

Groundwater in a Changing World - Buffer or Burnout?"

WRA Online Conference
Addressing Groundwater Resilience under Climate Change
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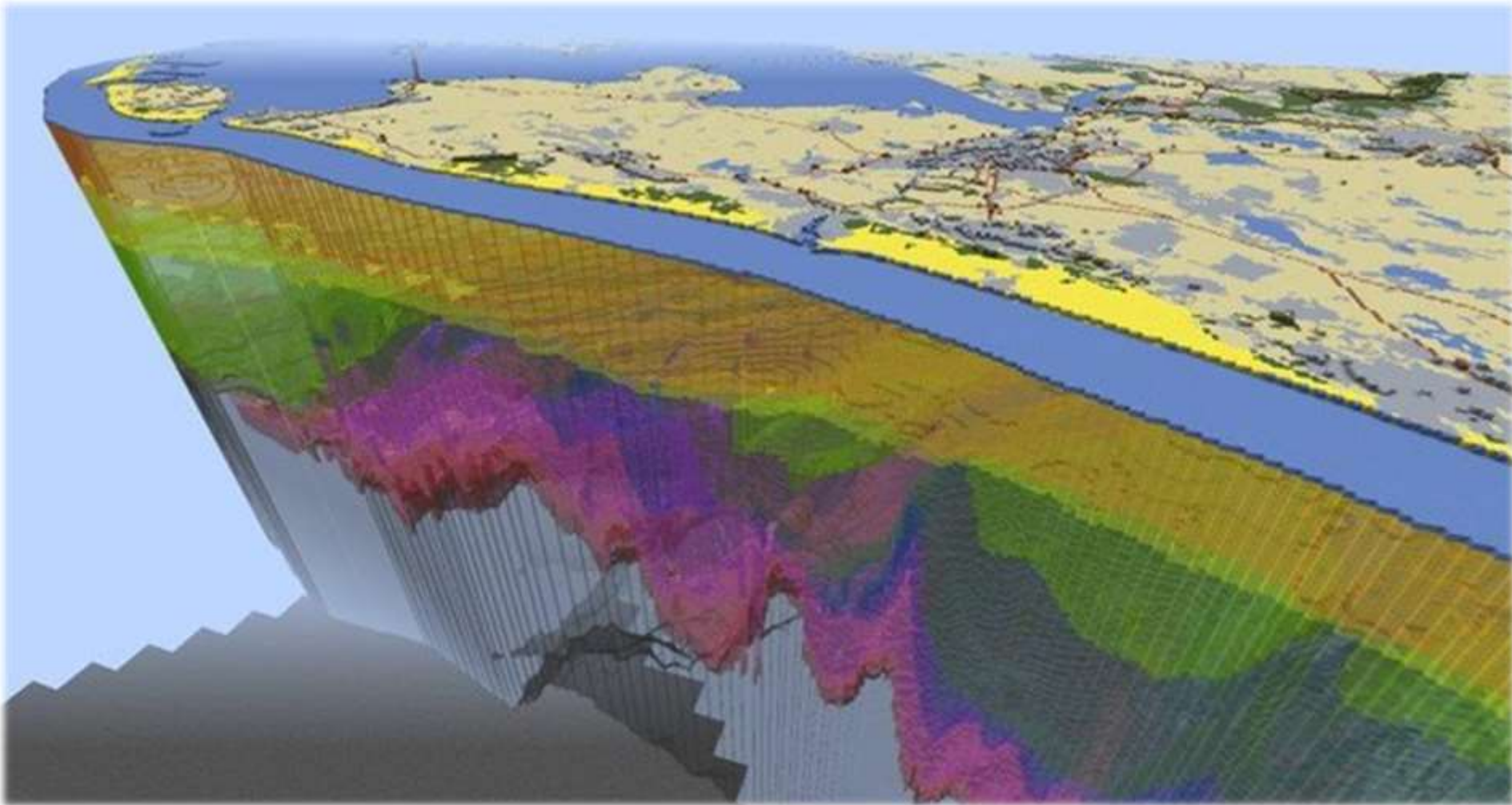


Outline

1. Groundwater – moving towards a buffer or burnout?
2. The quadrant of Climate Change impacts on groundwater
3. Adaptation – groundwater-based solutions
4. Some ways forward



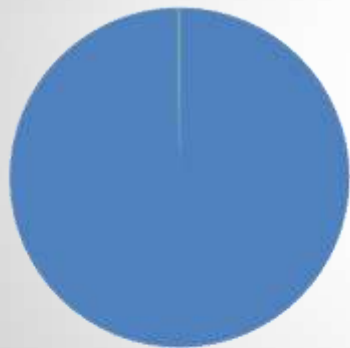
The world on its edge



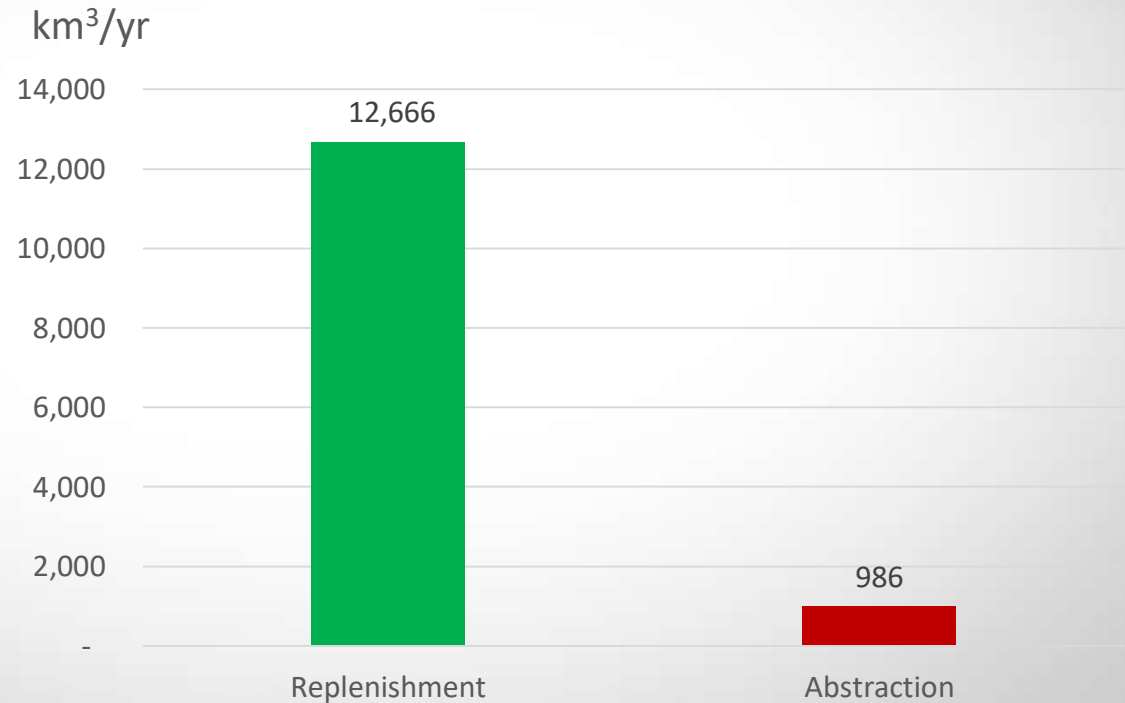
The world on its edge



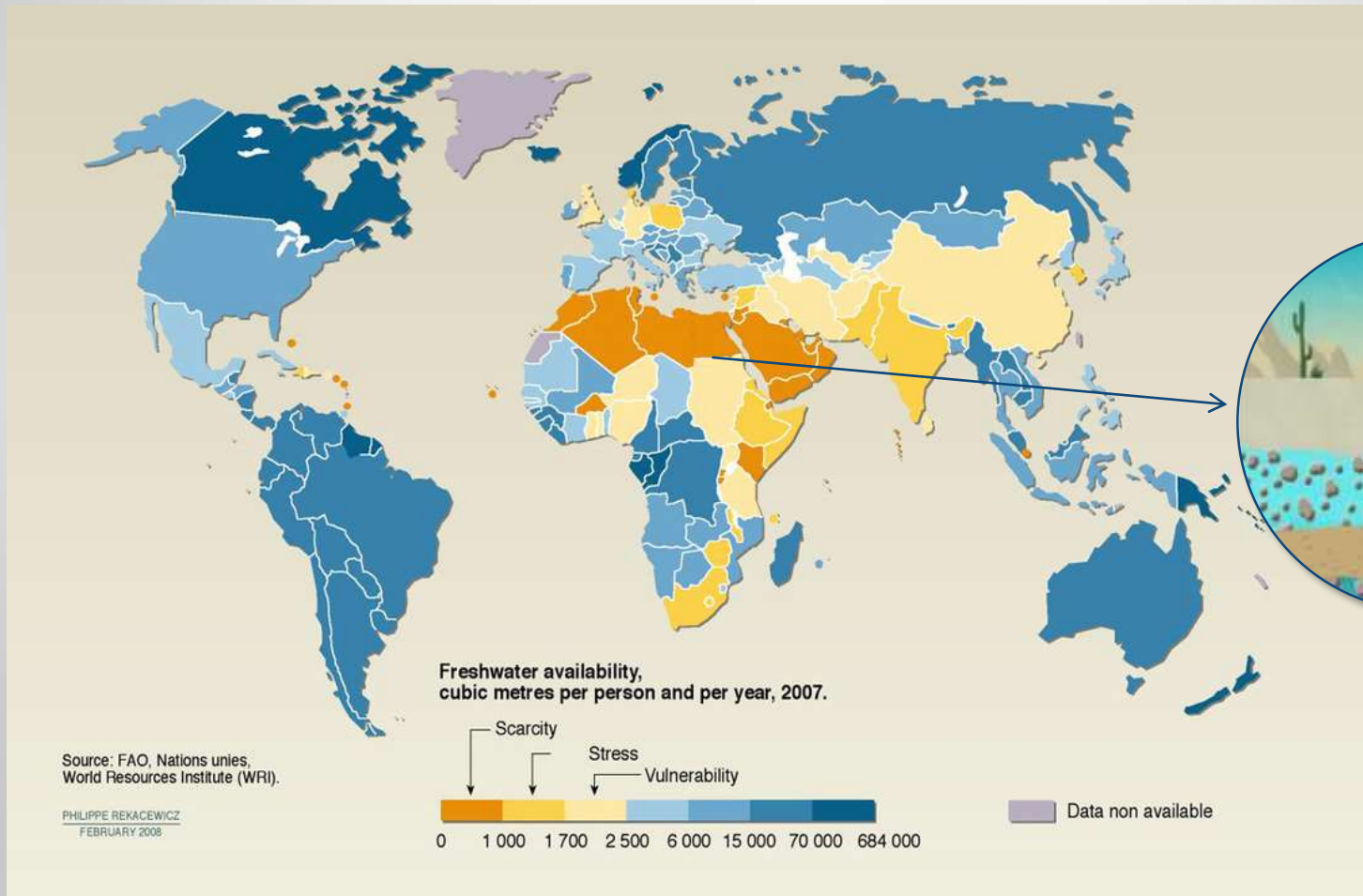
Renewable fresh groundwater resources



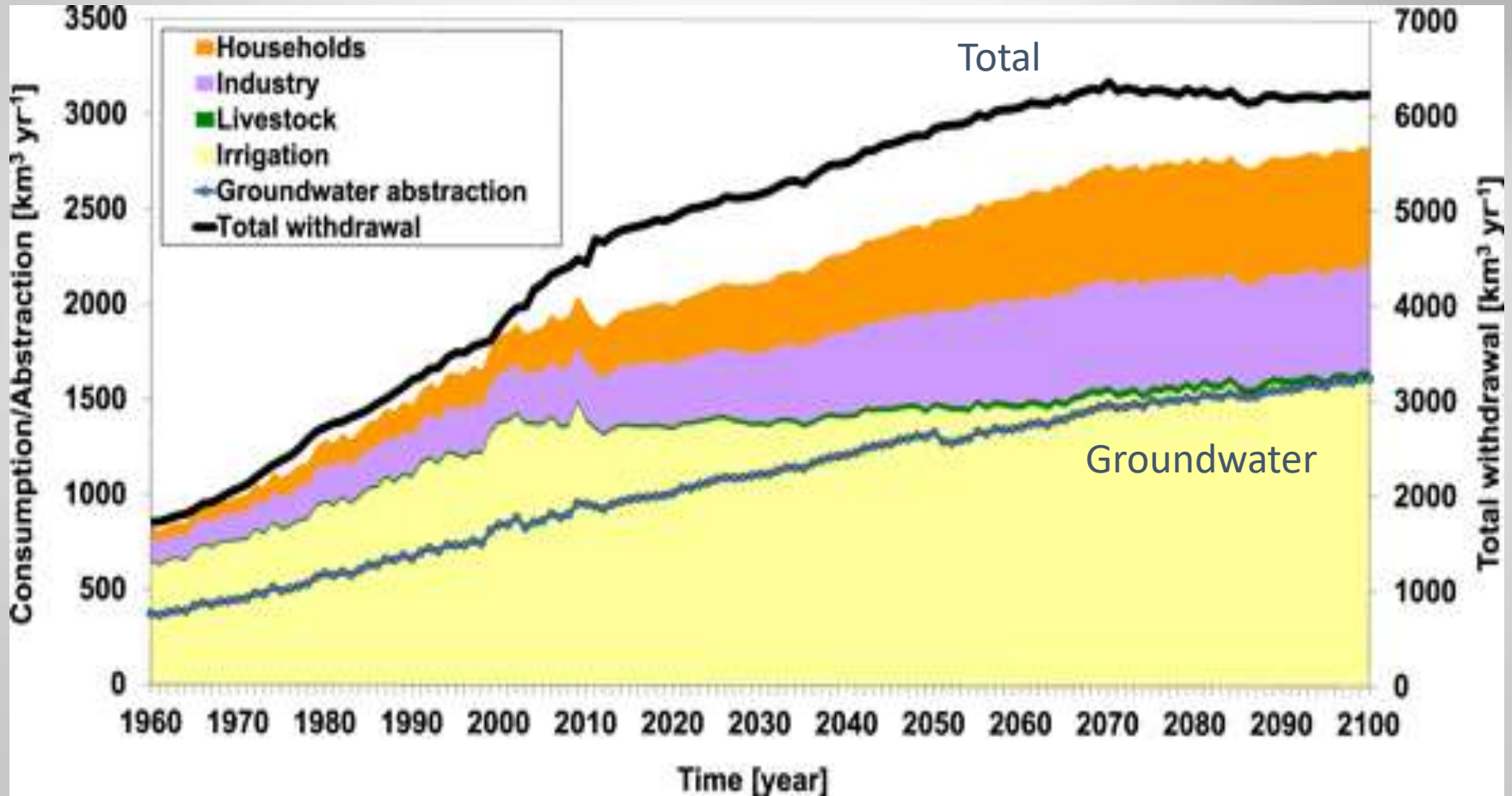
- Total storage
- Abstraction
- Replenishment



Global freshwater availability



Global groundwater abstraction



Wada and Bierkens (2014)

Drivers of groundwater development

- GW provides a reliable and suitable water source:
 - Often widely present
 - In-built distribution and storage
 - All-year availability and drought resilience
 - Individual access and management possible
 - Little loss from evaporation
 - Normally a safe source of drinking water
- Increasing demand for drinking water and food
- Better low-cost efficient pumps and wells
- Better knowledge on GW resources
- Increasing attention from governments, private sector and donors





Climate change impacts on groundwater

- Groundwater provides resilience and a critical adaptation mechanism if well-managed
- In arid areas, GW recharge will be increasingly episodic and focused (Cuthbert et al, 2019)
- Most vulnerable areas: large coastal cities, tropical deltas, and small islands (due to seawater intrusion, subsidence and dense populations)
- In humid areas, like Denmark, groundwater levels are rising
- Groundwater depletion and flooding will co-exist





Challenges

- Exact impacts are still not well understood
- Impacts on both quantity and quality important
- Groundwater is the ‘memory’ of climate, and so understanding groundwater in the context of climate (historic and future) is key
- Climate footprint on groundwater is increasingly confounded/overshadowed by human impact



The quadrant of GW and Climate Change impacts

Water quantity

Direct

Indirect

Water quality

Direct

Indirect



Direct impact on GW quantity

Water quantity

Direct

Indirect

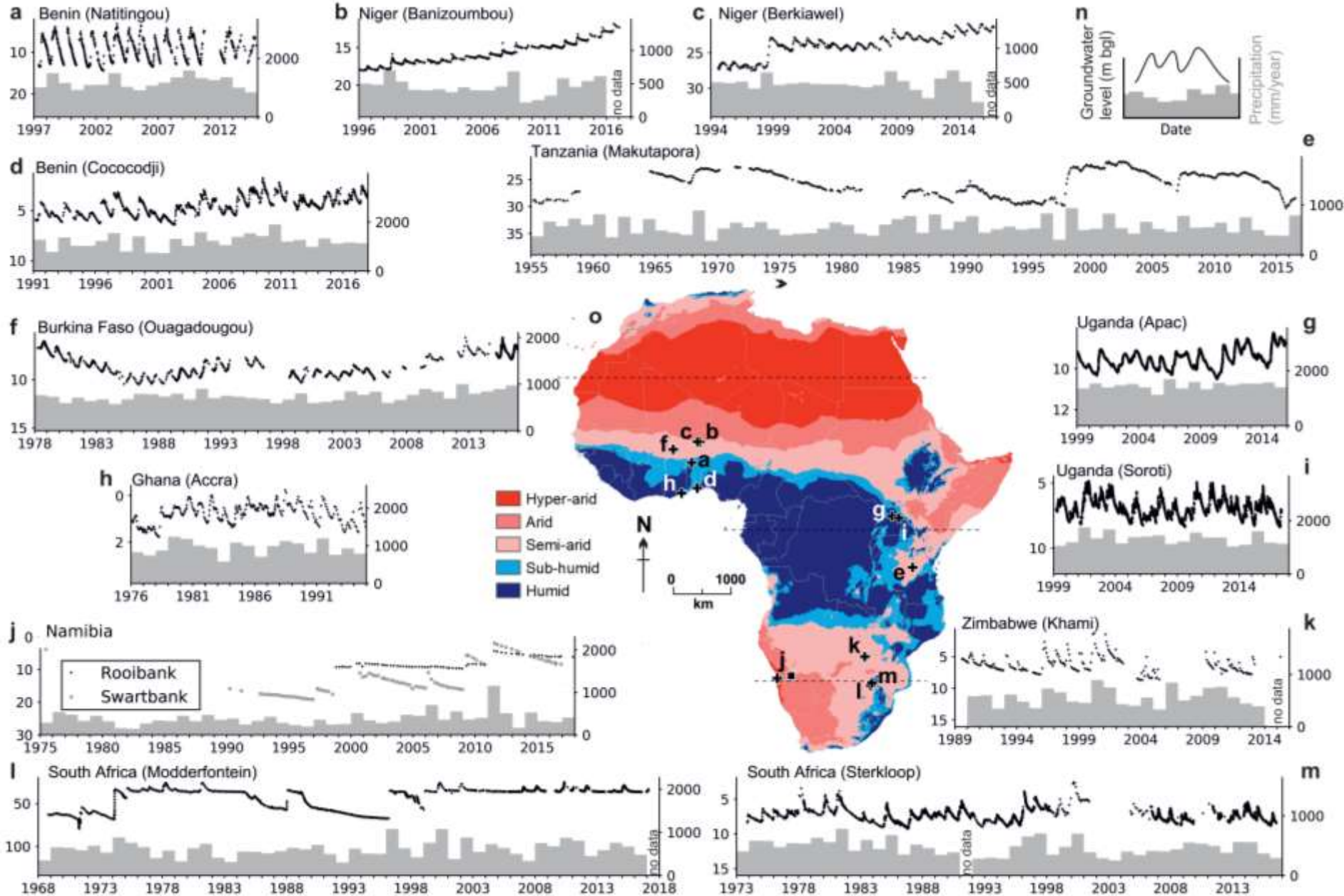
Water quality

Direct

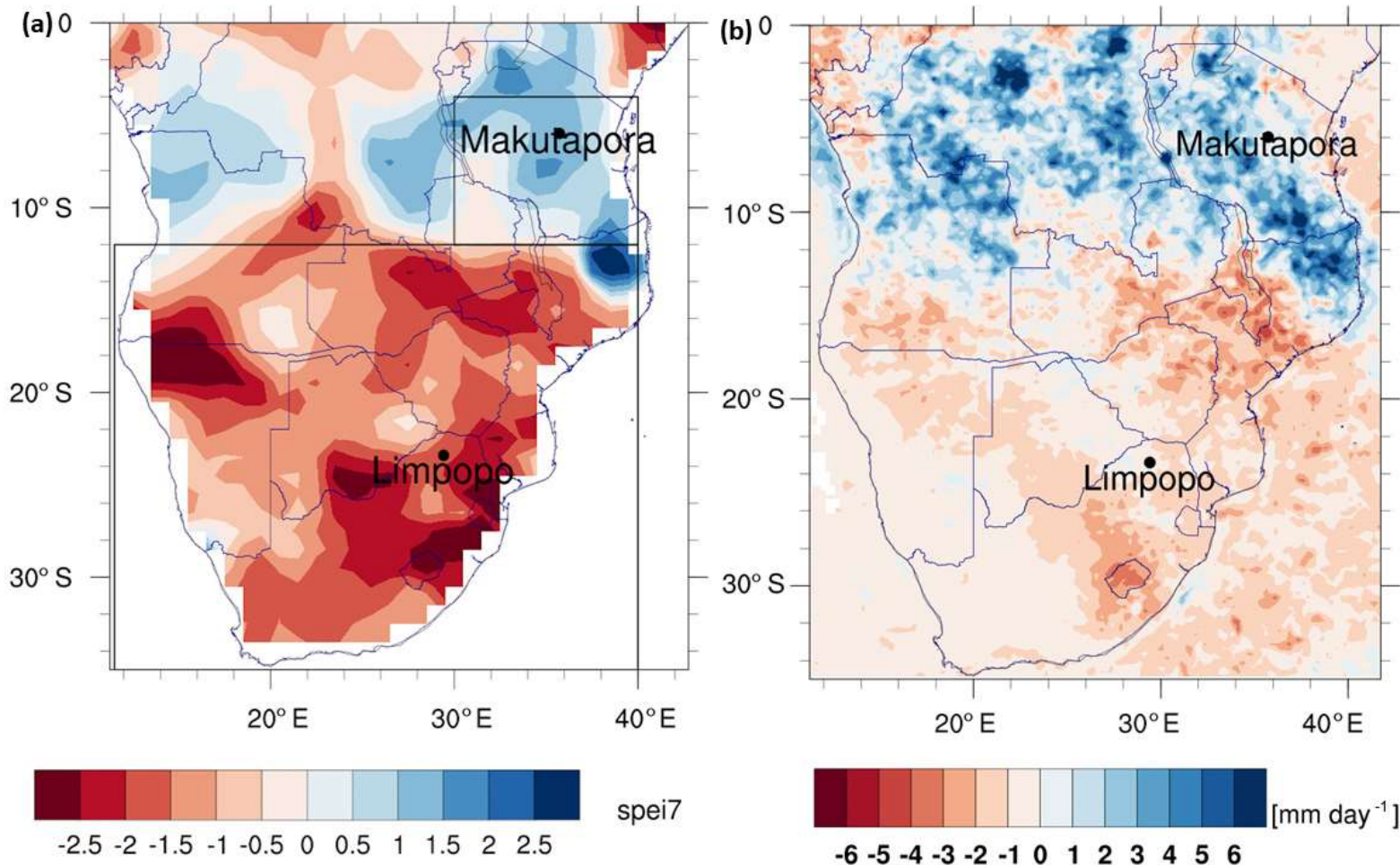
Indirect



Research in Sub-Saharan Africa



Anomalies during El Niño event 2015-2016



*Kolusu et al.,
2019*

Large-scale climate anomalies over the study region for Oct-Apr 2015–2016. (a) SPEI-7. (b) Anomalies of the 80th percentile of daily TRMM rainfall (mm day⁻¹).

Indirect impact on GW quantity

Water quantity

Direct

Indirect

Water quality

Direct

Indirect



Indirect impact on GW quantity

Water quantity

Direct

Indirect

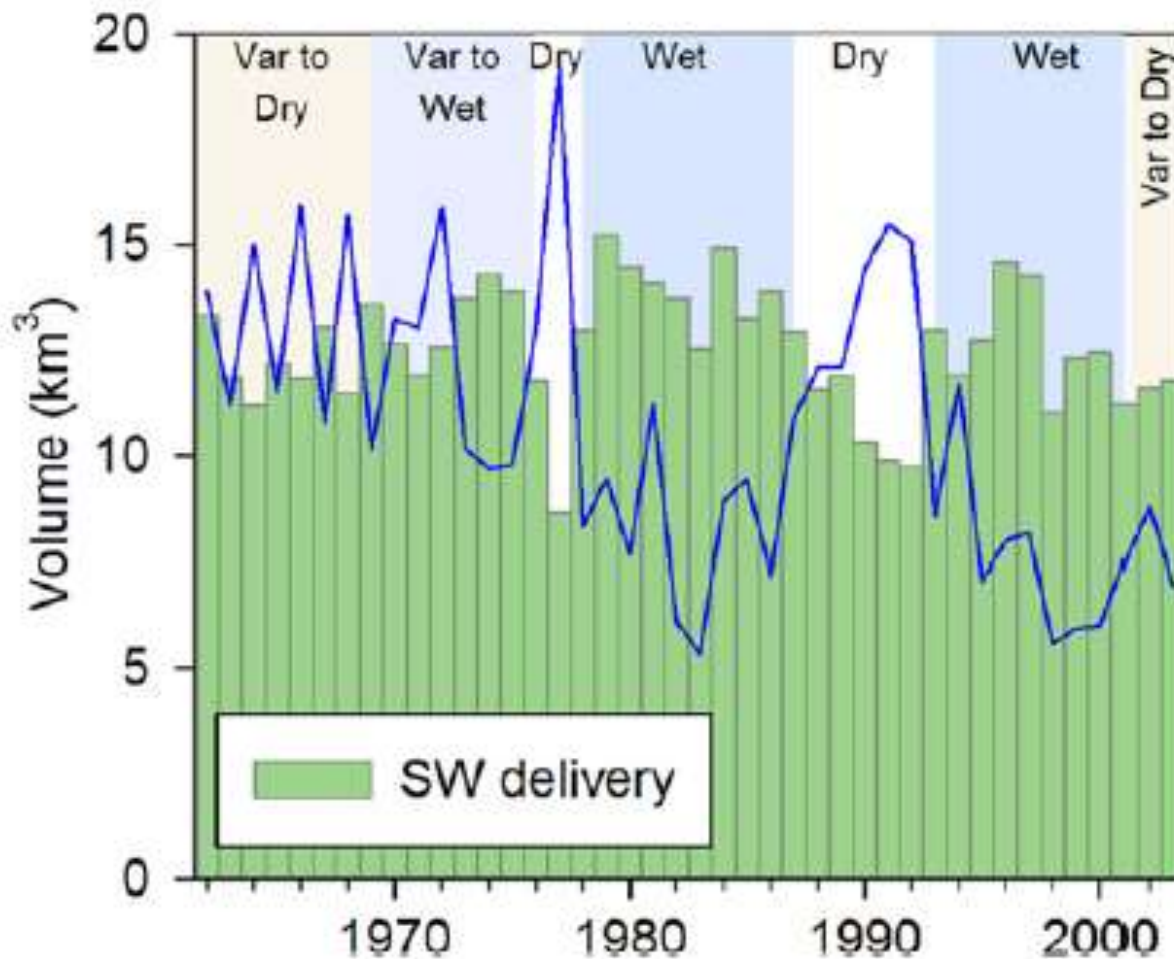
Water quality

Direct

Indirect



Indirect impact on GW quantity



Direct impact on GW quality

Water quantity

Direct

Indirect

Water quality

Direct

Indirect



Direct impact on GW quality

Water quantity

Direct

Indirect

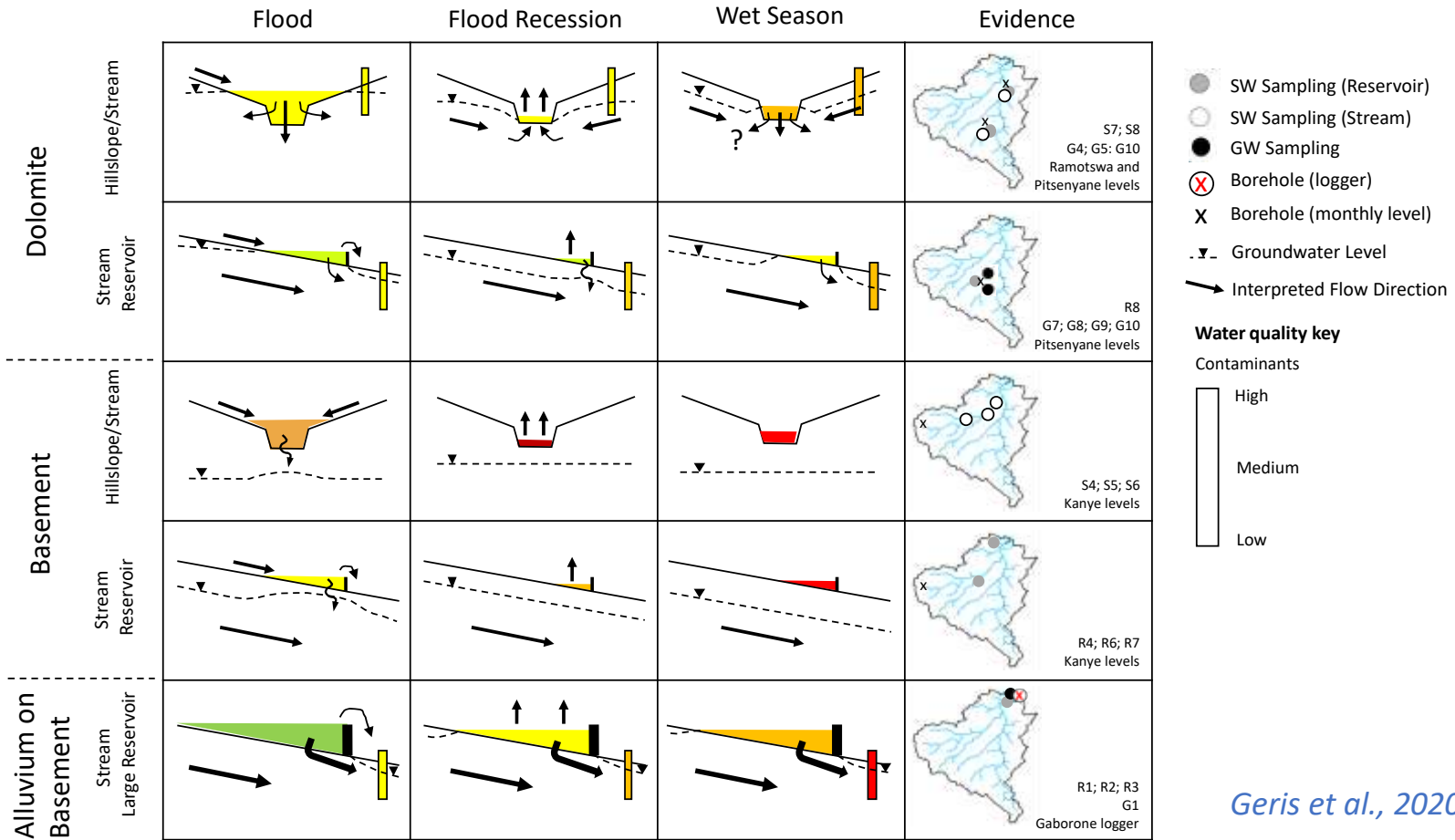
Water quality

Direct

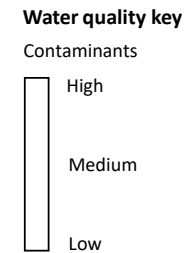
Indirect



Contamination impacts from flooding in Botswana



- SW Sampling (Reservoir)
- SW Sampling (Stream)
- GW Sampling
- ⊗ Borehole (logger)
- ⊗ Borehole (monthly level)
- Groundwater Level
- Interpreted Flow Direction



Geris et al., 2020



Indirect impact on GW quality

Water quantity

Direct

Indirect

Water quality

Direct

Indirect



Indirect impact on GW quality

Water quantity

Direct

Indirect

Water quality

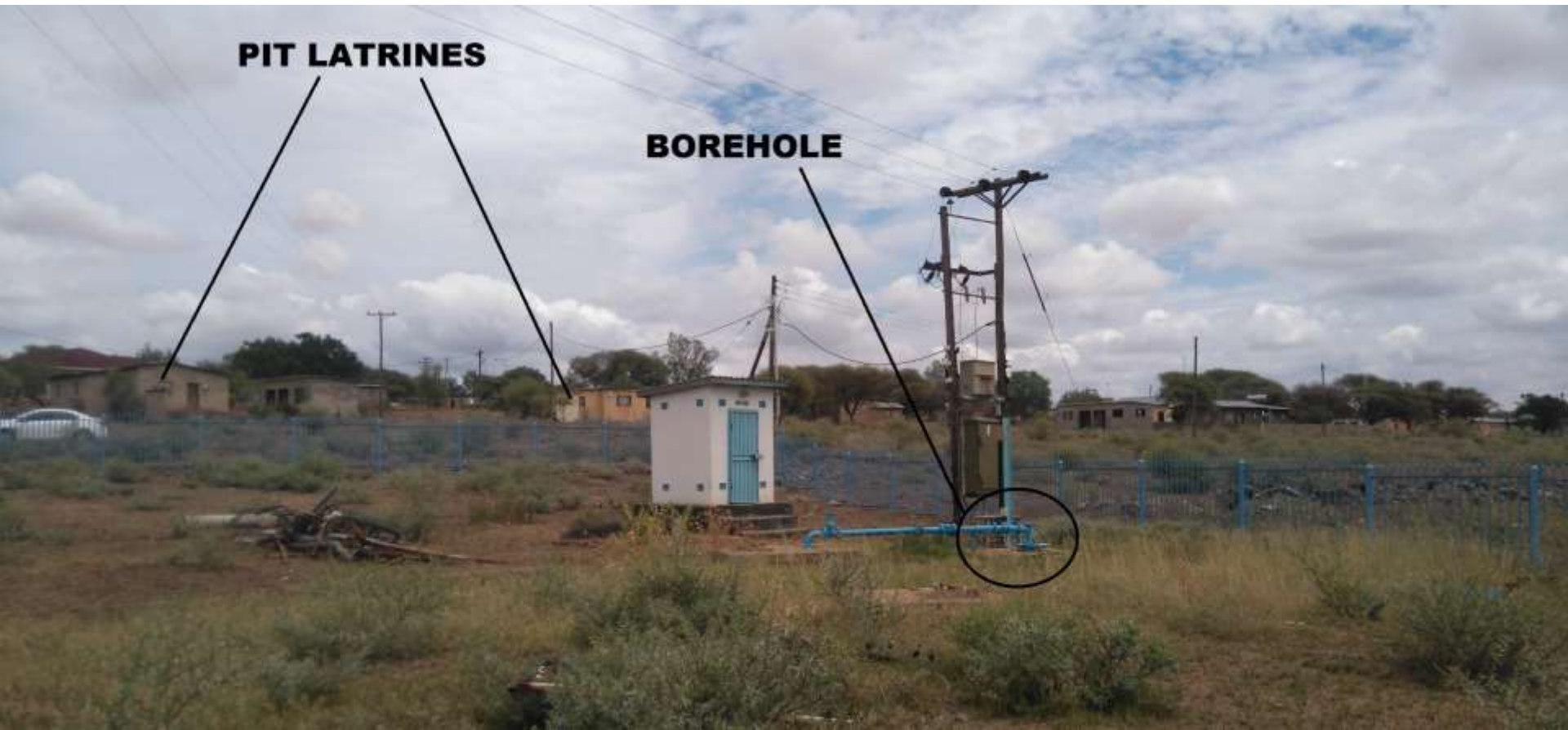
Direct

Indirect

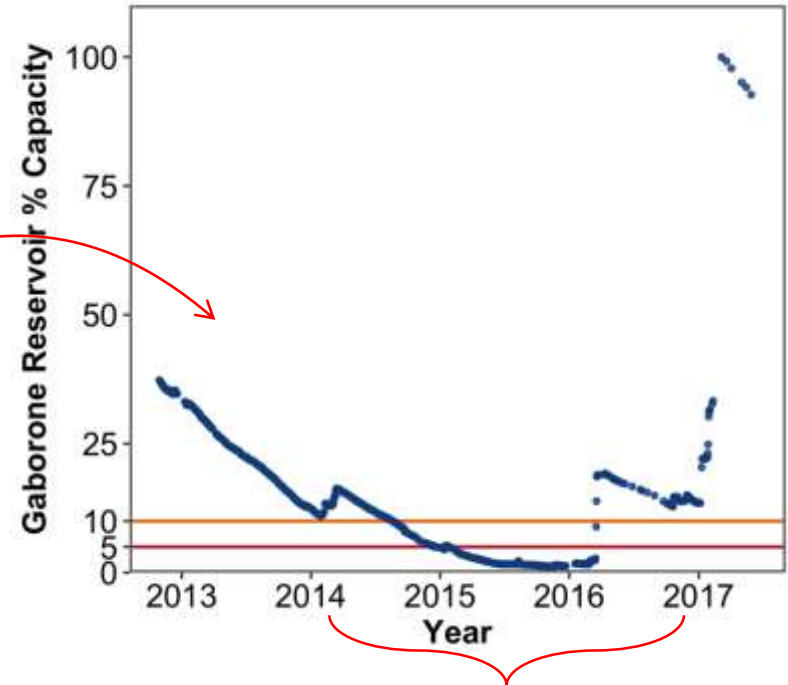
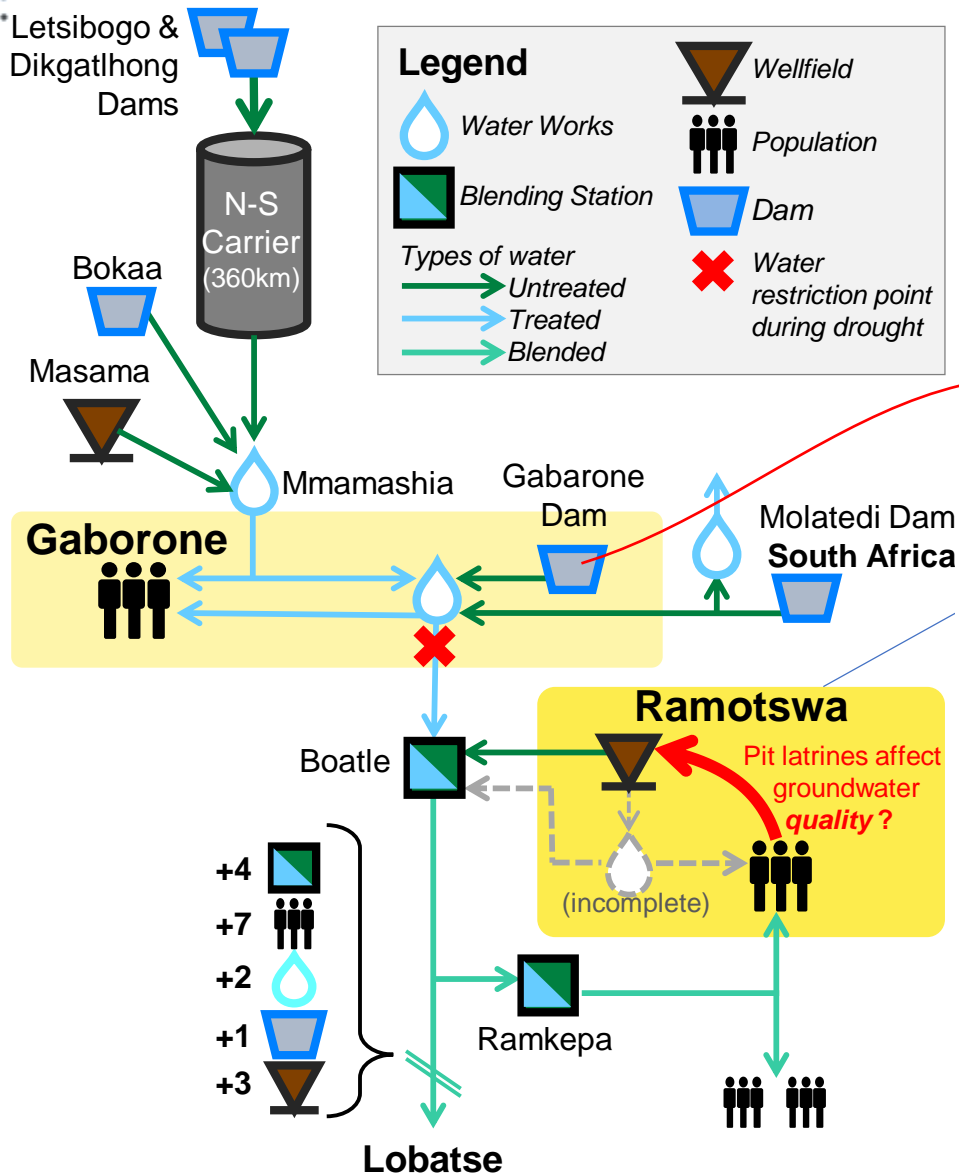


Climate change impacts on GW quality

Botswana case



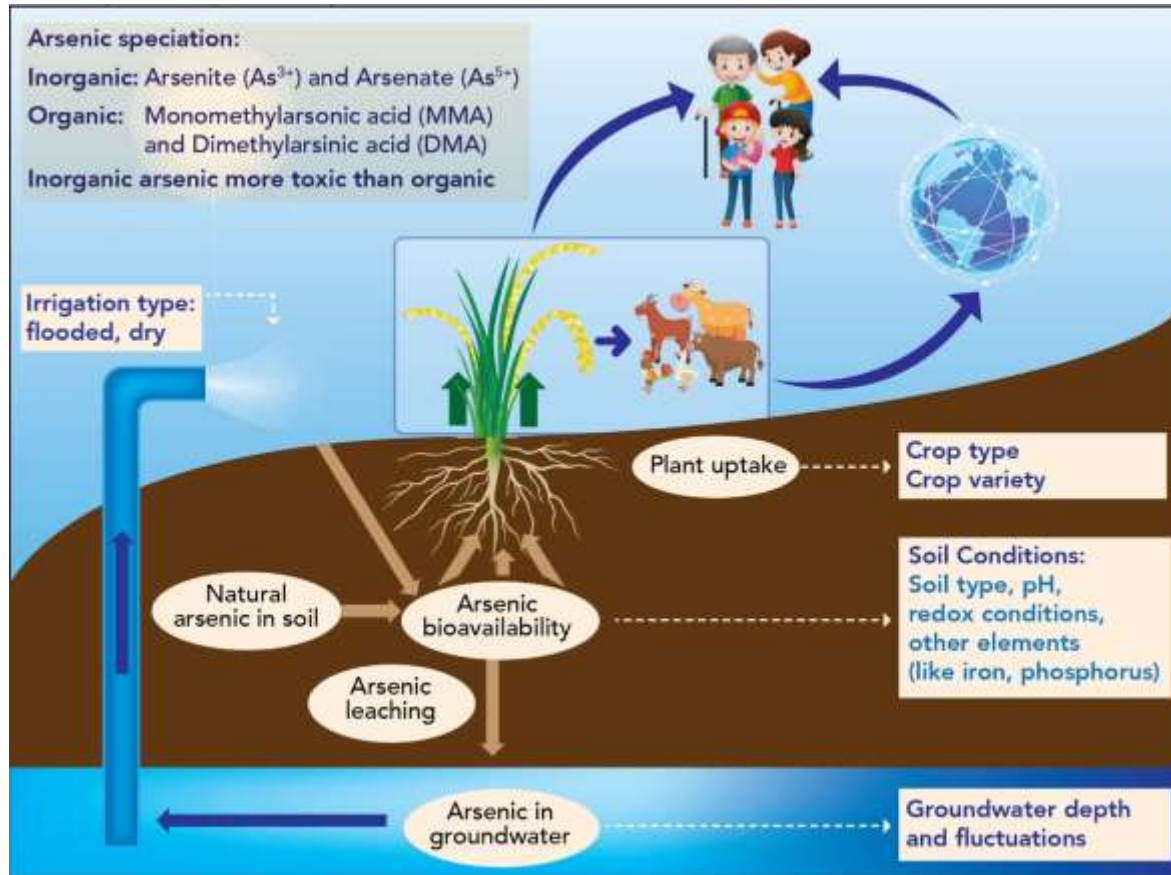
Ramotswa water supply system



**Water restrictions
=> no water to flush toilets**

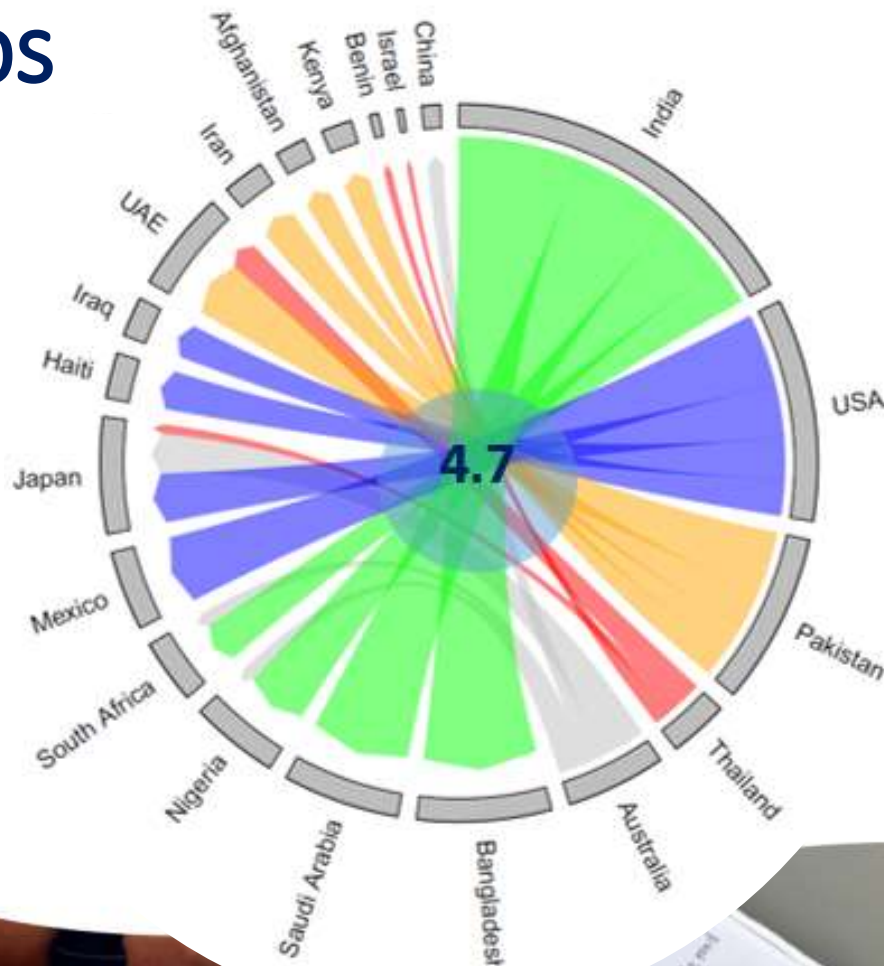
McGill et al., 2019

Human health risk propagation through food trade of arsenic in GW-irrigated crops



Alam et al., 2020

Human health risk propagation through food trade of arsenic in GW-irrigated crops

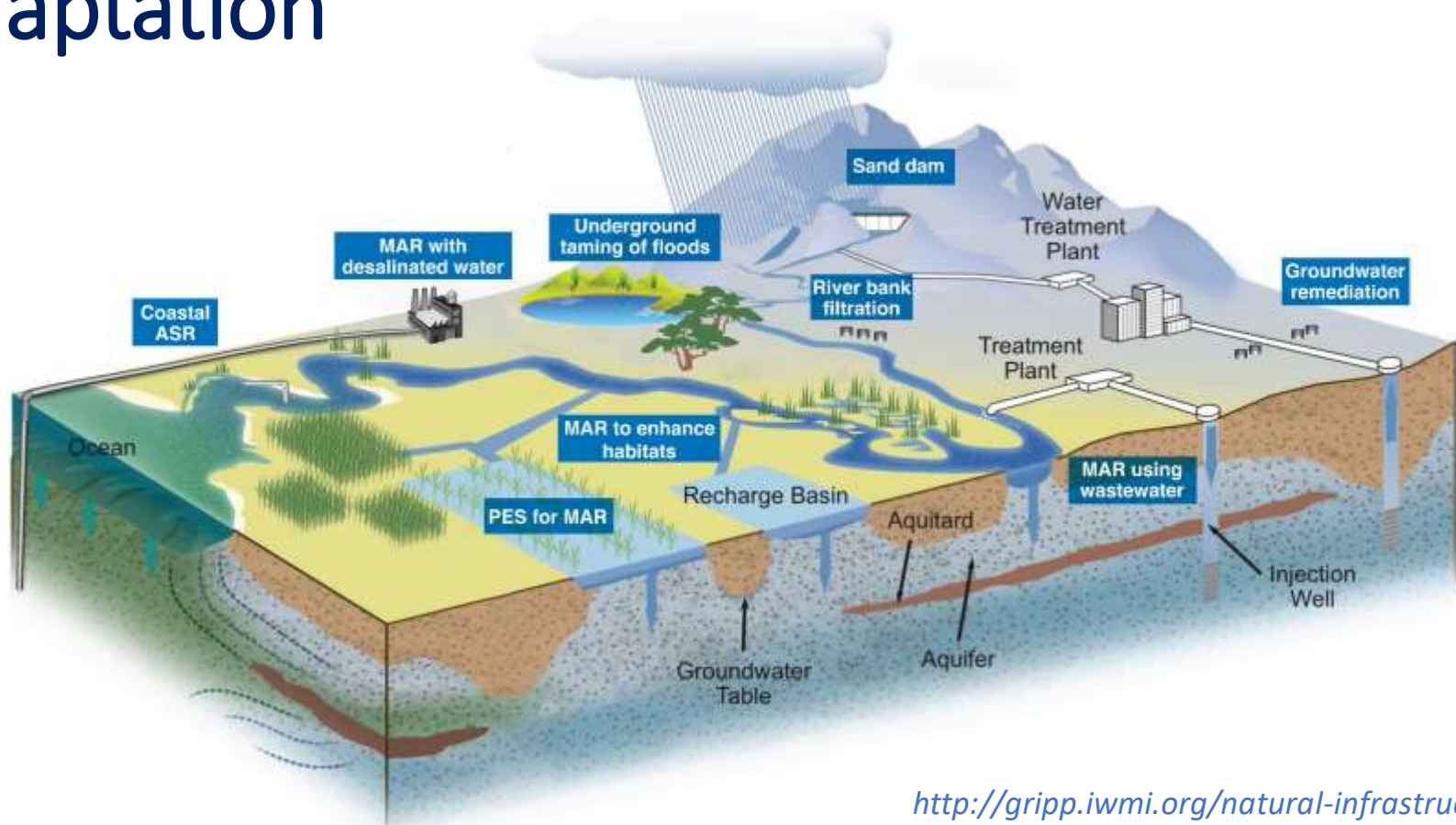


Currently, 4.7 MMT/yr of contaminated rice is traded globally, ~10.4% of global rice trade.

In future scenarios, the area grown under GW-irrigation in hazard areas may expand from 10.6 to 23.2 Mha.

Alam et al., 2020

Groundwater and climate change adaptation



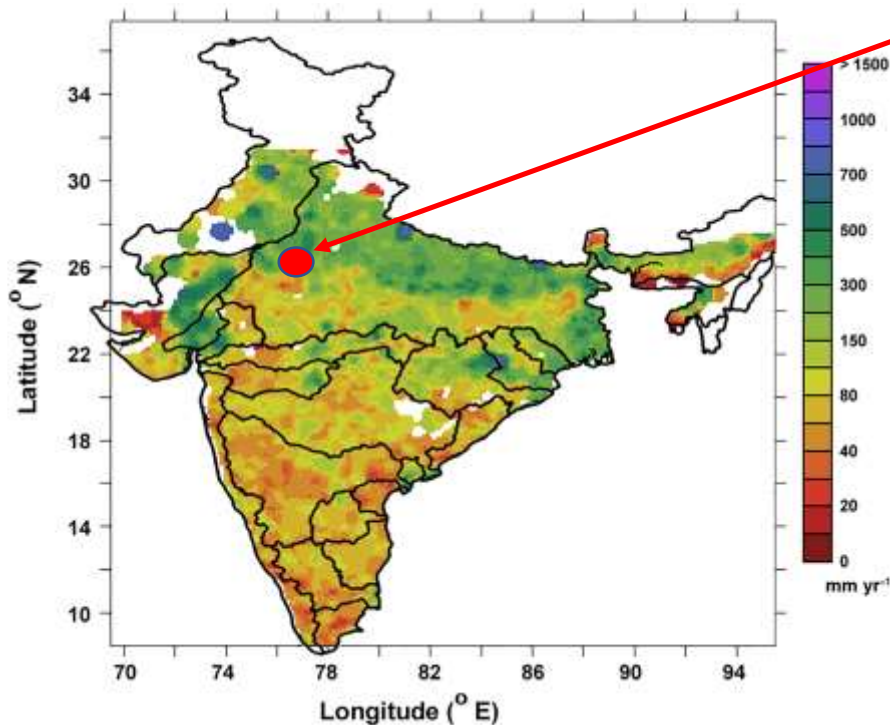
Underground transfer of floods



Pavelic et al., 2020



Time to GW depletion reversal



Bhanja et al., 2019

Jaipur:

Recharge: 100 mm/year (*Bhanja et al., 2019*)

GW level decline (1995-2010): 21.6 m

<http://www.imedpub.com/articles/spatiotemporal-characteristics-of-ground-water-level-fluctuation-in-jaipur-urban-area-rajasthan-india.php?aid=10090>

Average porosity: 0.4

Time to recover depleted aquifer: 86.4 years

At India scale (*Sutanudjaja, 2019*)::

Recovery time: 9.6 years

Possible ways forward

ရှေ့ညှိ ဖွံ့ဖြိုးတိုးတက်မှု အတွက် မြေအောက်ရေ၏ အရေးပါမှု

မြေအောက်ရေသည် ကမ္ဘာပေါ်ရှိ ၉၉% နီးပါး သော အစိုင်အခဲအဖြစ် တည်ရှိနေသော ရေချိုကို ကိုယ်စားပြုသည်။
မြေအောက်ရေသည် အသုံးပြုသော ရေအားလုံး၏သုံးပုံတစ်ပုံဖြစ်ပြီး ကမ္ဘာလူဦးရေ၏ ထက်ဝက်နီးပါးကို အိမ်သုံးရေအနေဖြင့်ထောက်ပံ့ပေးပြီး ကမ္ဘာတစ်ဝှမ်းရှိ ဆည်မြောင်းအတွက် အသုံးပြုသောရေ၏ ထက်ဝက်နီးပါး၏အရင်းအမြစ်ဖြစ်သည်။

၂၀၂၀ ခုနှစ်ထိတွင် အသုံးပြုနေသည့် ၁၀၀ ဘီလီယံနီးပါး သောရေ (အိမ်တွင်းသုံးရေ၊ စိုက်ပျိုးရေးနှင့် လုပ်ငန်းသုံးရေ)၏ အရင်းအမြစ်သည် မြေအောက်ရေမှ ဖြစ်သည်။ ဤကဲ့သို့ ကမ္ဘာတစ်ဝှမ်းမှ မြေအောက်ရေပေါ်တွင် ကျယ်ပြန့်စွာမှီခိုမှုသည် လတ်တလော လူ့သမိုင်း နှစ် ၅၀ ကျော် အတွင်း ထုတ်ယူသုံးစွဲမှု ၃ ဆဖြစ်လာသည်။ မြေအောက်ရေသည် ကုန်းခြေရေနှင့် ဂေဟစနစ်များစွာ ကို ကျောထောက်နောက်ခံပြုထားပြီး ဂေဟစနစ် ဝန်ဆောင်မှု (Ecosystem Services) နှင့် လူသားထိခိုက်အားထားသည့် သဘာဝသက်ရှိများအတွက် အရေးပါသည်။



1. IMPROVE WATER EFFICIENCY
Water efficiency is the use of water that results in the maximum benefit with the least amount of water. It is a key to sustainable water management and is essential for addressing water scarcity and drought. Water efficiency can be achieved through a variety of measures, including:

- Improving irrigation efficiency
- Reducing water losses in urban and industrial settings
- Promoting water-saving technologies and practices

2. PROTECT AND RESTORE ECOSYSTEMS
Ecosystems provide a wide range of services that are essential for human well-being and the health of the planet. These services include:

- Regulating water flows and quality
- Storing water in the soil and in ecosystems
- Filtering pollutants and sediments

 Protecting and restoring ecosystems is therefore essential for ensuring the long-term availability and quality of water.

3. IMPROVE WATER GOVERNANCE
Effective water governance is essential for ensuring that water is managed in a sustainable and equitable manner. This involves:

- Developing clear and enforceable water laws and policies
- Promoting transparency and accountability in water management
- Encouraging stakeholder participation and collaboration

4. INVEST IN WATER INFRASTRUCTURE
Investing in water infrastructure is essential for ensuring that water is available and of good quality. This includes:

- Improving water supply and distribution systems
- Investing in water treatment and sanitation facilities
- Developing resilient infrastructure that can withstand climate change and other risks

<https://www.pewresearch.org/groundwater/border/10568/1-08496>



Possible ways forward



Possible ways forward



Possible ways forward



**17 PARTNERSHIPS
FOR THE GOALS**



GRIPP

GROUNDWATER SOLUTIONS
INITIATIVE FOR
POLICY AND PRACTICE

GRIPP objective

Sustainable groundwater management for livelihoods, food security, climate resilience and economic growth

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Thank You

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<http://gripp.iwmi.org/>

<https://www.groundwaterstatement.org/>

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