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Towards Sustainable Groundwater Management of Transboundary Aquifers in the Lower Mekong Region

Prof. Dr. Ashim Das Gupta
Emeritus Professor, AIT, Bangkok, Thailand
Visiting Professor, UTS, Sydney, Australia

Outline of Presentations

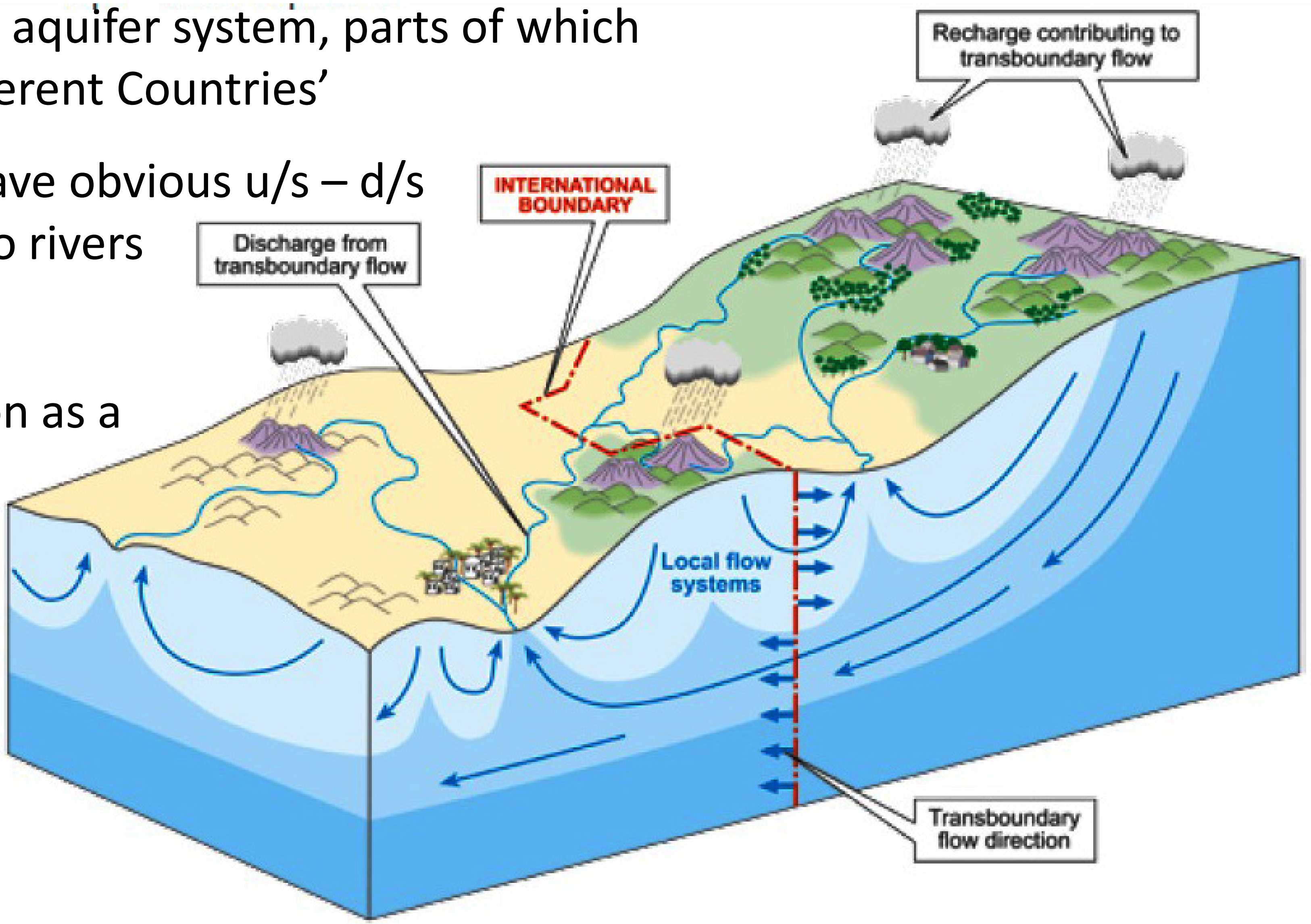
- Introduction
- Transboundary Aquifers in Lower Mekong Basin
- Sustainable GW Development & Management (SGWDM):
  - Principles and Concepts
  - How to apply in practice?
- Pragmatic Action Plan Needed for SGWDM
  - Implementation Stages and Scope of Work
  - Institutional System and Capacity Requirement
- Concluding Remarks

Transboundary Aquifer (TBA) & Groundwater

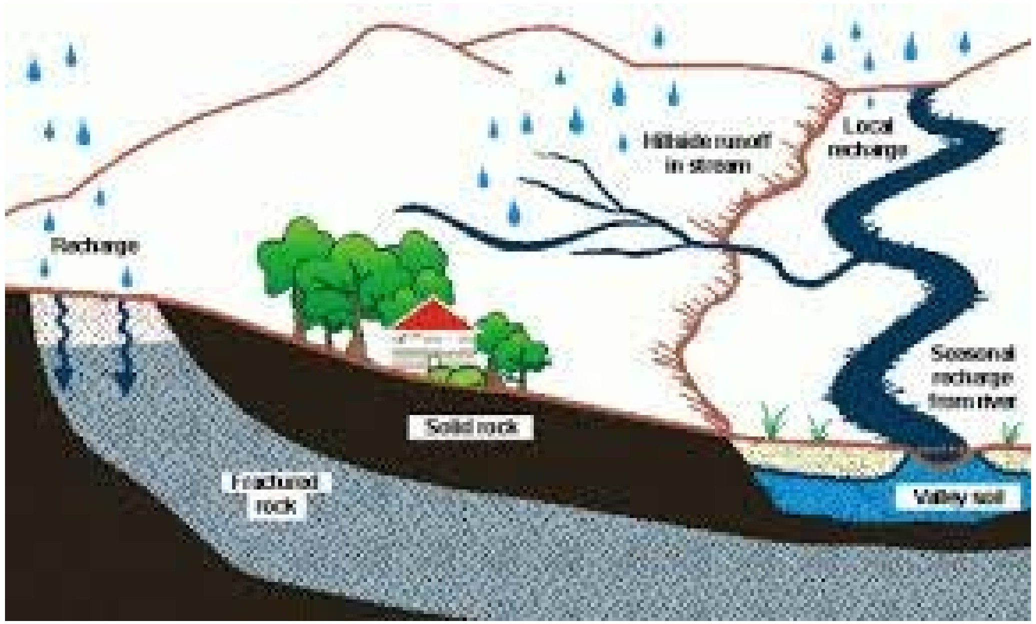
TBA: ‘an aquifer or aquifer system, parts of which are situated in different Countries’

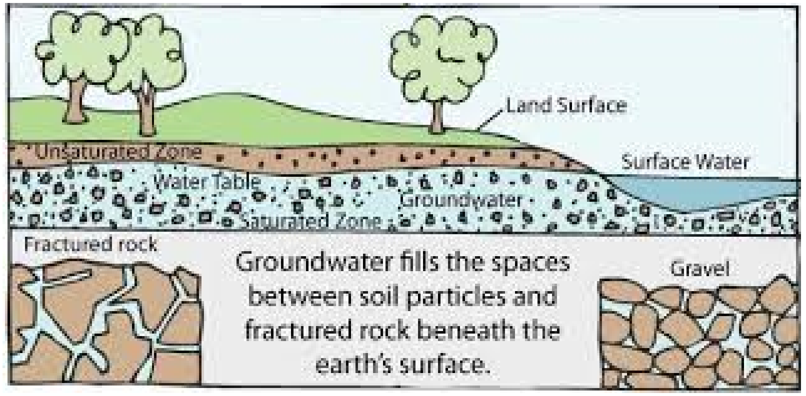
TBA-GW: may not have obvious u/s – d/s relations, opposed to rivers

TBA-GW: may even change flow direction as a result of changing abstraction patterns



GW Attributes





Common-pool resource; sub-tractability and low excludability

Irreversibility: GW pumping may lead to aquifers suffering irreversible damage in storage capacities

Time lag: in aquifers, the effect of pollution or water extraction may become evident, if at all, only after a considerable time lag

Fuzzy boundaries: Defining the exact hydrogeological boundaries of GW extremely challenging

Hydrogeological uncertainty: widely varying depending on physical situation

Data needs: Reliable groundwater-related data are imperative for making knowledge-based and appropriate decisions

Structure of abstraction: Information on the average extraction per GW device and the number of devices provides important information

Information asymmetry: Information is always limited and asymmetrically with stakeholders involved in use and service delivery of GW system.

Groundwater Development

DEVELOPMENT: Progresses in stages

ASSESSMENT : should proceed concurrently with DEVELOPMENT

Detailed Field-Level Hydro-geological Investigation Integrated with Modelling : Contributes significantly to Assessment

MONITORING and EVALUATION
(dynamic Process)
Concurrently Performed and an Integral part of Investigation for Groundwater Systems Management

Distribution of TBAs in GMS

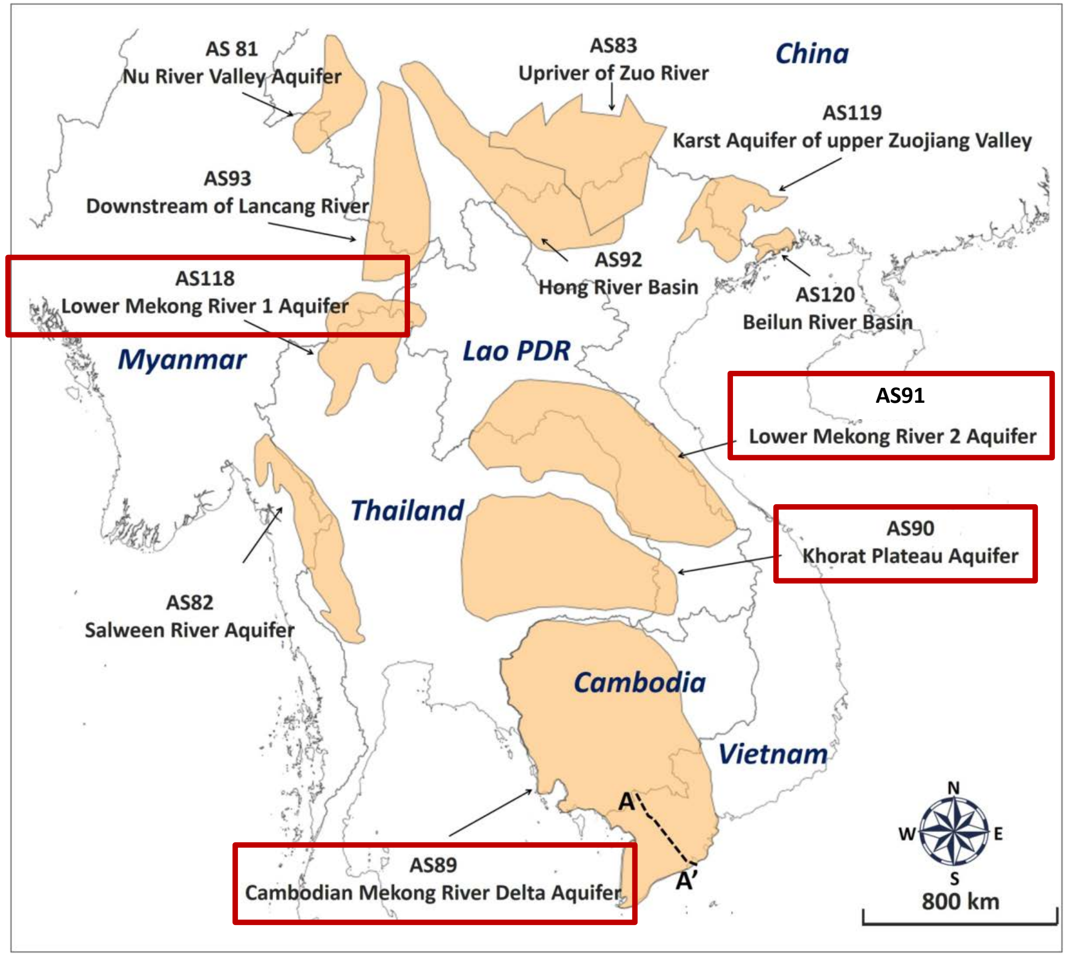
AS118

36,769 km^2
Shared by Lao PDR, Myanmar, Thailand

AS89

200.000 km^2
(63% of TBA in Cambodia)

Annual RF:
1400-2200 mm/yr



TBAs in Greater Mekong Sub-region and adjacent region (modified from IGRAC, 2015)

(Adopted from Lee et al., 2018)

AS91

122,000 km^2
TBA distribution:
Lao PDR (73%)
Thailand (21%)
Vietnam (6%)

AS90

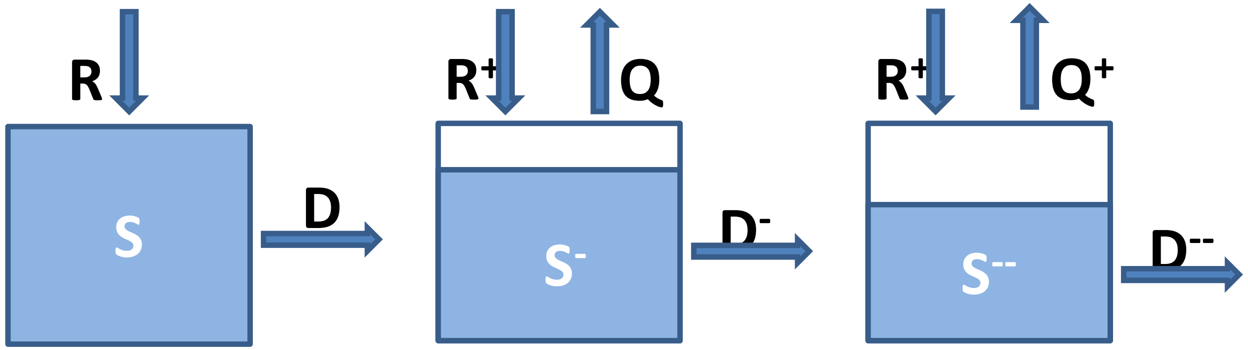
109,000 km^2
(91,00 km^2 in Thailand, Lao PDR accounts for a small portion in the northeastern area)

Annual RF:
1000 mm/yr

Sustainable Groundwater Development & Management (SGWDM)

- Safe Yield concept: average annual rate of GW withdrawal not exceeding the average annual rate of natural recharge (misperception)

Safe Yield (to) Sustainable Yield



Natural Conditions In the long run R = D & S is constant	Stable Groundwater Pumping Q is equivalent to reduction in D & S plus increase in R	Unsustainable Groundwater Pumping Q^+ is greater than R^+ plus D^{--} (which reduces to zero) and S^{--} decreases continuously

- Sustainable Yield concept: GW withdrawal regime that can be maintained indefinitely without causing unacceptable environmental, economic, or social consequences

Sustainable Groundwater Development

- GW pumping regime (spatial and temporal variations) determined for a specific physical system from the dynamic balance of inflow, outflow and change in storage using specified withdrawal rates, well-field locations, drawdown limits and a defined planning horizon.
- The withdrawal rate patterns that meet the constraint on drawdown and/or any other environmental concerns (like minimum outflow, limit on quality deterioration, land subsidence, seawater intrusion) will indicate the level of sustainable GW development.
- The analysis has to be based on proper identification and estimation of the following four elements of the groundwater system, including their states and inter-relationship: (1) *Available Groundwater Resource,* (2) *Groundwater Development and Use,* (3) *Groundwater Dependent Ecosystems, and* (4) *Governance and Management.*

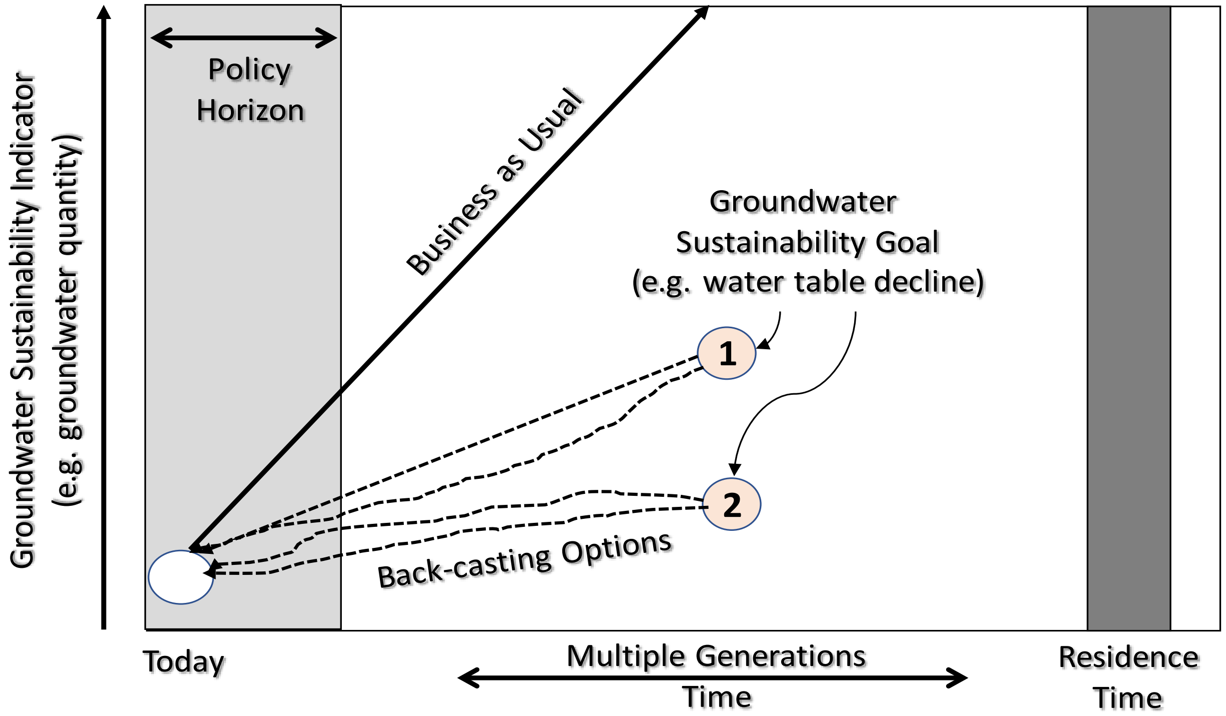
SGWDM: Principles and Concepts

- *Protection of groundwater supplies from depletion*
- *Protection of groundwater quality from contamination*
- *Protection of ecosystem viability*
- *Achievement of economic and social well-being*
- *Application of good governance*

Specific "Measurable Objectives" are required to avoid a series of "undesirable results"

SGWDM: How to Implement in Practice?

- “Measurable objectives” to avoid “undesirable results” and to achieve “sustainability goals for the basin”
- Collaborative process of investigation, analysis needed to arrive at a consensus by riparian countries.
- In practice, attaining GW sustainability is difficult: due to long timescales of groundwater processes and impacts
- At a global scale, mean residence times of GW much longer than the residence times of other parts of the hydrologic cycle.
- Mean residence times of groundwater: from <10 years to >1,000,000 years



A conceptual representation of development progression along multi-generation time horizon to achieve sustainability development goals

However, GW policy horizons, typically 5 to 20 years, are often inconsistent with natural groundwater time scales

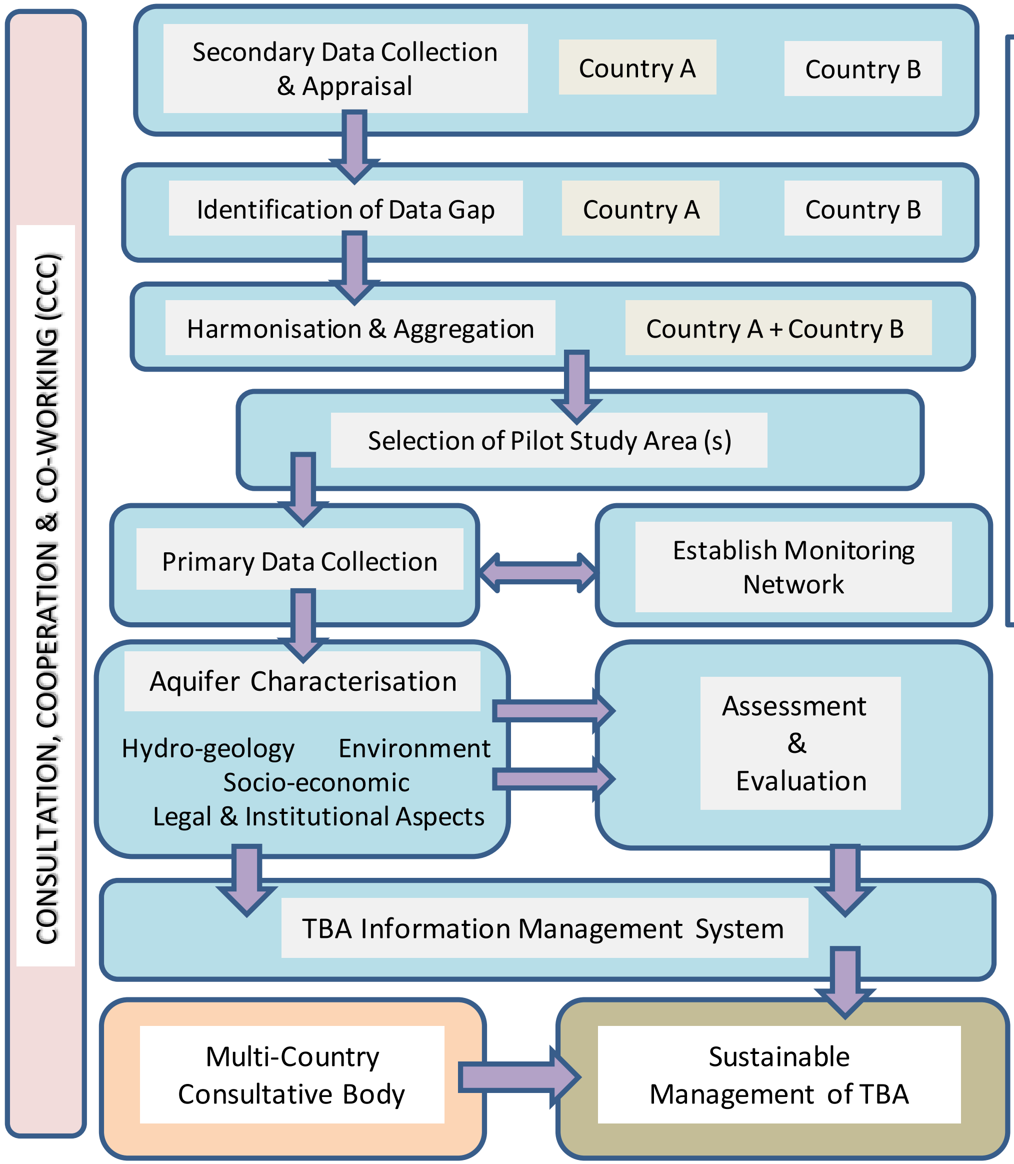
MONITORING & ADAPTIVE MANAGEMENT

Pragmatic Action Plan for SGWDM

- A Pragmatic Action Plan needed to Institutionalise on long-term basis a system to address the sustainable use of groundwater of TBAs.
- Stage I: secondary data collection, documentation and a preliminary assessment,
- Stage II is on detailed analysis and development, and
- Stage III is on implementation, operation, management and monitoring.

Multi-Country Consultation Body

TBA Information Management System



Harmonisation implies that the same standard (like the level of detail, the period of time and frequency of measurement, units, etc.) is agreed upon by MCs and used in observation and compilation of data for the entire TBA system; while, **Aggregation** is the process of assembling all data and information from MCs in the same form for the TBA shared by countries to produce different mapping output in unified manner.

Concluding Remarks

- Unlike all other water bodies, aquifers are located in the subsurface and visible only through the eyes of science – **hydrogeology**. Aquifer boundaries are often very poorly known, and many aquifers remain unknown or only partly recognised as separate, often unconnected entities. This is particularly true for TBAs, often not recognised by sharing countries.
- There is a need for a systematic effort to identify and delineate aquifers that are transboundary (**Inventory**) and to provide a standardised description of their main characteristics in terms of hydro-geology, environmental role and implications, socio-economic value and governance structure (**Characterisation**).
- An **Institutional system** in the form of a **Coordinating Council or a Multi-Country Consultative Body** is recommended for the management of TBA. The in-house capacity and resources at different administrative levels to provide the know-how and expertise should be adequate to address development and management issues.

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