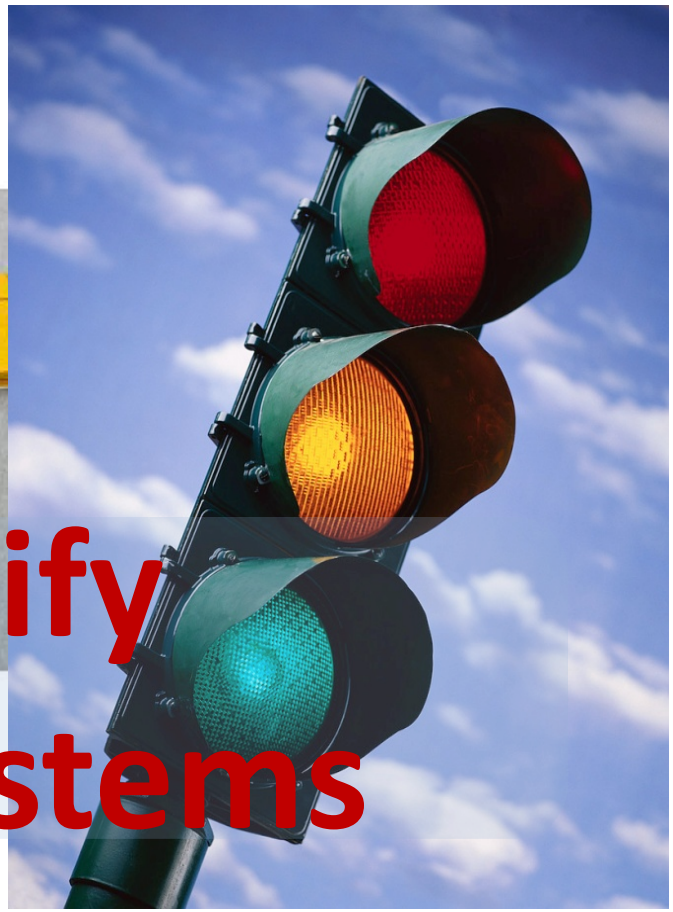
GROUNDWATER RESOURCES
GOVERNANCE
in TRANSBOUNDARY AQUIFERS
(GGRETA Project)

Presentation of the Stampriet Transboundary Aquifer System assessment indicators
+
Adoption of workplan for follow-up

Tales Carvalho Resende
31 July 2015
Johannesburg, South Africa

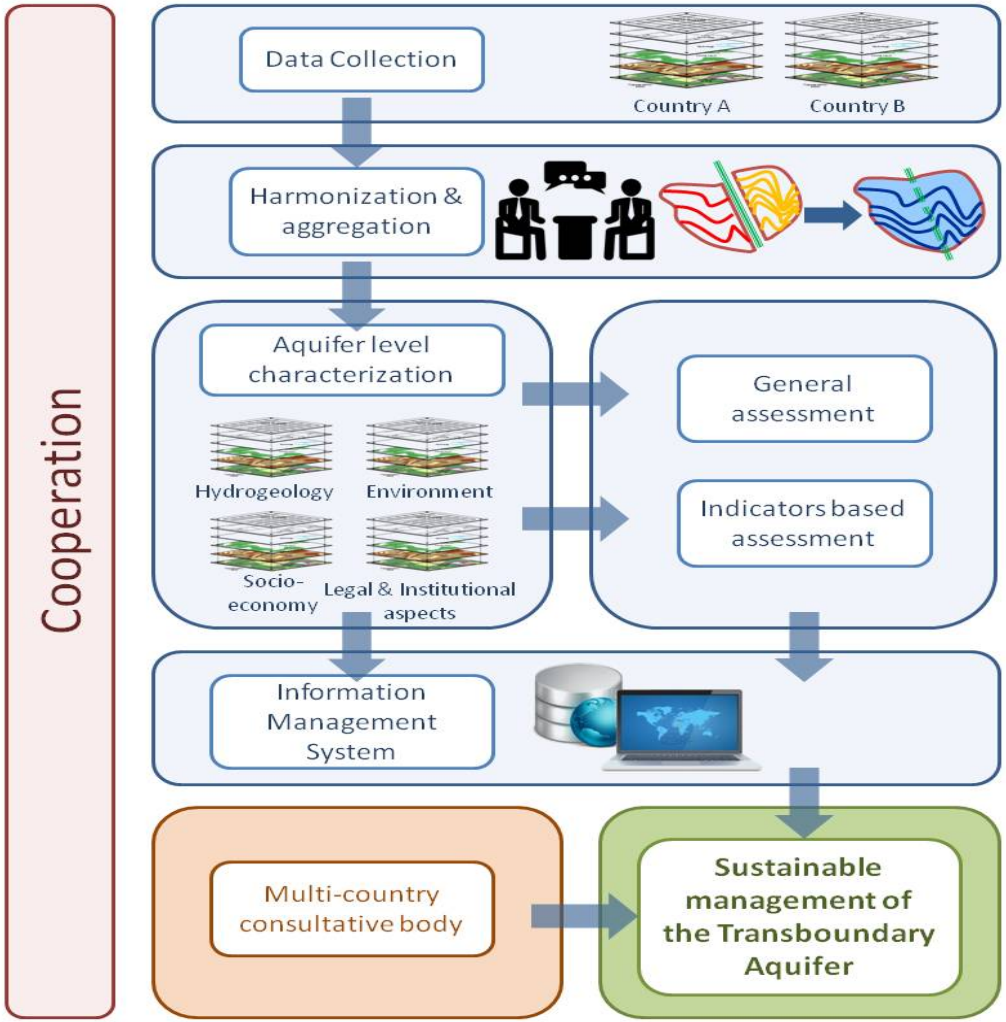
GGRETA - Methodology



To simplify complex systems

GGRETA - Methodology

- **Multi-disciplinary assessment:**
  - Hydrogeology
  - Environmental & Socio-economic (incl. gender)
  - Legal & Institutional (incl. gender)
- **Indicators based assessment**
  - Existing data
- **Target group for outputs is non-technical:**
  - Managers, Decision makers, Stakeholders incl. general Public



GGRETA – Data to be collected

Parameters and variables to be collected	Priority for data collection*	Indicators** 1.1 Mean annual groundwater recharge depth (mean annual recharge volume per unit of area)	1.2 Annual amount of renewable groundwater resources per capita	1.3 Natural background groundwater quality	1.4 Aquifer buffering capacity	1.5 Aquifer vulnerability to climate change	1.6 Aquifer vulnerability to pollution	2.1 Human dependency on groundwater (Is definition of "human water uses" unambiguous?)	2.2 Human dependency on groundwater for domestic water supply	2.3 Human dependency on groundwater for agricultural water supply	2.4 Human dependency on groundwater for industrial water supply	2.5 Ecosystem dependency on groundwater	2.6 Prevalence of springs	3.1 Groundwater depletion	3.2 Groundwater pollution	4.1 Population density	4.2 Groundwater development stress	5.1 Transboundary legal framework****	5.2 Transboundary institutional framework****	6.1 Control groundwater abstraction****	6.2 Groundwater quality protection****
A. Physiography and climate																					
A.1. Temperature***	1	X	X		X	X															
A.2. Precipitation***	1	X	X		X	X															
A.3. Evapo-transpiration	1	X	X		X	X															
A.4. Land use / land cover***																					
A.4.1. Groundwater-fed agricultural land	3																				
A.4.2. Groundwater irrigated land	3																				
A.4.3. Groundwater supported wetlands and ecosystems	3																				
A.4.4. Areas with land subsidence	3																				
A.5. Topography and elevation***	2						X														
A.6. Surface water network (rivers, lakes, swamps, reservoirs, canals, etc)	3																				
B. Aquifer Geometry																					
B.1. Hydrogeological map	3																				
B.2. Geo-referenced boundary of the Transboundary Aquifer	1	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
B.3. Depth of water table/piezometric surface	2						X														
B.4. Depth to top of aquifer formation	2					X															
B.5. Vertical thickness of the aquifer																					
B.6. Degree of confinement						X															
B.7. Representative cross-sections																					
C. Hydrogeological characteristics																					
C.1. Aquifer recharge																					
C.1.1. Natural recharge						X											X				
C.1.2. Return flows from irrigation						X											X				

1. Data to be collected

2. Indicators calculated from data collected

GGRETA – Data to be collected

- **Hydrogeology:**

A. Physiography and Climate

Temperature, Precipitation, Evapo-trasnpiration, Land use, Topography and Surface water network

B. Aquifer geometry

Hydrogeological map, Geo-referenced boundary of the Transboundary Aquifer, Depth of water table/piezometric surface, Depth to top of aquifer formation, Vertical thickness of the aquifer, Degree of confinement, Aquifer's cross section

C. Hydrogeological Characteristics

Aquifer recharge, Aquifer lithology, Soil types, Porosity, Transmissivity and vertical connectivity, Total groundwater volume, Groundwater depletion, Natural discharge mechanism, Discharge by springs

GGRETA – Data to be collected

- **Hydrogeology:**

A. Physiography and Climate

Temperature, Precipitation, Evapo-trasnpiration, Land use, Topography and Surface water network

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GGRETA – Data to be collected

- **Environmental & Socio-economic:**

D. Environmental

Suitable for human consumption (natural groundwater quality), Groundwater pollution, Solid Waste and waste water control, Shallow groundwater table

E. Socio-economic

Population (total and density), Groundwater and Surface water use, Dependence of industry and agriculture on groundwater, Percentage of population covered by public water supply, Percentage of population covered by public sanitation

GGRETA – Data to be collected

- **Legal & Institutional:**

  F. Transboundary legal and institutional framework

  Agreement, treaty, MoU

  I. Domestic legal and institutional framework

  Ownership of groundwater, Water resources planning, Groundwater resources abstraction and use, Abatement and control of groundwater pollution, Water resources protection measures, Government and non-government (including informal) water institutions, Implementation, administration and enforcement of the legislation on the statute books

GGRETA – Indicators

Parameters and variables to be collected	Priority for data collection*	Indicators** 1.1 Mean annual groundwater recharge depth (mean annual recharge volume per unit of area)	1.2 Annual amount of renewable groundwater resources per capita	1.3 Natural background groundwater quality	1.4 Aquifer buffering capacity	1.5 Aquifer vulnerability to climate change	1.6 Aquifer vulnerability to pollution	2.1 Human dependency on groundwater (Is definition of "human water uses" unambiguous?)	2.2 Human dependency on groundwater for domestic water supply	2.3 Human dependency on groundwater for agricultural water supply	2.4 Human dependency on groundwater for industrial water supply	2.5 Ecosystem dependency on groundwater	2.6 Prevalence of springs	3.1 Groundwater depletion	3.2 Groundwater pollution	4.1 Population density	4.2 Groundwater development stress	5.1 Transboundary legal framework****	5.2 Transboundary institutional framework****	6.1 Control groundwater abstraction****	6.2 Groundwater quality protection****
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1. Data to be collected

2. Indicators calculated from data collected

Indicators

Indicator group 1: Defining or constraining the value of aquifers and their potential functions

1.1 Recharge Rate	Comments
1. Very low: < 2 mm/yr **2. Low: 2-20 mm/yr** 3. Medium: 20-100 mm/yr 4. High: 100-300 mm/yr 5. Very high: > 300 mm/yr	No reliable recharge estimate is available for the confined aquifers, but it is very low (virtually non-renewable groundwater resources)

Indicators

Indicator group 1: Defining or constraining the value of aquifers and their potential functions

1.2 Renewable groundwater per capita	Comments
1. Low: < 1000 m^3/yr/capita **2. Medium: 1000 – 5000 m^3/yr/capita** 3. High: > 5000 m^3/yr/capita	Very low recharge in combination with low population density

Indicators

Indicator group 1: Defining or constraining the value of aquifers and their potential functions

1.3 Natural Background Quality

1. Very low: < 20%
2. Low: 20 - 40%
3. Medium: 40-60%
4. **High: 60-80%**
5. Very high: > 80%

fresh

Comments

Suitability for drinking water used as criterion. It is accepted that local drinking water standards may vary.

Saline

Arsenic

fresh

Percentage of aquifer area with natural groundwater quality satisfying local drinking water standards.

Indicators

Indicator group 1: Defining or constraining the value of aquifers and their potential functions

1.4 Aquifer buffering capacity	Comments
1. Low: < 10 years 2. Medium: 10 – 100 years **3. High: > 100 years**	Proxy for the aquifer's resilience to climatic variability

Ratio between volume stored and long-term mean groundwater recharge (equivalent to mean residence time)

Indicators

Indicator group 1: Defining or constraining the value of aquifers and their potential functions

1.5 Aquifer vulnerability to climate change	Comments
1. *Low*: confined aquifers containing only fossil water or receiving negligible recent recharge. 2. *Medium*: weakly recharged aquifers with limited interaction with other components of the hydrological cycle, due to location at considerable depth and/or hydraulic confinement. 3. *High*: aquifers actively interacting with streams, atmosphere	- Auob/Nossob - Class 1 corresponds to 'non-renewable groundwater'

Extent of expected groundwater budget regime change in response to change in climatic conditions

Indicators

Indicator group 1: Defining or constraining the value of aquifers and their potential functions

1.5 Aquifer vulnerability to pollution	Comments
1. Very low: < 20% 2. Low: 20 -40% 3. Medium: 40-60% 4. High: 60-80% 5. Very high: > 80%	- Approximate criteria for "Moderately to highly vulnerable: " > 0.3 in GOD method > 100 in DRASTIC method

Percentage of its horizontal area where the aquifer is considered moderately to highly vulnerable to pollution

Indicators

Indicator group 2: Role and importance of groundwater for humans & environment

2.1 Human dependancy on groundwater	Comments
1. Very low: < 20% 2. Low: 20-40% 3. Medium: 40-60% 4. High: 60-80% **5. Very high: > 80%**	Abstraction of water includes the quantity used and all losses. No data available, but there is no permanent surface water in the area.

Percentage of groundwater in total water abstraction for all human water uses

Indicators

Indicator group 2: Role and importance of groundwater for humans & environment

2.2 Human dependency on groundwater for domestic water supply

1. Very low: < 20%
2. Low: 20-40%
3. Medium: 40-60%
4. High: 60-80%
5. **Very high: > 80%**

Comments

Abstraction of water includes the quantity used and all losses.

Percentage of groundwater in total water abstraction for domestic use

Indicators

Indicator group 2: Role and importance of groundwater for humans & environment

2.3 Human dependency on groundwater for agricultural water supply

1. Very low: < 20%
2. Low: 20-40%
3. Medium: 40-60%
4. High: 60-80%
5. **Very high: > 80%**

Comments

Surface water contributes to livestock watering, in the form of water ponds

Percentage of groundwater in total water abstraction for agricultural water supply

Indicators

Indicator group 2: Role and importance of groundwater for humans & environment

2.4 Human dependency on groundwater for industrial water supply

1. Very low: < 20%
2. Low: 20-40%
3. Medium: 40-60%
4. High: 60-80%
5. Very high: > 80%

Comments

(**Not applicable** – apparently no industries in the area)

Percentage of groundwater in total water abstraction for industrial use

Indicators

Indicator group 2: Role and importance of groundwater for humans & environment

2.5 Ecosystem dependency on groundwater	Comments
1. Very low: < 5% 2. Low: 5-10% 3. Medium: 10-25% 4. High: 25-50% 5. Very high: > 50%	- Auob/Nossob only - Phreatic water level taken as a proxy

Percentage of the aquifer's area where the aquifer has a phreatic water level shallower than 5 m below surface

Indicators

Indicator group 2: Role and importance of groundwater for humans & environment

2.6 Prevalence of springs

1. Very low: < 5%
2. Low: 5-10%
3. Medium: 10-25%
4. High: 25-50%
5. Very high: > 50%

Comments

Springs are very sensitive for changes in groundwater budget. Therefore a meaningful indicator of change.

Total annual groundwater discharge by springs, divided by mean annual groundwater recharge

Indicators

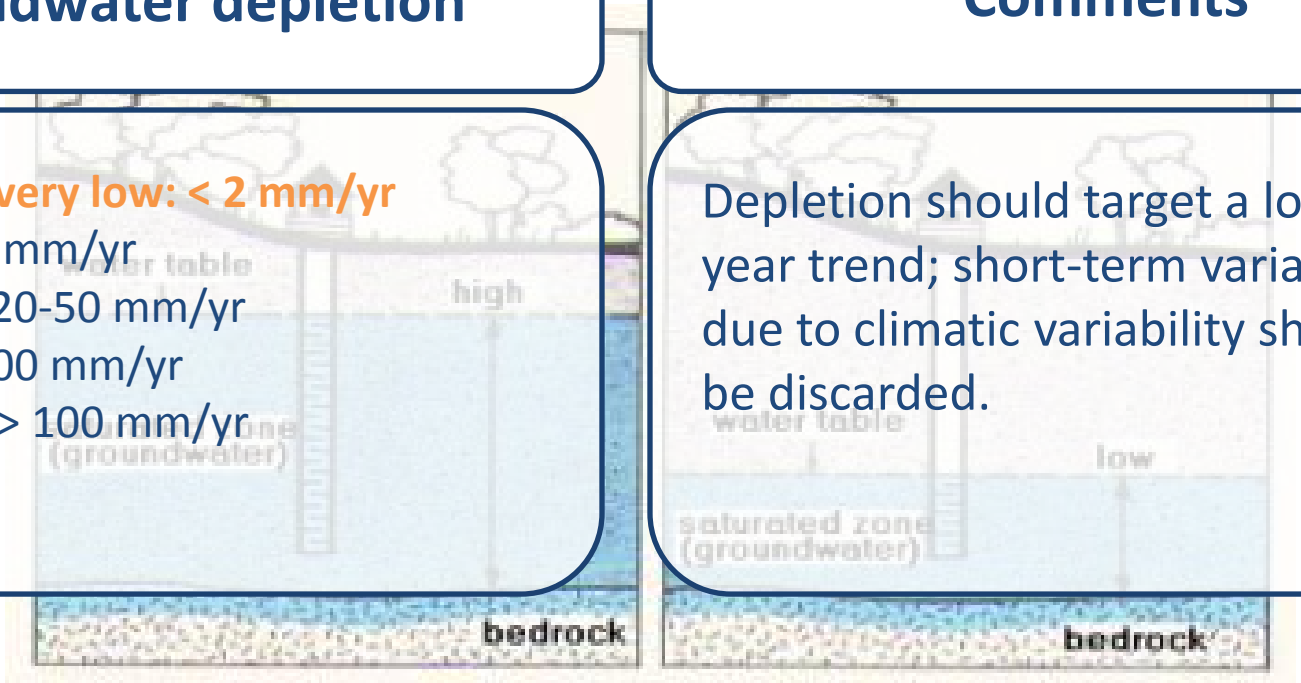
Indicator group 3: Changes in groundwater state

3.1 Groundwater depletion

1. **Absent to very low: < 2 mm/yr**
2. Low: 2 -20 mm/yr
3. Medium: 20-50 mm/yr
4. High: 50-100 mm/yr
5. Very high: > 100 mm/yr

Comments

Depletion should target a long-year trend; short-term variations due to climatic variability should be discarded.

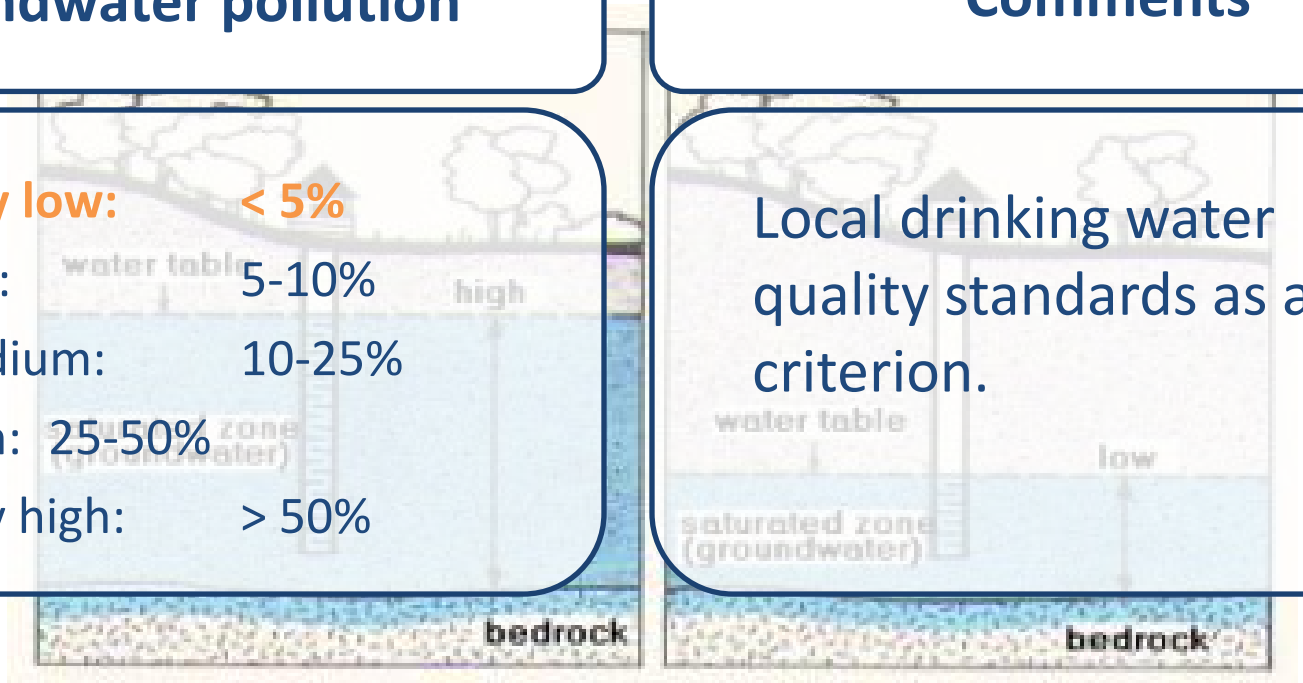


Observed polluted zones as percentage of total aquifer

Indicators

Indicator group 3: Changes in groundwater state

3.2 Groundwater pollution	Comments
1. Very low: < 5% 2. Low: 5-10% 3. Medium: 10-25% 4. High: 25-50% 5. Very high: > 50%	Local drinking water quality standards as a criterion.

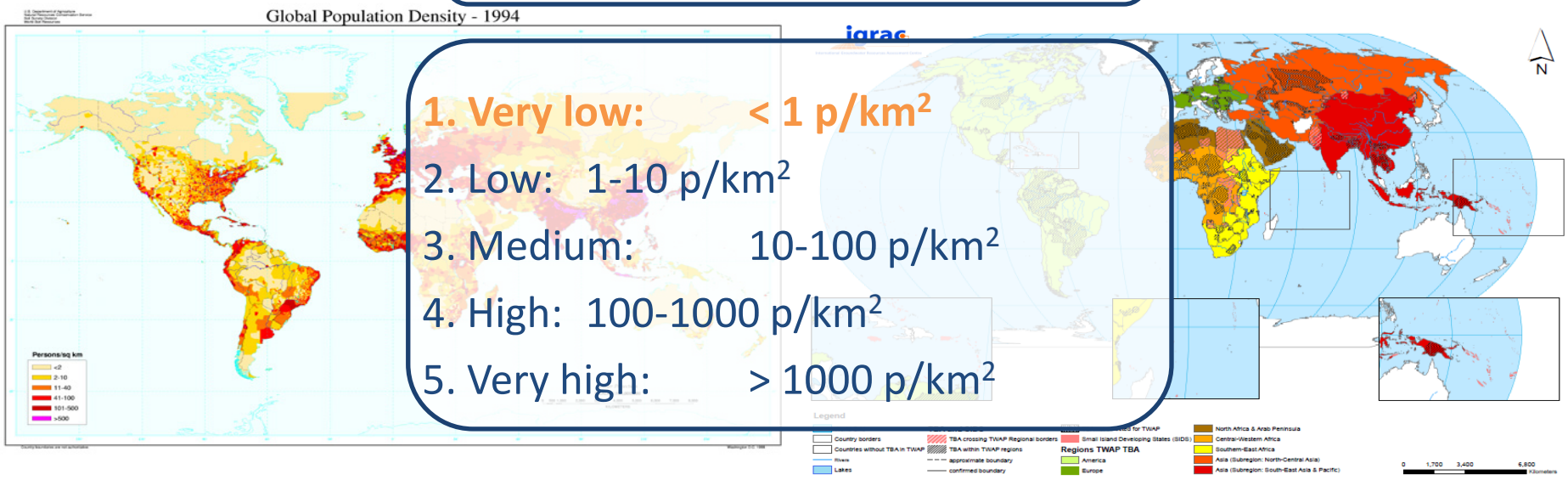


Observed polluted zones as percentage of total aquifer

Indicators

Indicator group 4: Drivers of change and pressures

4.1 Population Density on Transboundary Aquifer



1. **Very low:** **< 1 p/km²**
2. Low: 1-10 p/km²
3. Medium: 10-100 p/km²
4. High: 100-1000 p/km²
5. Very high: > 1000 p/km²

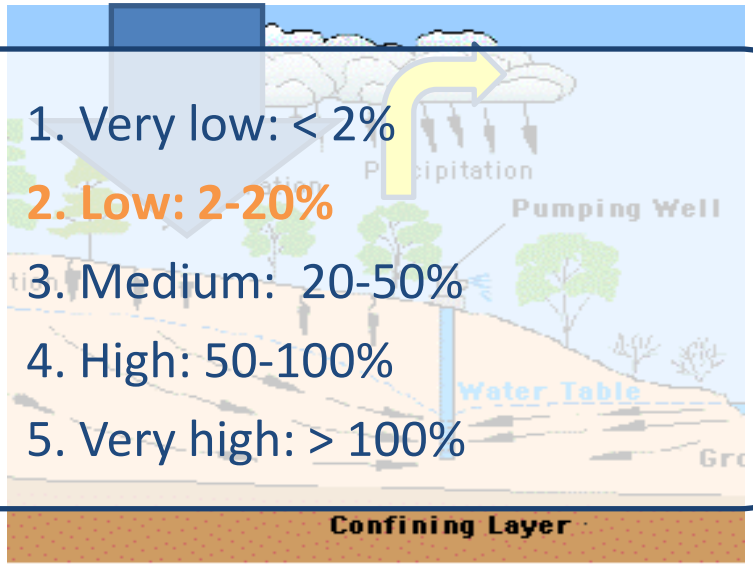
Number of people on top of aquifer per unit of area.

Indicators

Indicator group 4: Drivers of change and pressures

4.2 Grondwater Development Stress (=Abstraction/Recharge)

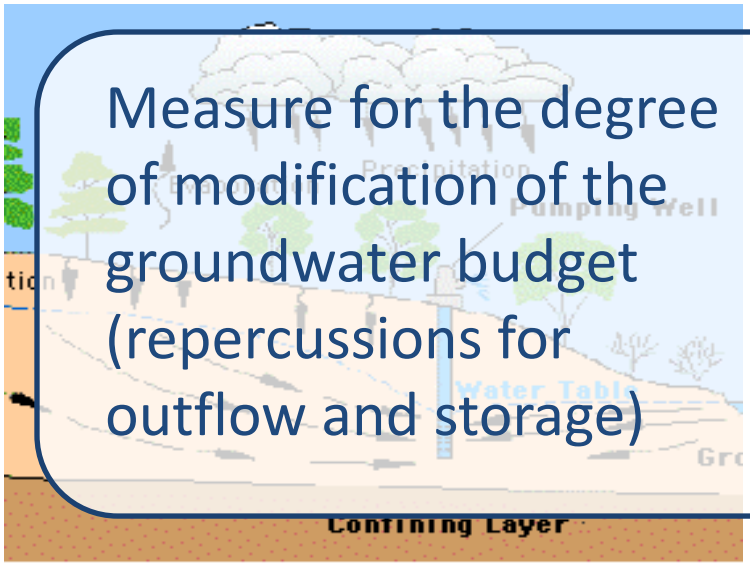
1. Very low: < 2%
2. **Low: 2-20%**
3. Medium: 20-50%
4. High: 50-100%
5. Very high: > 100%



d from USGS)

Comments

Measure for the degree of modification of the groundwater budget (repercussions for outflow and storage)



d from USGS)

Total annual groundwater abstraction divided by long-term mean annual recharge.

Indicators

Indicator group 4: Drivers of change and pressures

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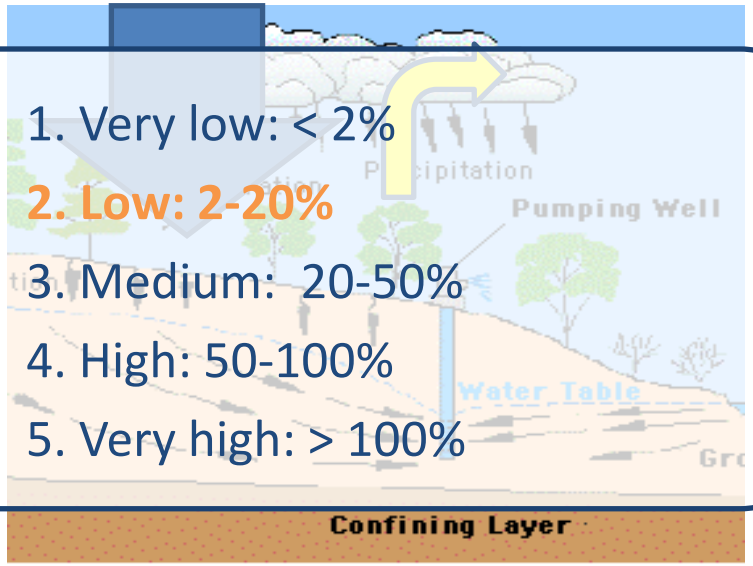

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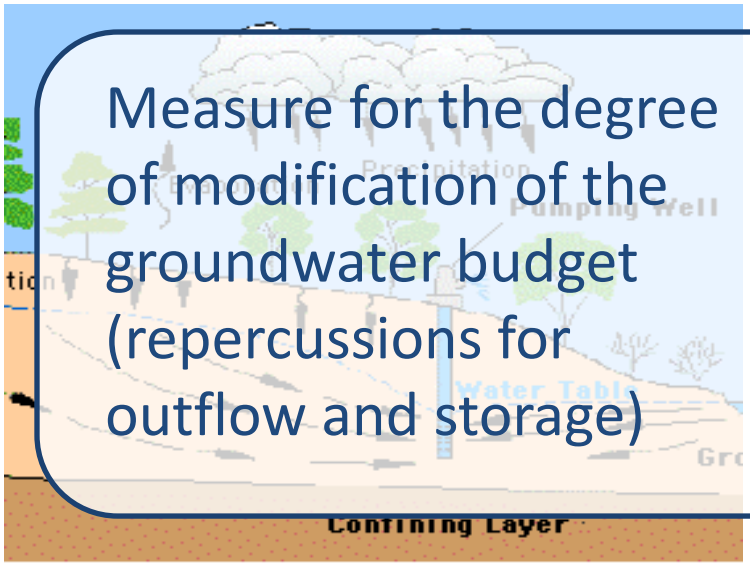

d from USGS)

Total annual groundwater abstraction divided by long-term mean annual recharge.

Adoption of workplan for follow-up

Activities	Time
Finalization of the final draft assessment report	End September 2015
Feedback from Governments	End of October 2015
2nd stakeholder consultation meeting (Stampriet)	Early November 2015
Finalization of final assessment report	November 2015
Final meeting (Paris?)	First half of December 2015

THANK YOU

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