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Governance and institutional framework session

Groundwater – rational use to enhance urban water security under global change

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OUTLINE OF THE PRESENTATION

1) Introducing UPGro

2) Water security and ground water resources

Concept of water security

Role of groundwater in water security

3) Self-supply boom – current trends in use of ground water

Urban growth unprecedented and growth of water demand

Typical “supply” response

Africa regional evolution of type of supply

Causes and consequences of the self-supply boom (Rich and Poor people)

Advantages of using groundwater resources for the utilities/ water security

4) How to enhance water security through ground water use

Example of conjunctive use of ground and surface with loop of reuse

What should be done to optimize use of ground water in the utilities’ perspective (to enhance source security)

Mapping the sources of pollution of the aquifers (Risks and hazards assessment)

What should be done to regulate and optimize; policy implications, role of the utilities

1) INTRODUCING UPGro

Unlocking the Potential of Groundwater for the Poor (UPGro),
7 year international research programme (2013-2020)

Focus on improving the **evidence base** around **groundwater** availability and management in **sub-Saharan Africa** (SSA) to enable developing countries and partners to use groundwater in a sustainable way in order to **benefit the poor**.

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UPGro is funded by:



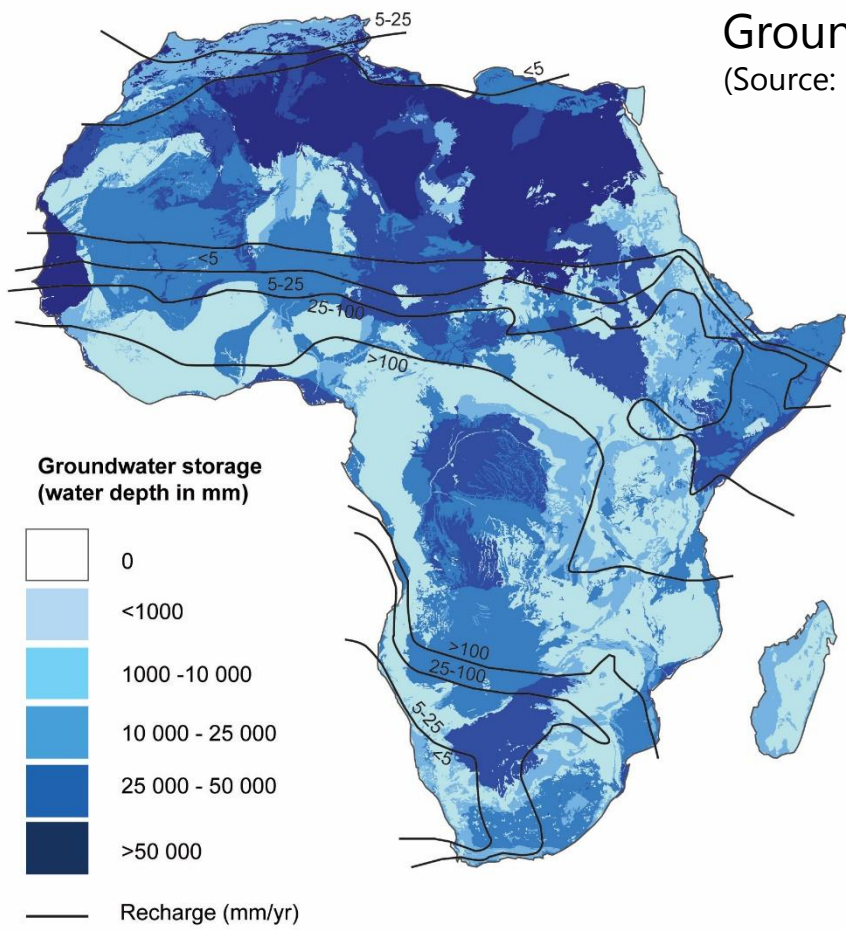
UPGro Knowledge Broker charged with facilitating the uptake
the research findings into policy and practice.

Diverse groundwater

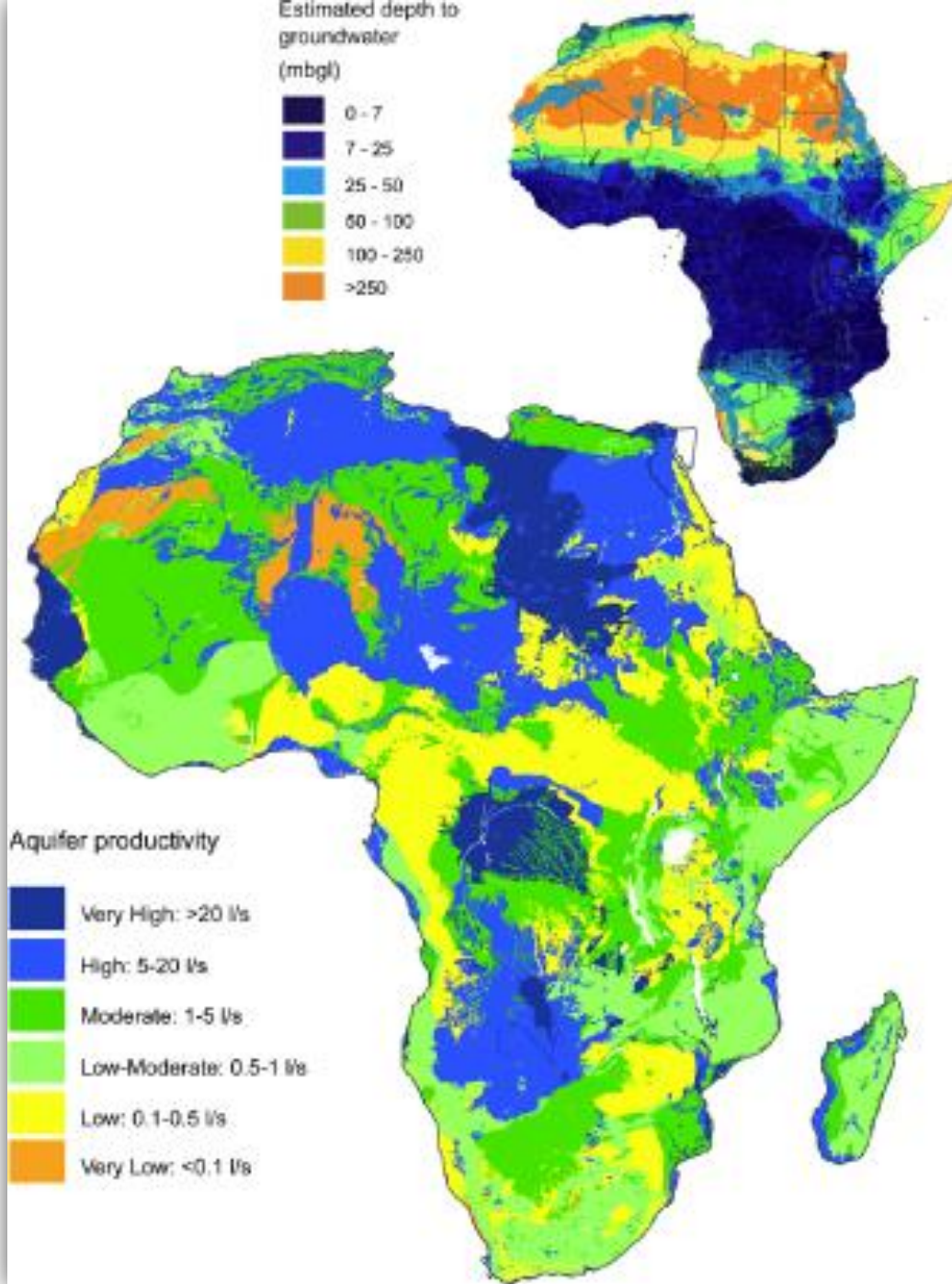
2012: first quantitative continent-wide maps of aquifer storage and potential published

- 0.66 million km³ of storage (not all available for abstraction)

Groundwater storage
(Source: MacDonald et al, 2012)



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Boundaries of surficial geology of Africa, courtesy of the U.S. Geological Survey.
Country boundaries sourced from ArcWorld © 1995-2011 ESRI. All rights Reserved
Modern annual recharge data (Doll and Fielder 2008)



The Consortium Projects (2015-19)



Working in **Benin, Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Niger, Nigeria, South Africa, Tanzania, Uganda**



Grofutures

+ research commissioned on ground water use and urban utilities =>Stephen Foster

Upgro.org

2) WATER SECURITY AND GROUND WATER RESOURCES

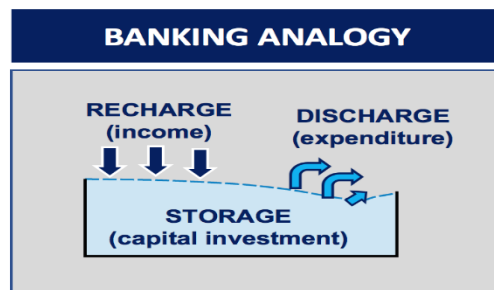
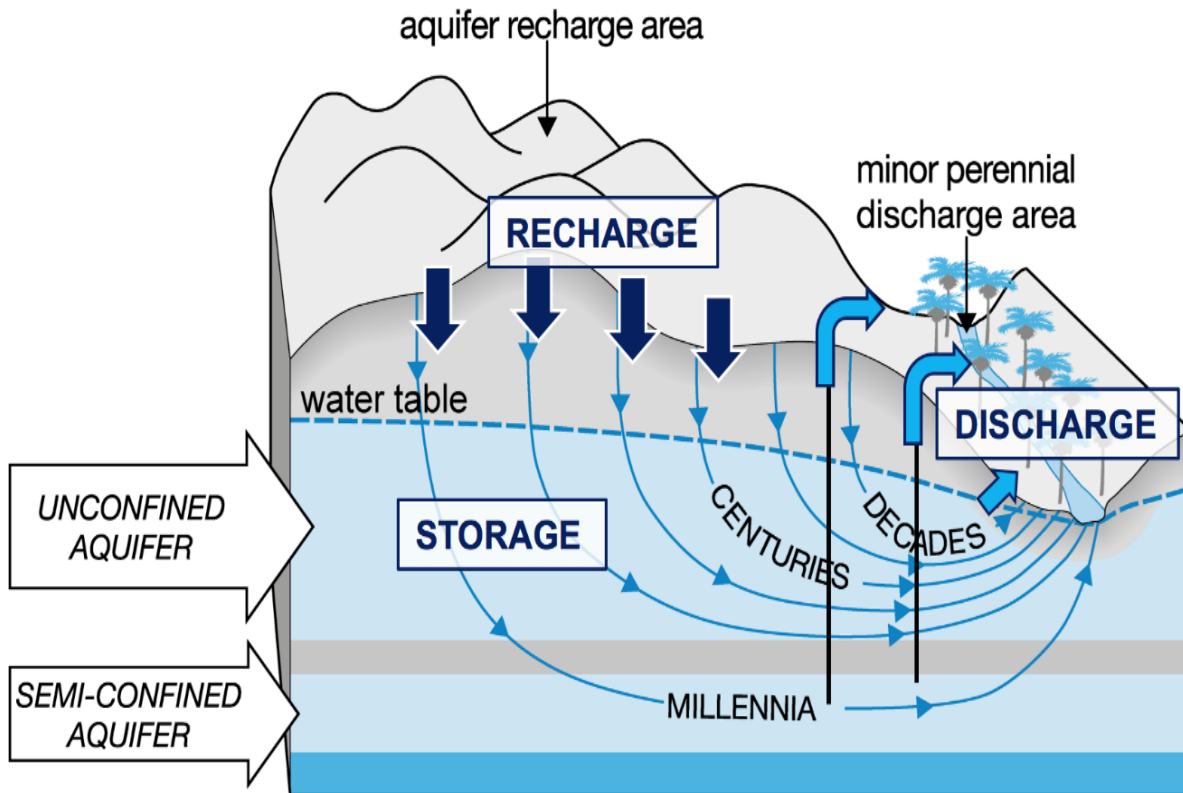
DEFINITION

- ‘Availability of an acceptable **quantity and quality** of **water** for **health, livelihoods, ecosystems and production**, coupled with and **acceptable level of water-related risks** to people, environments and economies’*.
- The ‘scale’ issue – use at national level too nebulous better when referred to **specific city (or basin)** and to a **specific function (like water-supply)****
- Urban water-supply security assessed in terms of:
 - accessibility – in effect availability and continuity
 - affordability – cost especially for lowest income quintile
 - acceptability – safety as regards quality
 - sustainability – susceptibility to decline/vulnerability to pollution

*Grey & Sadoff, 2007 ** Foster & MacDonald, 2014

ROLE OF GROUNDWATER IN WATER-SUPPLY SECURITY

vast stocks (storage) but modest fluxes (flows)



Predominant form of global freshwater storage

95-97% of 'circulating freshwater' = groundwater – but only 0.03 % of 'groundwater stock' replenished annually

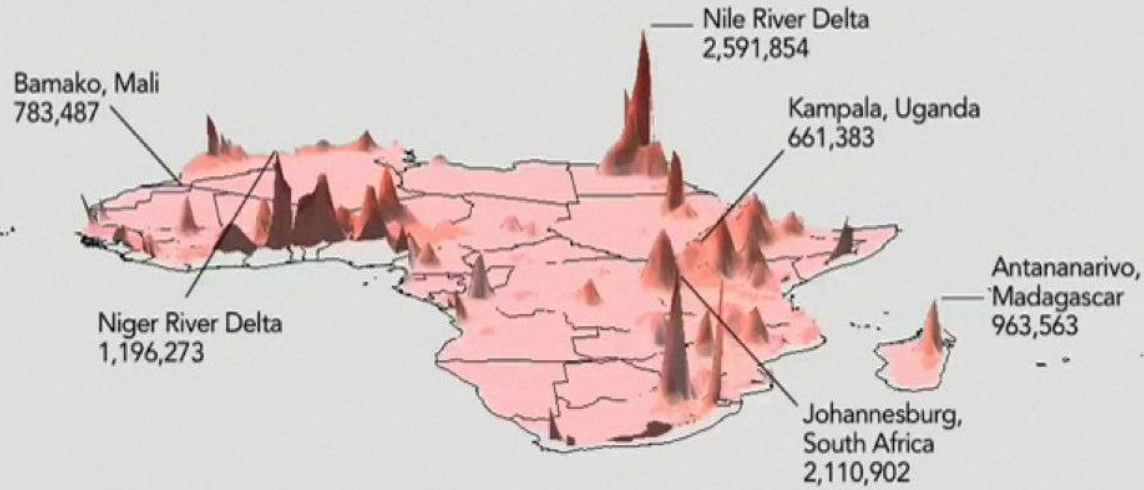
Very large storage means= subsurface 'residence times' large and 'aquifer memories' long (decades to millennia)
high microbiological and chemical quality

But any pollution can be very persistent and remediation problematic

3) SELF-SUPPLY BOOM AND CURRENT TRENDS

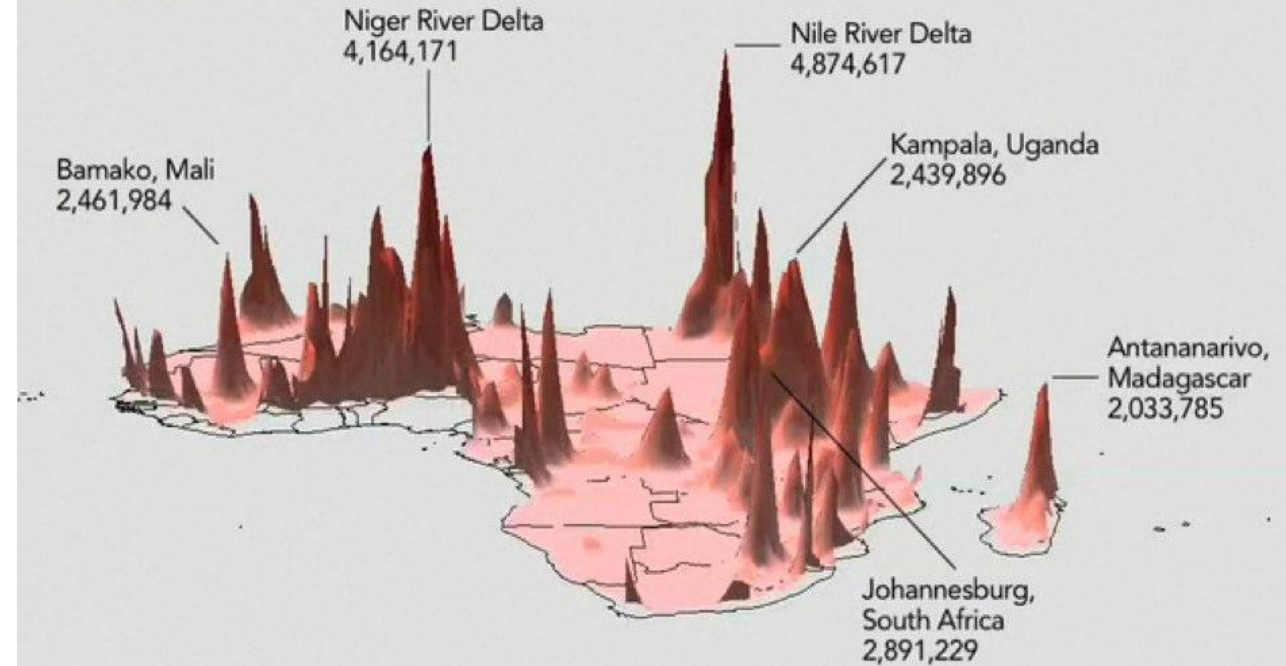
TOTAL POPULATION IN AFRICA

1990



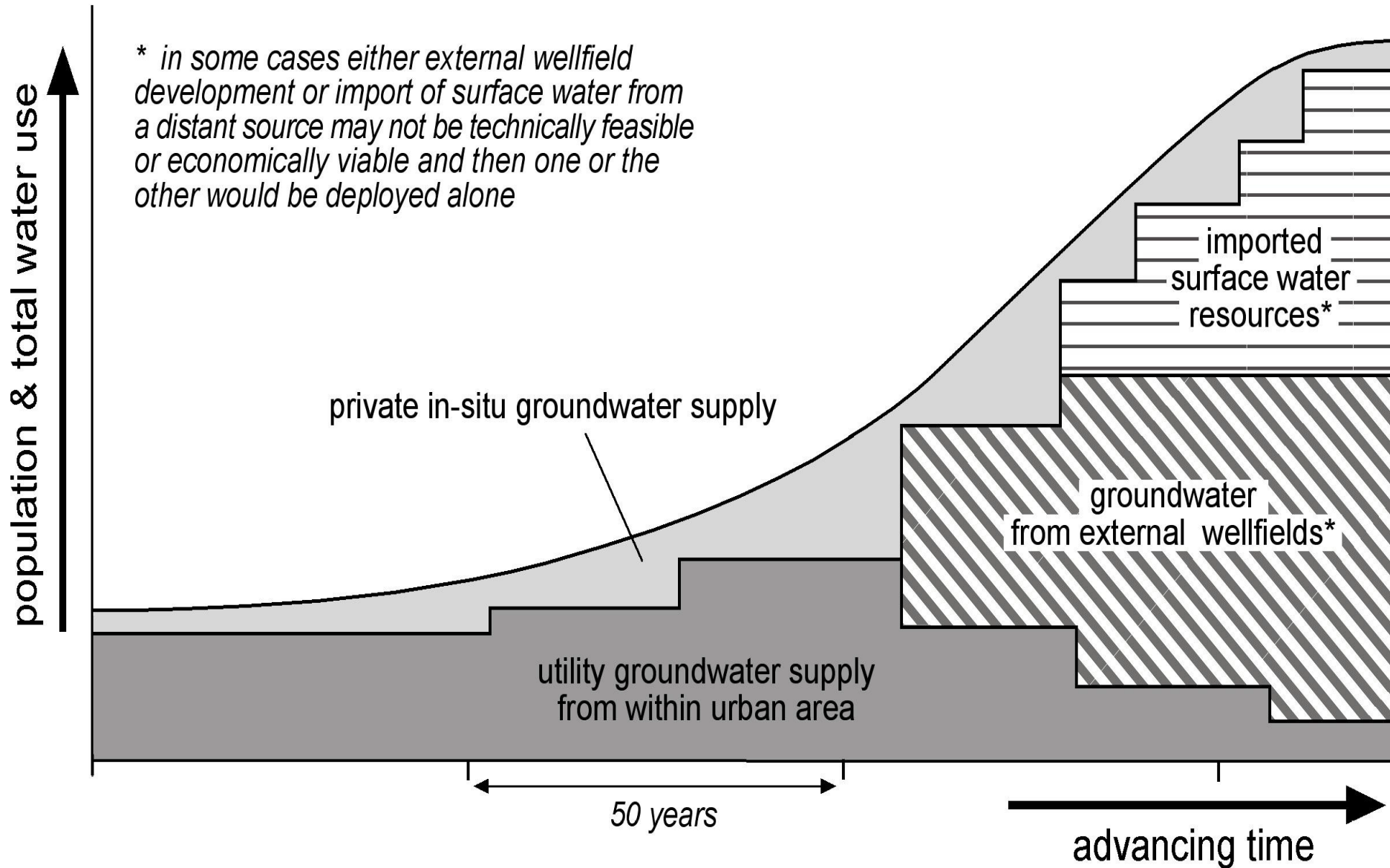
TOTAL POPULATION IN AFRICA

2035



Unprecedented growth in urban population and water demand, **especially West Africa**

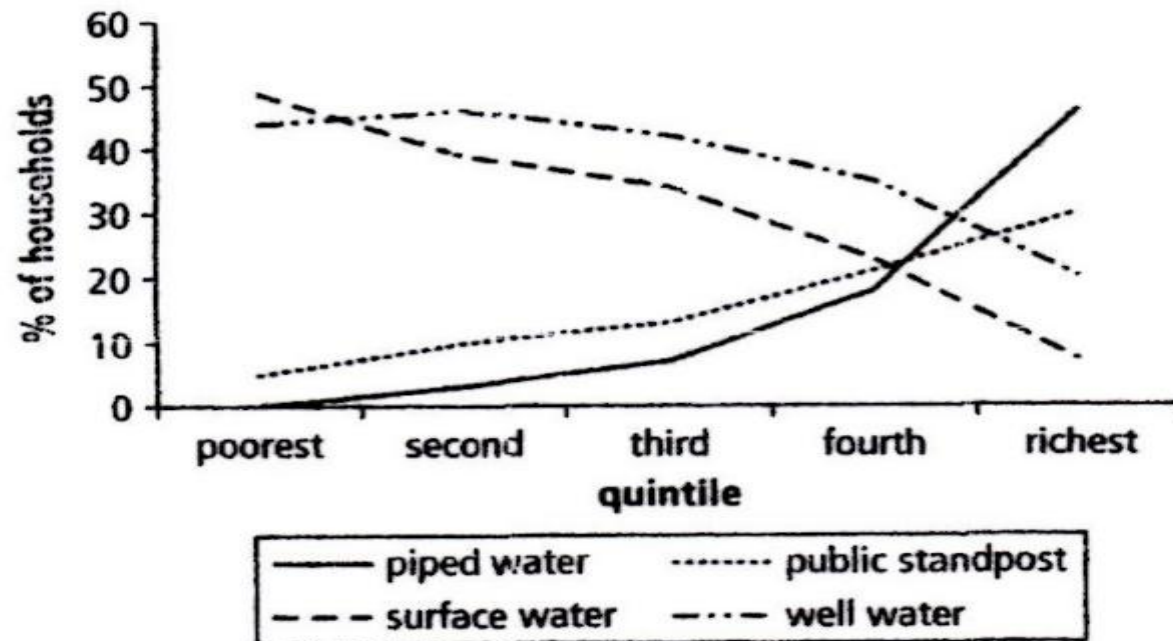
TEMPORAL GROWTH IN URBAN WATER DEMAND with typical supply-side response



EVOLUTION OF WATER-SUPPLY SOURCES IN AFRICAN CITIES: ACCESSIBILITY AND AFFORDABILITY *

Regional average urban water-supply accessibility

PERIOD	PIPED-SUPPLY	WATERWELLS (boreholes/dugwells)	STAND-POSTS	SURFACE WATER
1990-1995	50%	20%	29%	6%
1995-2000	43%	21%	25%	5%
2000-2005	39%	24%	24%	7%



Regional average urban water-supply affordability

* Sources: World Bank AICD + Foster & Briceño-Garmendia, 2010, and Banerjee et al, 2017

GROUNDWATER USE IN SELECTED AFRICAN CITIES
 data for sometime in period 2011-2015

CATEGORY OF CITY	CITY	UTILITY GW USE (MI/d) (propn)	UTILITY SERVICE LEVEL	PRIVATE GW USE (MI/d)
Water Utility with Major Groundwater Dependency	Abidjan **	285 (100%)	moderate	some #
	Dakar **	210 (70%)	excellent	minor #
	Arusha	50 (80%)	excellent	minor
	Dodoma **	45 (100%)	good	minor
	Kabwe	40 (100%)	good	minor
	N'Djamena **	35 (100%)	poor	some #
Water Utility with Conjunctive Resource Use	Addis Ababa	120 (40%)*	moderate	minor #
	Dar-es-Salaam	30 (10%)*	poor	major
	Benin City	45 (50%)	poor	major
Water Utility with Poor Service Levels & Major Private Groundwater Use	Nairobi	30 (5%)	moderate	80-240 #
	Lusaka	135 (45%)	moderate	100-300
	Mombasa	80 (100%)	poor	major

* major new groundwater source under exploration/development

** modern supply system deploying external wellfield(s)

cost constructing/equipping private water borehole > US\$ 10k

CAUSES AND CONSEQUENCES OF THE SELF-SUPPLY BOOM (RICH AND POOR PEOPLE)

- Coping strategy' for confronting poor water-utility service coverage and/or reliability
- High cost of constructing/equipping water-supply boreholes means only affordable by high-income quintile
- Poorer households have to resort (where feasible) to shallow handpump dugwells with poor sanitary completion which are more vulnerable to pollution
- Private borehole use likely to be perpetuated long-term as cost-reduction strategy
- Massive private domestic self-supply reality – can distort utility water operations with major implications for finance/investment
- Open-access to groundwater cannot be regarded as 'pro-poor' since reduces revenue of water utilities
- Could be regarded as reducing demand on (and recovering leakage from) utility water-supply and very good practice for 'secondary uses'
- 'Banning' such practice too simplistic (unrealistic and impractical), except where it poses major public health or environmental hazard
- Need for systematic study of hydrogeologic dynamics, engineering economics and sociologic impact (only limited work in districts of Accra, Lusaka & Lagos)

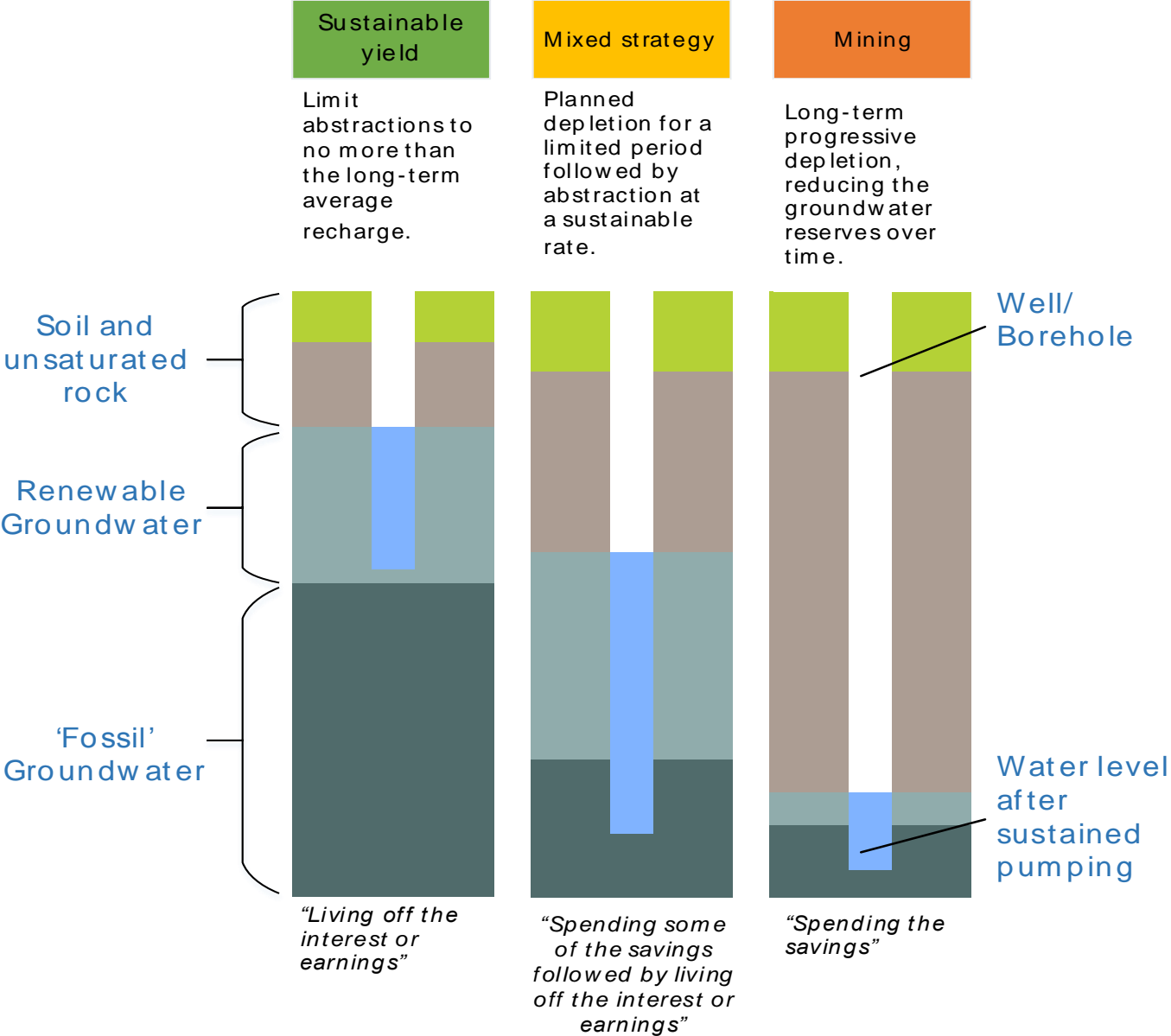
WHY TAPPING INTO THE POTENTIAL OF GROUND WATER RESOURCES

- allow phased investment in supply expansion at much lower capital cost (avoiding advanced treatment)
- suitability located and constructed groundwater sources provide supply security against drought and pollution
- basis for providing a high level of water-supply reliability and continuity
- but requires proactive involvement in resource management and quality protection



4) HOW TO ENHANCE WATER SECURITY THROUGH GROUND WATER USE

Recommendations on management of the aquifers:
 Enhance recharge, reduce pollution load, improve construction standards for private wells and in-situ sanitation, advise users on potential hazards, charge or regulate groundwater use(?)



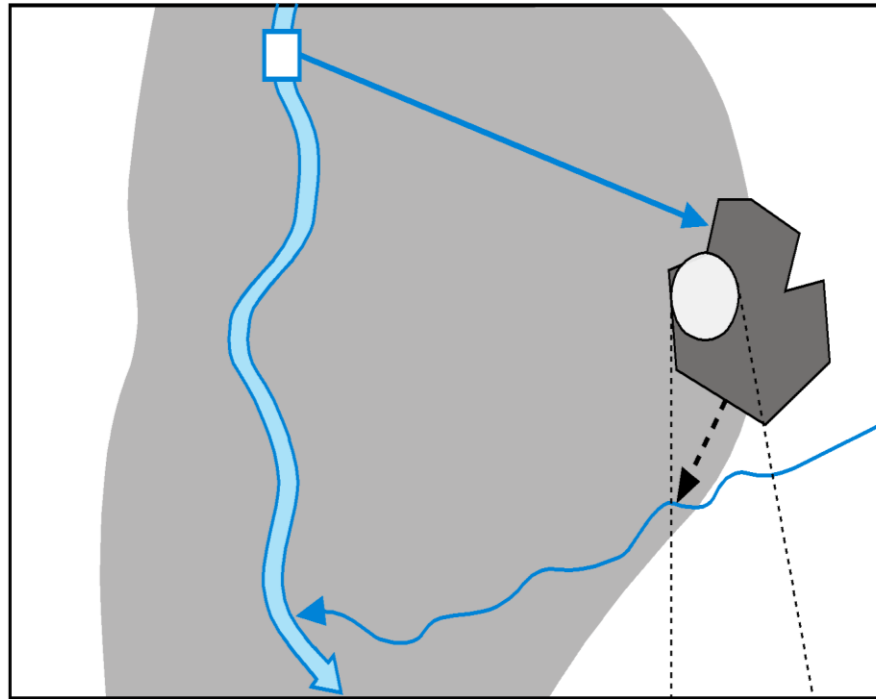
UTILITIES' INVOLVEMENT, RECOMMENDATIONS:

- Proactively integrate utility and private investment
- Coordinate piped and non-piped service provision
- Develop utility involvement and capacity for groundwater resource management and protection
- Establish utility low-income user support units for :
 - construction/operation of community stand-post boreholes
 - advisory/registration services for private waterwell users (with appropriate charging especially if generating sewer discharge)

CONJUNCTIVE USE & MANAGEMENT OF RESOURCES

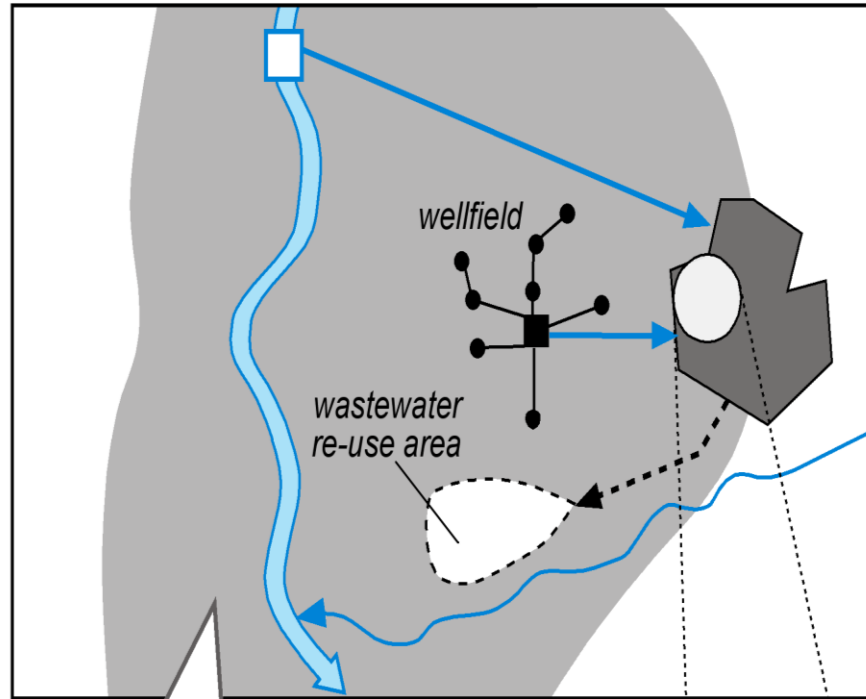
key to urban water-supply security

SPONTANEOUS



- municipal water-supply boreholes
- private waterwells
- major river
- river intake
- alluvial plain

PLANNED



much less dependence on intra-urban public (and private) waterwells with development of 'external' municipal wellfields

RECOMMENDATIONS (ctd)

Measures to enhance the source security

- develop protected external municipal wellfields (with agreement between urban and rural municipalities involved on land-use controls)
- establish municipal waterwell protection zones (to take advantage of parkland and prevent generation of polluting discharges)
- prioritise main sewerage in densely-populated zones and limit population density of new unsewered zones
- undertake groundwater pollution hazard assessments and reduce dependence on vulnerable municipal waterwells

Deep Trouble

The Hidden Threat of Groundwater Pollution



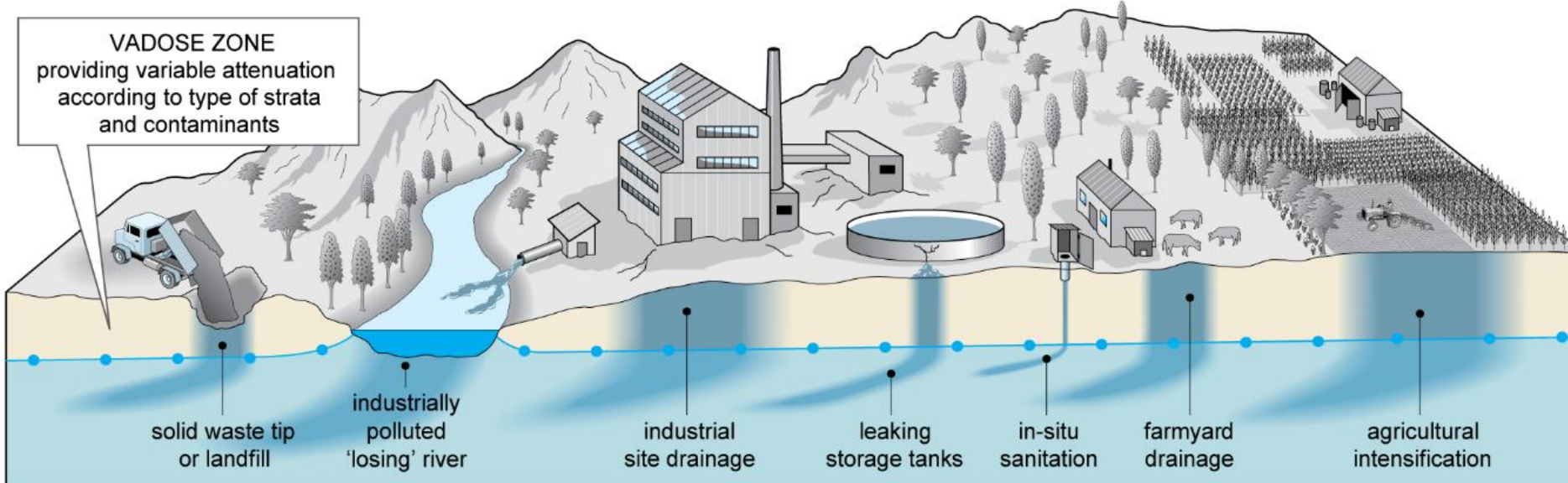
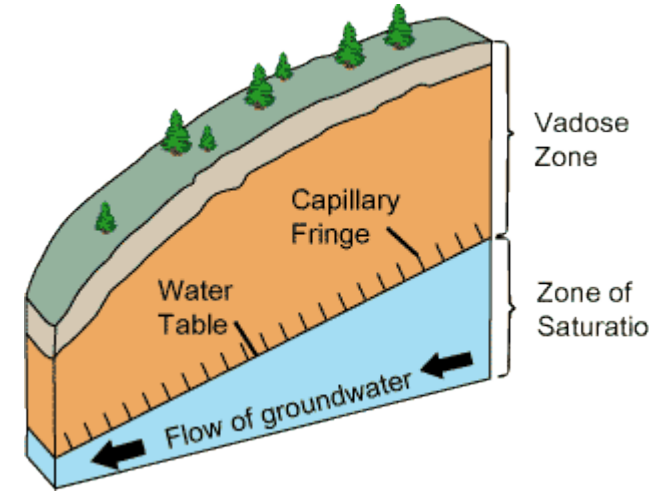
December
2000

Payal Sampat

GROUNDWATER POLLUTION PROTECTION

'avoiding unexpected hazards from above'

- understand vadose-zone attenuation
- map aquifer pollution vulnerability
- assess pollution risk and manage by prevent/limit measures



THANK YOU!

MERCI!

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