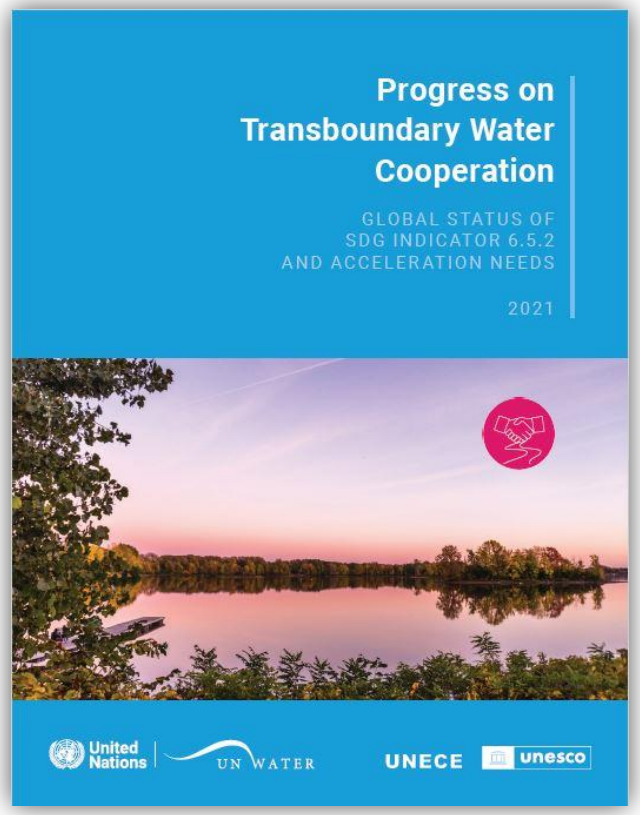

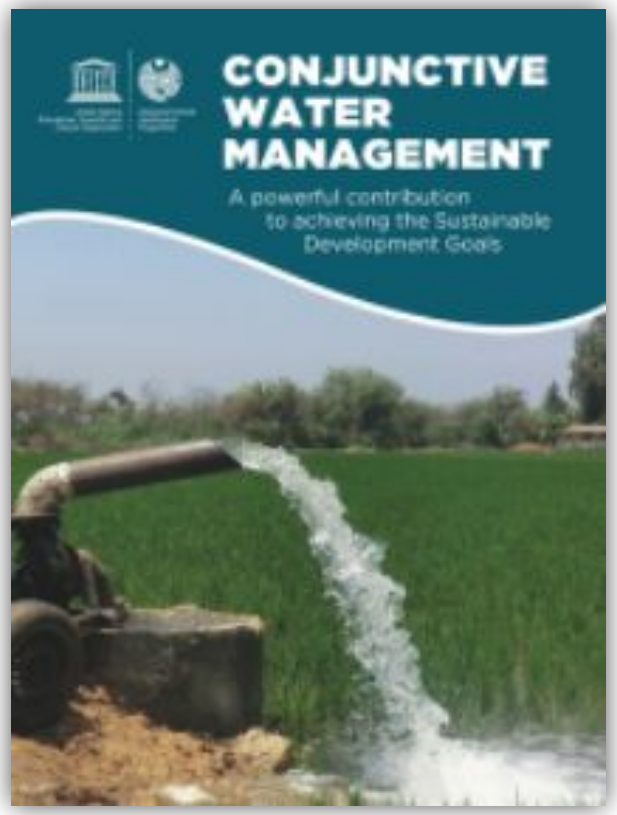

Conjunctive Water Resources management: concepts and application to SDG indicator 6.5.2

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Introductory remarks

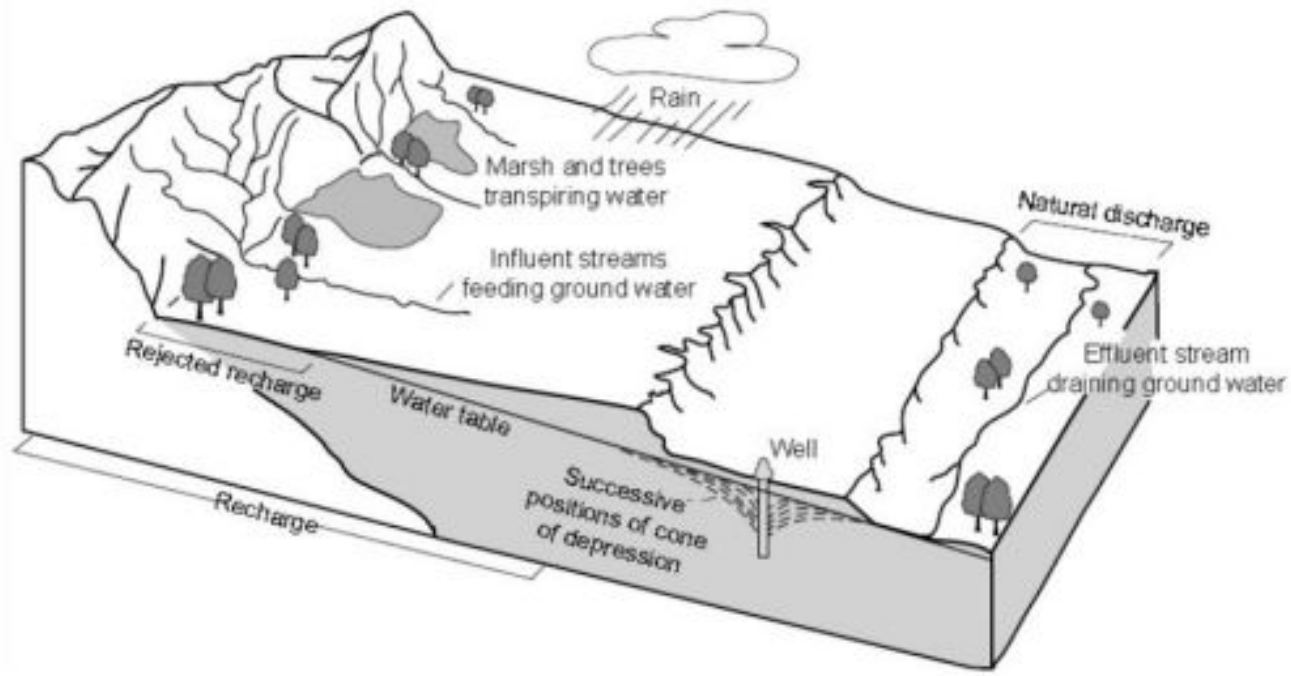


Figure 2.4. Factors controlling the response of an aquifer to discharge by wells. Source: Sophocleous (1998) (adapted from Theis, 1940)

- Groundwater pumping captures flows (*quantitative view*) (through perturbation of table)
- Groundwater pumping redistribute flows (*spatial view*)
- Lack of consideration in decision-making, conclusions of scientists, modelling, formulation of indicators, etc.

Introductory remarks

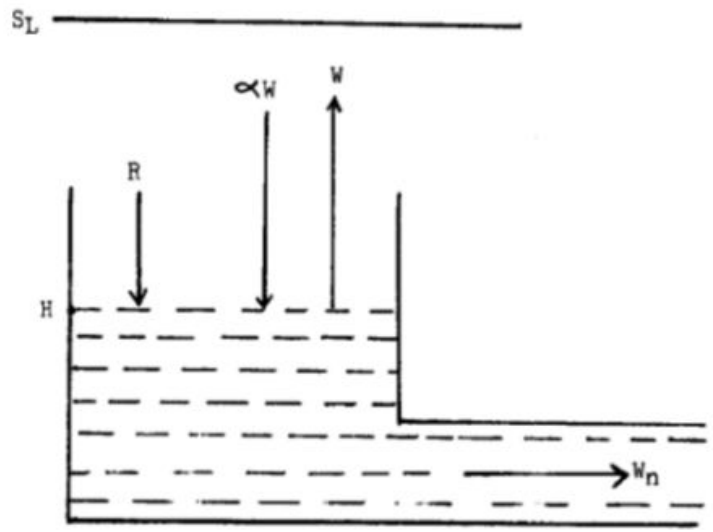


Fig. 1. A model of an aquifer.

The differential equation which describes the water table as a function of time is obtained by equating 'rate in' minus 'rate out' with the impact on the water table, as displayed in Figure 1, namely

$$AS \cdot \dot{H} = R + (\alpha - 1)W \qquad (6)$$

where R is natural recharge, α is return flow coefficient, and AS is area of the aquifer times storativity.

Figure 3.2. Extracts of the paper by Gisser & Sánchez (1980) showing that the factor accounting for the outflows in the water budget is disregarded. Source: Gisser & Sánchez (1980).

Conjunctive Water Management is an approach to water resources management in which surface water, groundwater and other components of the water cycle are considered as one single resource, and therefore are managed in closest possible coordination, in order to maximize overall benefits from water at the short and at the long term.

Source: UNESCO-IHP, upcoming

What is conjunctive water management (CWM) ?

1.At area-wide planning level	2. Activities and techniques at the level of implementation in the field		
Incorporating all water components	**Optimal selection of source of supply**	**Resource augmentation**	**Environmental control**
• Exploring and analysing connectivities and exchanges of water • Preventing 'double counting' • Identifying promising opportunities • Identifying hazards of harmful interaction	• Conjunctive use of surface water and groundwater	• Managed aquifer recharge (MAR) • Watershed management (e.g. Water harvesting) • Desalination of brackish and saline water • Recycling treated wastewater • Improvement of irrigation efficiency	• Restricting ground-water pumping to control surface water environmental flows • Groundwater level control to prevent flooding (e.g. surface water irrigated zones, urbanized wetlands, or polder) • Managing waste-water

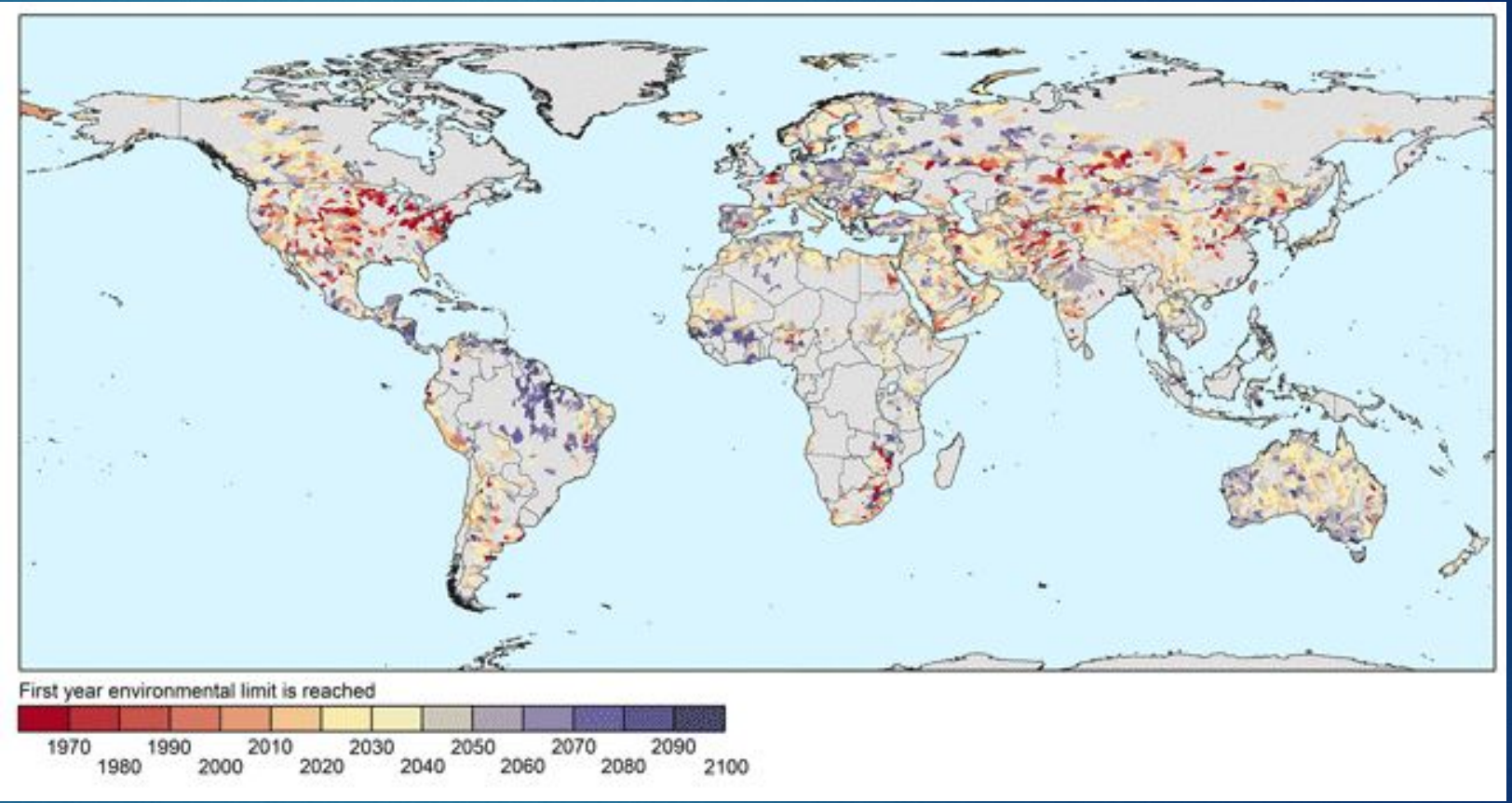
What is conjunctive water management (CWM) ?

1.At area-wide planning level

Incorporating all water components

- Exploring and analysing connectivities and exchanges of water
- Preventing 'double counting'
- Identifying promising opportunities
- Identifying hazards of harmful interaction

de Graaf, I.E.M., Gleeson, T., (Rens) van Beek, L.P.H. et al. *Environmental flow limits to global groundwater pumping*. **Nature** 574, 90–94 (2019).



- *(…) by 2050,* **environmental flow limits** *will be reached for approximately 42 to 79 per cent of the watersheds in which there is groundwater pumping worldwide, and that this will generally occur before substantial losses in groundwater storage are experienced.*

1.At area-wide planning level	*2. Activities and techniques at the level of implementation in the field*		
Incorporating all water components	Optimal selection of source of supply	Resource augmentation	Environmental control
• Exploring and analysing hydraulic connectivities and exchanges of water • Preventing 'double counting' • Identifying promising opportunities • Identifying hazards of harmful interaction	• Conjunctive use of surface water and groundwater	• Managed aquifer recharge (MAR) • Watershed management • Desalination of brackish and saline water • Recycling treated wastewater	• Water level control in polder areas • Groundwater level control in surface water irrigated zones • Restricting ground-water pumping to control surface water environmen-tal flows

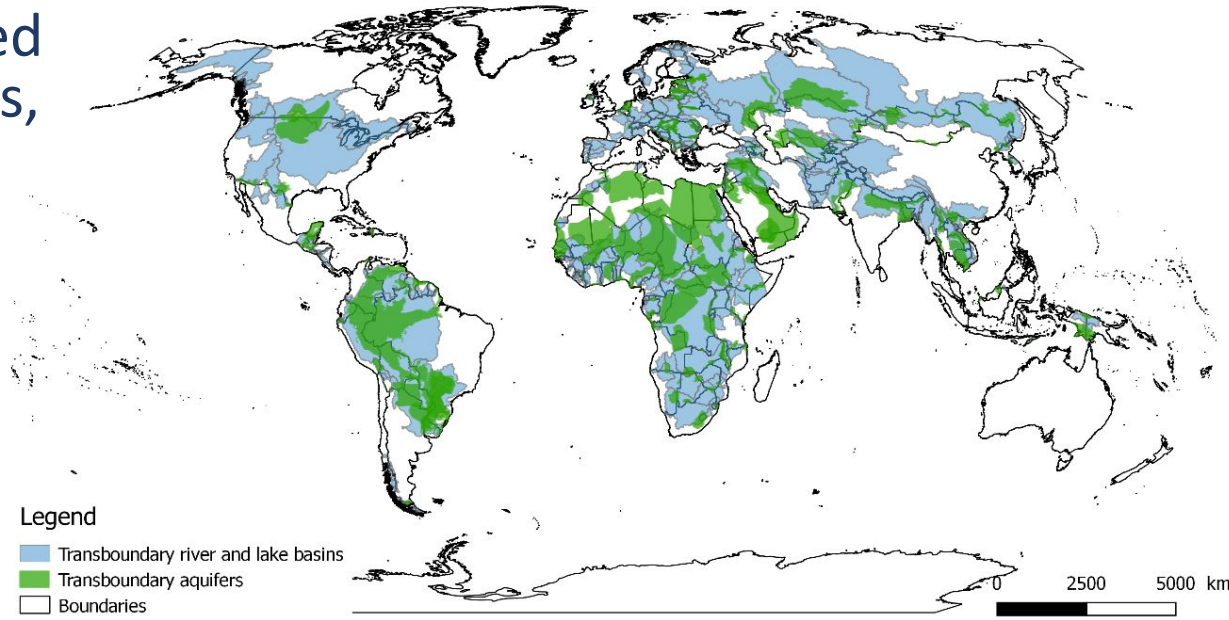
Conjunctive Water Management objective:
"maximize overall benefits from water"

QUALITY **QUANTITY** **EXTREME EVENTS / CLIMATE**

multiple benefits

SDG 6: Ensure availability and sustainable management of water and sanitation for all.

Target 6.5: By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.



Indicator 6.5.1 Degree of IWRM

Indicator 6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation

- **Most of the world's water resources are shared** => cooperation required.
- **The only SDG indicator on transboundary cooperation** => important for other natural resources

Calculation of SDG indicator 6.5.2

Indicator 6.5.2: Proportion of *transboundary basin area* with an *operational arrangement* for water cooperation

- **What is an 'operational' arrangement?**
  - Treaty, convention, agreement or other formal arrangement
  - Joint body for transboundary water cooperation
  - Annual meetings
  - Annual exchange of data and information
  - Adoption of joint/coordinated water management plan, or joint objectives

- Two components necessary for indicator value
  - Transboundary River and lake basins
  - Transboundary aquifers
- Aquifer component:
  - Directly (= a dedicated arrangement about the aquifer)
  - Groundwater / Aquifers included in river basin/ upper level (binational) arrangement

Results of the 2nd reporting in 2020 on SDG 6.5.2 – 1

Indicator 6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation

High level of engagement

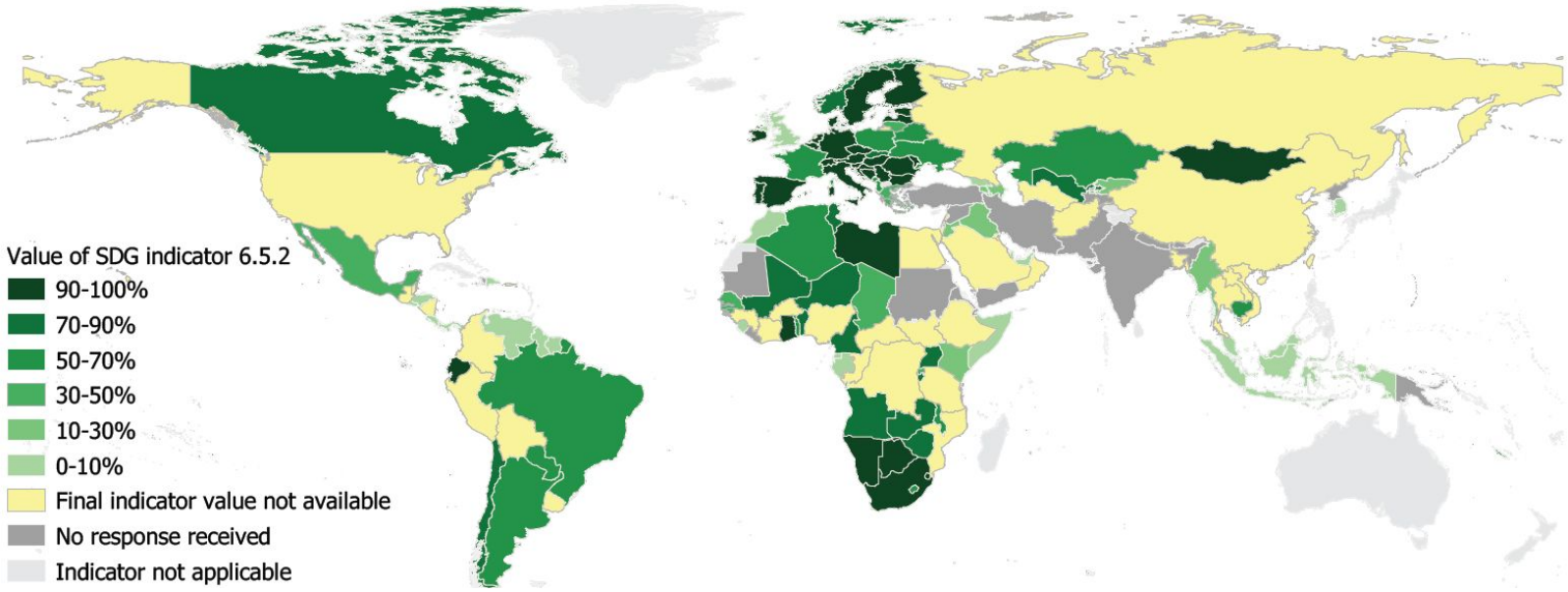
⇒ In 2020: **129** out of 153 countries submitted reports

Not on track

⇒ Only **24 countries** report **all** transboundary surface waters and groundwaters covered by **operational arrangements**

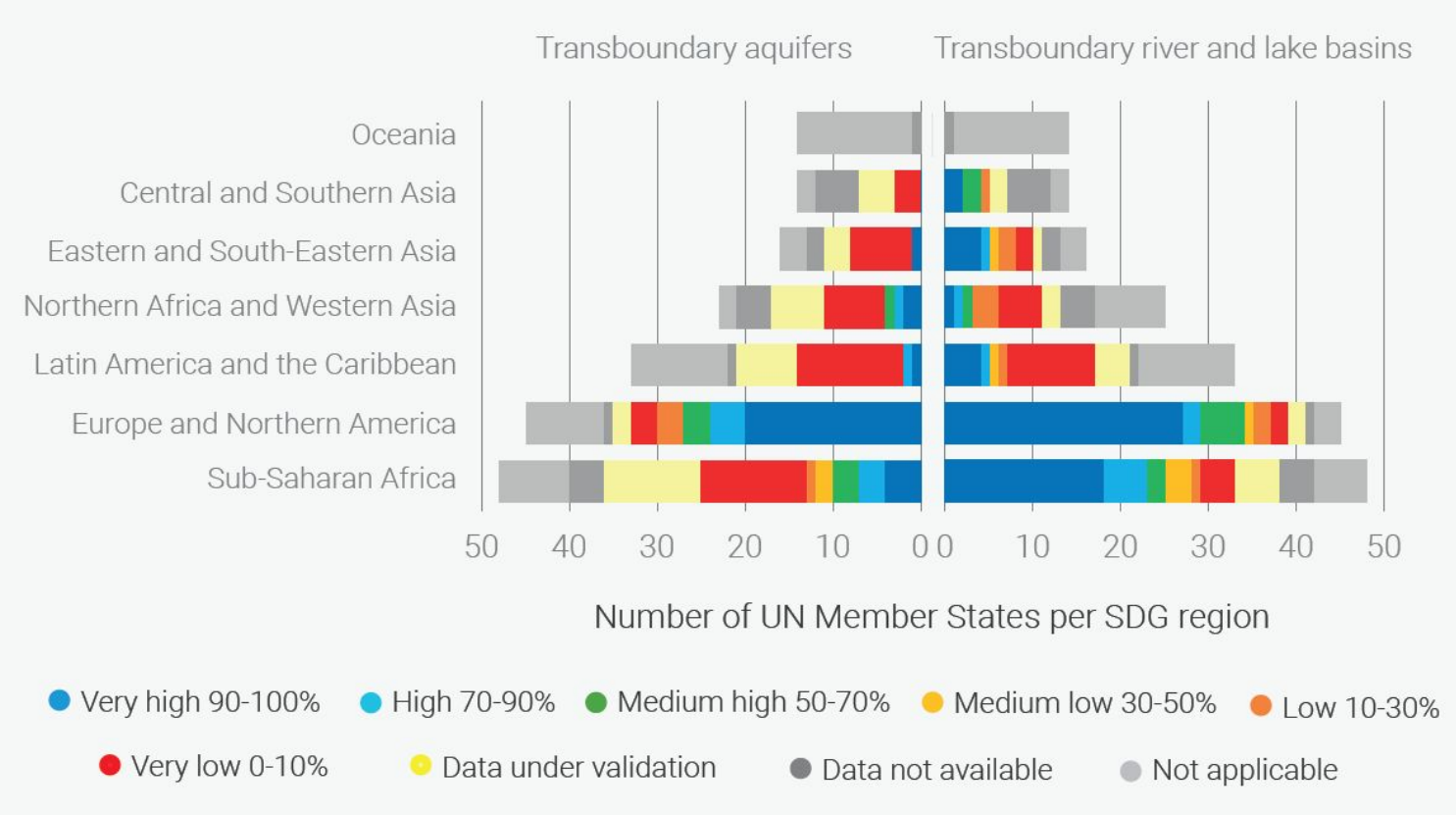
⇒ Progress must be **accelerated** to ensure that all transboundary basins are covered by operational arrangements by 2030

SDG Indicator 6.5.2 values and responses received during the 2nd exercise



Results of the 2nd reporting in 2020 on SDG 6.5.2 – 2

- Europe, North America and Sub-Saharan Africa show greatest levels of **cooperation**
- In Latin America and Asia, much more progress is needed for water cooperation
- At least **128 basins reported lack agreements**
- Insufficient knowledge on **groundwater** systems, despite an unprecedented opportunity for countries to consider their transboundary aquifers



Positive impact

⇒ Reporting triggered **follow-up actions** in countries to **improve cooperation**

Final remarks / Synthesis

- Groundwater integrated with surface water and land management: not only as a concept but implement it! (change of vision of groundwater as a stock, etc.)

- Need of promotion at of conjunctive water resources management at planning level and field level (techniques).

- An example of way forward: building on the groundwater / transboundary aquifers integration within the transboundary agreements (on the basis of SDG indicator 6.5.2 monitoring).