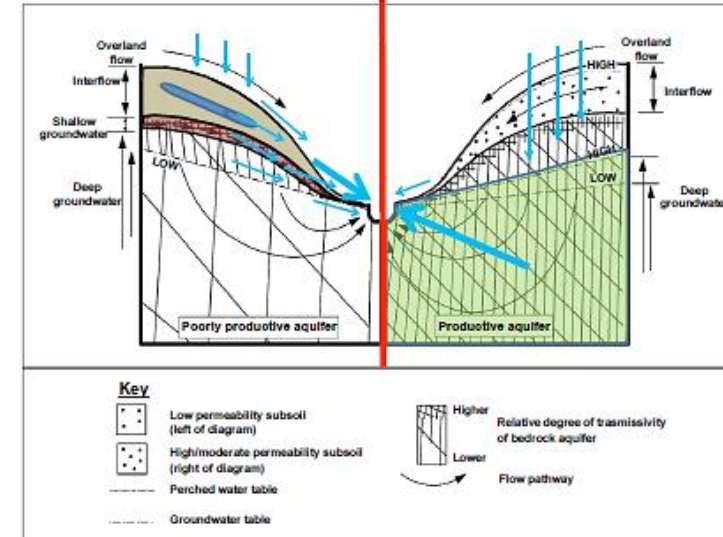
Methodological

- What are **priority parameters**?
- **Upscaling** local studies to regional assessments
- The **3rd (3-D flow) and 4th (time) dimensions**
- Poor **sampling** and **analysis** procedures; poor monitoring **well construction**

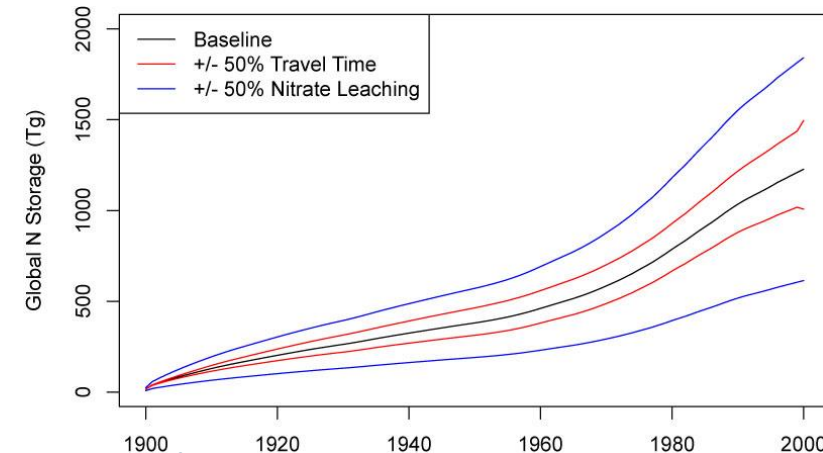
Seasonal variations in groundwater chemistry, Bergen region, Norway (Data from Geological Survey of Norway, reproduced in *Mistear et al., 2017*)



www.groundwater-quality.org



3-D nature of groundwater flow and contaminant migration: pathways present in poorly productive aquifers (left) and productive aquifers (right) (*Archbold et al., 2016*).



Long-term effect: modelled global increase in nitrate stored in unsaturated zone, potential impact on groundwater quality for decades (*Ascott et al., 2017*)

Challenges and opportunities for a global groundwater quality assessment & groundwater quality management

Data and information challenges:

- **Mandate** and use of national data sources
- Opportunities to use **Citizen Science**
- **Earth Observations**

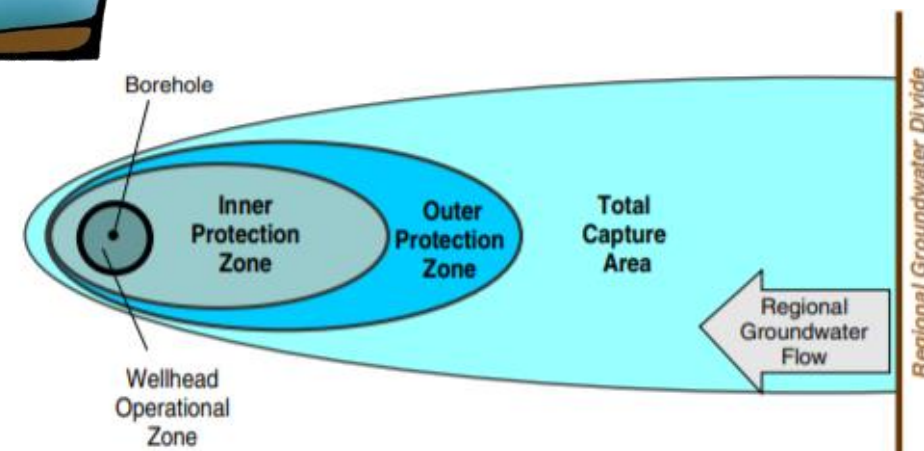
Global sources of data and information:

- Global Assessments & Overviews (e.g. IGRAC, BGS)
- Global studies using modelling (e.g. EAWAG GAP)
- UN Environment GEMStat (GEMS/Water)

Current world-wide assessments:

- Country data: SDG 6.3.2 ambient water quality
- World Water Quality Assessment (UN Environment)

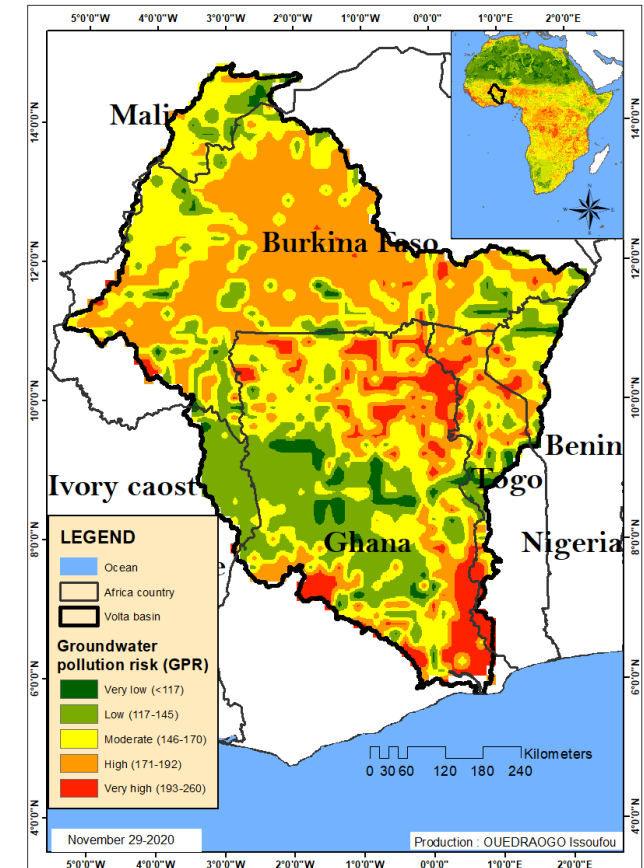
Regional and country-wide data sources



Groundwater Protection Zones around production borehole (Rajkumar & Xu, 2011)

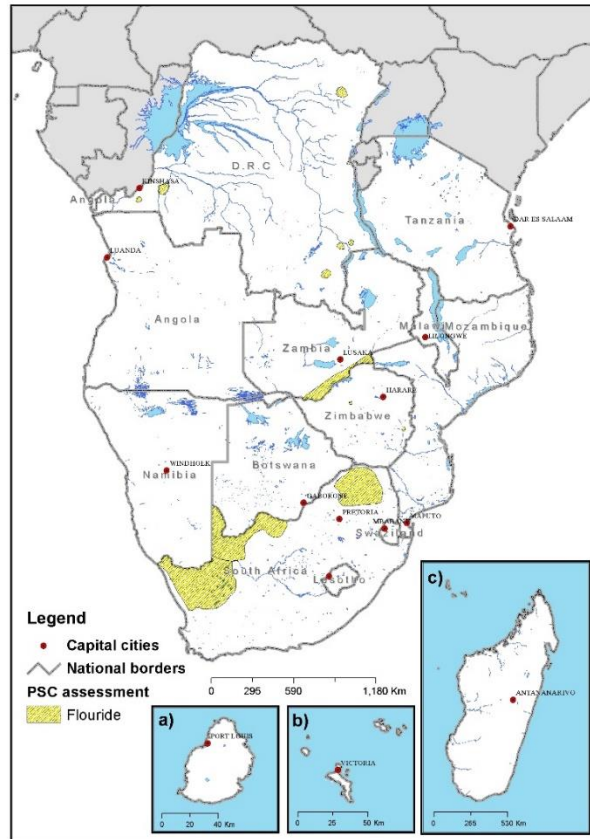
Groundwater quality: Opportunities for Africa

- **GW quality in Africa:**
 - **70% of population in Africa** rely directly on GW for basic water needs
 - GW increasingly **developed for multiple purposes**, including urban supply and economic sectors (agriculture/food processing, etc.), requiring adequate water quality
 - GW **monitoring, assessment and management** remains area of relatively low **technical and human capacity**
- Strengthening partnerships through **strategic initiatives for groundwater quality:**
 - **AMCOW / APAGroP** (AMCOW Pan-African Groundwater Program)
 - Regional organisations such as **SADC / SADC-GMI and others**
 - Building on **Use Cases**

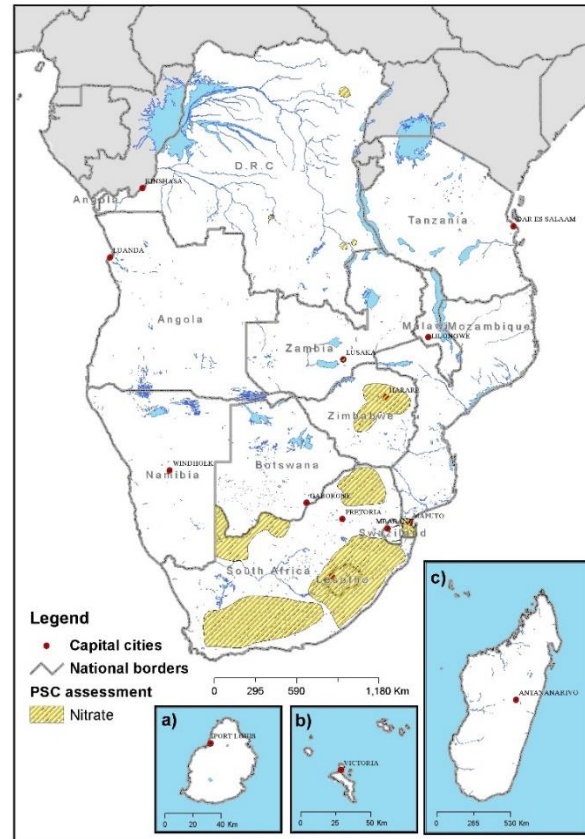


**Groundwater Pollution Risk,
Groundwater Vulnerability,**
Ouedraogo et al., 2016

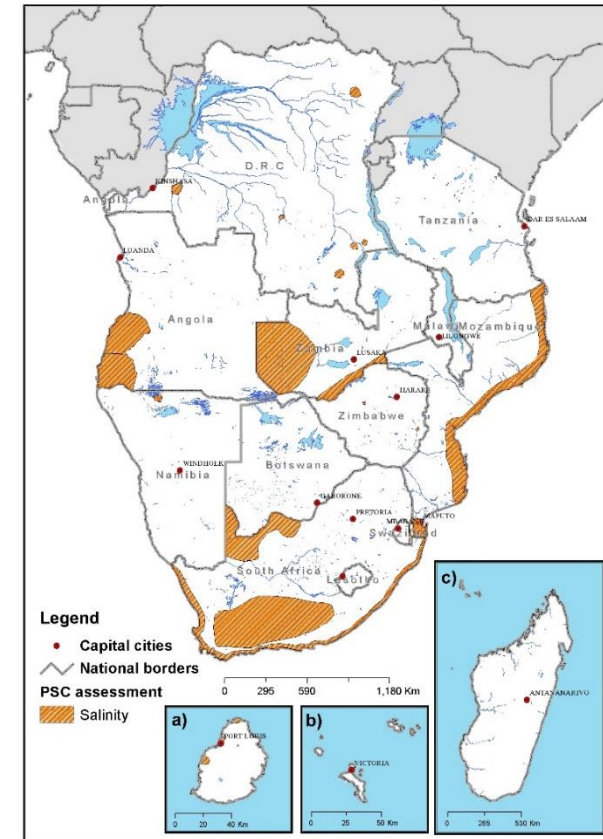
Examples of groundwater quality in SADC region



Fluoride problem areas



Nitrate problem areas

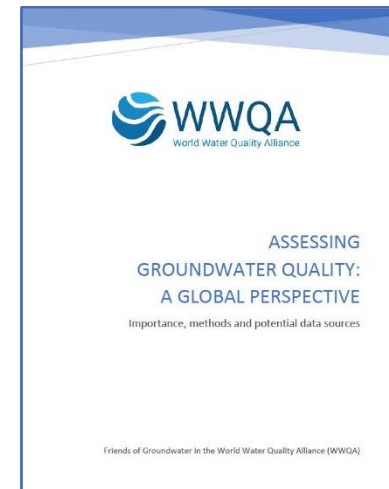


Salinity problem areas

Groundwater Problem Areas, maps from stakeholder surveys across SADC, Villholth *et al.*, 2011

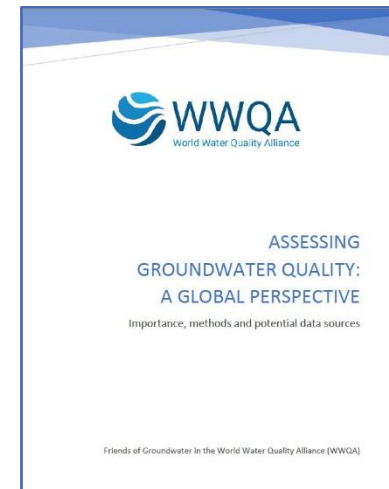
Key messages 1 of 2

1. Increased attention to GW quality utmost importance for **achievement of SDGs**.
2. Dedicated **global GW quality assessment is necessary and timely**.
3. Existing **large variability of anthropogenic and natural, chemical and microbiological contaminants** found in GW at different scales across the globe. Contaminant characteristics require expert knowledge.
4. GW systems are **heterogeneous, three-dimensional** water reservoirs in complex rock formations. Contaminant transport and remediation involve **long time scales**. Mapping contaminant distributions is challenging.
5. Information and **data on GW quality** are very variable across the globe. Often less information available in countries of Global South. Substantial efforts are needed for a comparable global assessment.



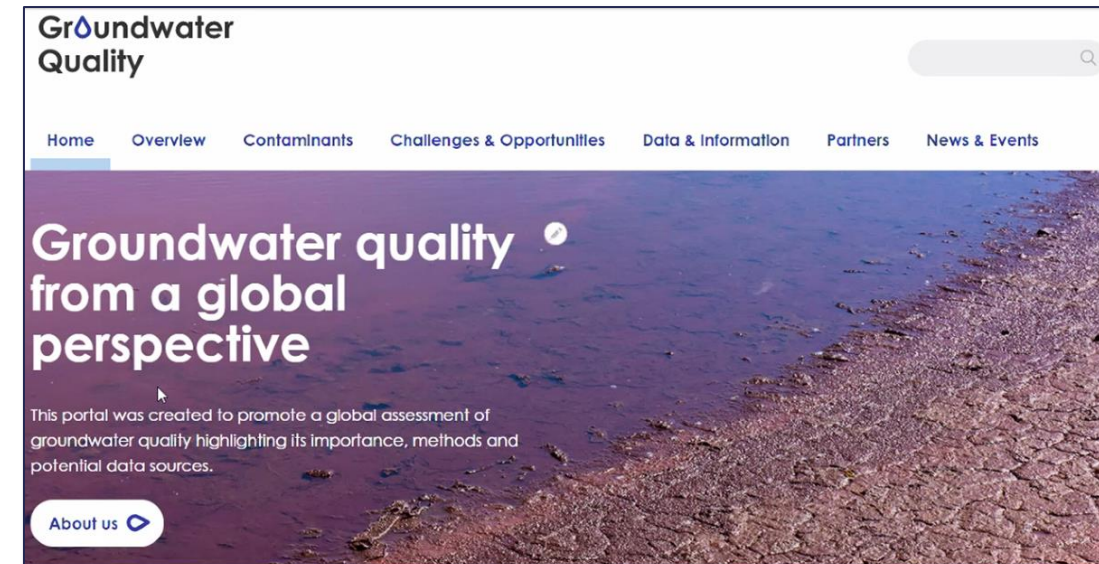
Key messages 2 of 2

6. GW quality needs to be understood at **various scales** depending on the issues, **in relation to different end uses** e.g. drinking water, ecosystems, food production, energy production and others.
7. GW **monitoring programmes** need to be targeted and designed according to the purpose of the monitoring.
8. Important **new advances** are becoming more common, e.g. earth observations, citizen science, machine learning, numerical modelling of contaminant fate and transport, complementing traditional methods.
9. Monitoring programmes for GW quality are based on **national level legislation and regulations**, where these exist. Special attention is required for **transboundary aquifers**.
10. To advance management of GW quality local-to-global **partnerships and investments in research, capacity development and evidence-based policymaking** are required.



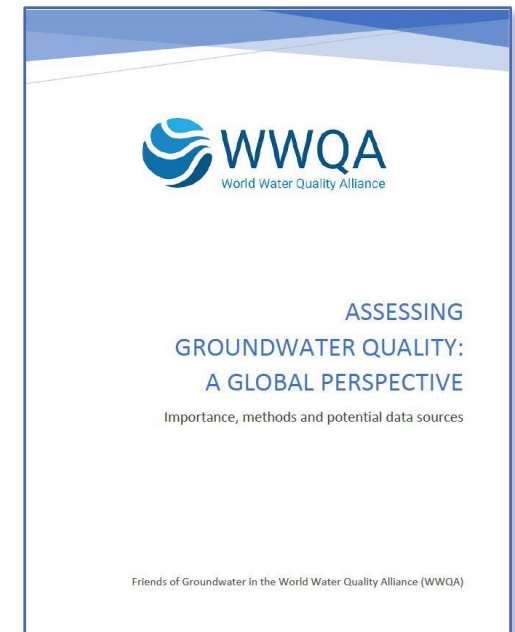
Way forward – proposal for next phase of FoG work submitted to UNEP

- **Global GW Quality Assessment Portal**
www.groundwater-quality.org
- **Global GW Quality Assessment Network**
building on GEMS/Water and SDG 6.3.2
- **National GW Quality Monitoring Programmes collated**,
incl. institutions, purpose, parameters, methodology,
availability and accessibility
- **2022 “Groundwater: Making the Invisible Visible”**:
UN-Water theme, WWDR, WWD, SWWW, GW Summit, ...
- Assistance to **national GW Quality assessment programmes**, capacity development and advocacy
- **Upscaling and regionalisation** - main **FoG research activity**: regional/global modelling (e.g. machine learning, remote sensing), building on Use Cases, in-situ sensors citizen science, etc.



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Importance, methods and potential data sources



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