Background Document for APN Funded CAPaBLE Project

"Enhancing the groundwater management in Asian cities through the development and application of groundwater sustainability index in the context of global change"

CONTEXT

Depletion of water levels in aquifers, decline in design yield of water wells, land subsidence and salinity intrusion in coastal aquifers are becoming a major concern across the globe (Pandey et al., 2011). Because of the reasons, there are rising concerns for sustainable development and management of groundwater resources. The sustainability is neither fixed nor constant but rather time- and space-dependent (De Carvalho et al., 2009). It therefore, needs to be quantified in order to evaluate the progress in achieving the groundwater sustainability over time and space.

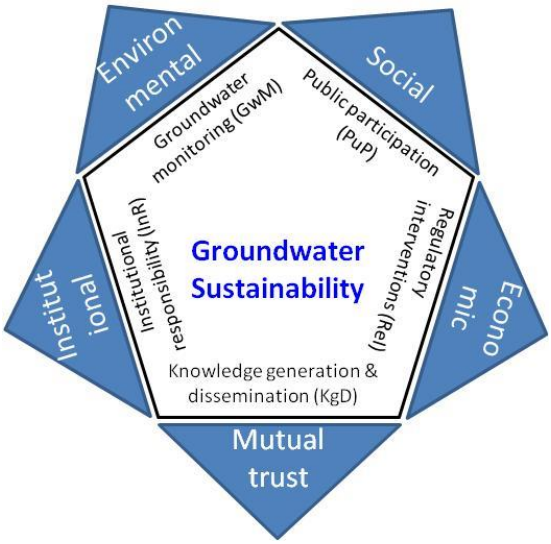


Figure 1 Five dimensions of sustainability and groundwater sustainability infrastructures (Pandey et al., 2011)

A framework developed by Pandey et al. (2011) for measuring groundwater sustainability consists of an index (i.e., groundwater sustainability infrastructure index, GSII), five components, and sixteen indicators (Annex-1). The framework conceptualized that the sustainability consists of following five dimensions: social, environmental, economic, institutional and mutual trust dimensions (Figure 1). The five dimensions in the framework are represented as public participation (PuP, for social), groundwater monitoring (GwM, for environmental), regulatory intervention (ReI, for economic), institutional responsibility (InR, for institutional), and knowledge generation and dissemination (KgD, for mutual trust).

The approach used by Pandey et al. (2011) was an attempt in the direction of developing a robust index for measuring progress in achieving groundwater

sustainability. The five components of the GSII are supposed to be universal. Indicators, however, may vary as per location and availability of data/information. What is lacking is identifying easily quantifiable indicators for the selected cities (*Bangkok, Bandung, Ho Chi Minh, Karachi and Lahore*) and developing rating criteria for the indicators based on some quantitative values. For this, it is necessary to get feedback from the relevant stakeholders in this regard considering relevancy and data availability in the particular city.

In the course of analyzing the groundwater sustainability of the selected Asian cities, comprehensive background information about status of groundwater environment in the study cities would also be collected. The background information can be synthesized under the framework of Driver-Pressure-State-Impact-Response (DPSIR).

The DPSIR framework, developed by Organization for Economic Co-operation and Development (OECD), serves as a communication tool between researchers from different discipline, policy makers and entire stakeholders sharing the aquifer resources. The components in the framework are related by a logic relation: **Drivers** generate pressure, **Pressures** influence/modify state; **State** provokes of cause impacts; **Impacts** stimulate or ask for responses; and **Responses** modify or substitute drivers, eliminate/reduce/prevent pressures, restore/influence state and compensate or mitigate impacts. The logic relation as well as potential indicators for D, P, S, I, and R is provided in Annex-2.

OBJECTIVES

The objectives of this project is to re-confirm the adequacy of the groundwater sustainability components, their naming and description (Annex-1), identifying suitable set of easily quantifiable indicators of the components for each cities under study, and finally developing criteria for rating and evaluating the indicator values based on some quantitative values. The framework would be applied to the selected cities in the Asia.

EXPECTED OUTCOMES

- A general framework and city specific groundwater sustainability index for the cities under study
- Enhanced understanding on status of groundwater development and use in each city in a form of a synthesized report of DPSIR analysis for the cities under study.
- Enhanced collaboration for better groundwater management among participant countries that comes from sharing experiences in regional workshops.

GUIDELINES FOR MOVING FORWARD WITH DISCUSSION

- The background document (including framework of study) would be shared with collaborators from each of the study cities via email.
- The collaborators will provide critical comments on the proposed names of components, proposed indicators (Annex-1) and may suggest addition and/or removal of the indicators. They would also provide their thoughts on criteria for rating and evaluating the indicator values based on experience in their cities.

- The collaborators are expected to suggest suitable indicators for Drivers, Pressures, State, Impact and Response for particular cities based on proposed indicators (Annex-2).
- A moderator would facilitate the e-discussion aimed at finalizing indicators and rating/evaluating criteria for groundwater sustainability index as well as for DPSIR analysis.
- The project would be implemented as per the time plan shown in Annex-3. The Annex-3 would be effective after confirmation/agreement of all the collaborators and project proponents.

REFERENCES

- **2011.06**: Pandey V.P., Shrestha S., Chapagain S.K., Kazama F. A framework for measuring groundwater sustainability. *Environmental Science & Policy*, 14(4), 396-407.
- **2009.04**: De Carvalho, S.C.P., Carden, K.J., Armitage, N.P. Application of a sustainability index for integrated urban water management in Southern African cities: case study comparison – Maputo and Hermanus. Water SA (Online) 35 (2), 44–151.

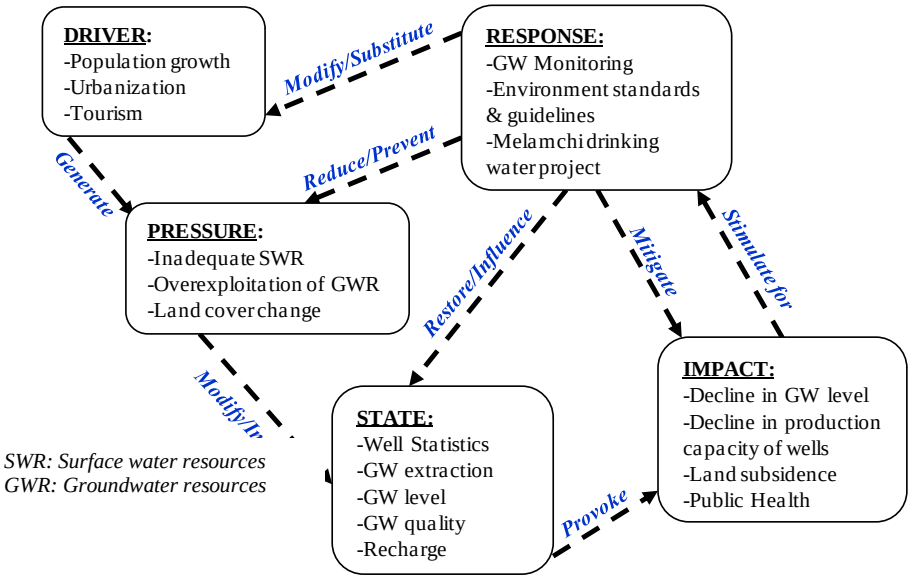
ANNEXES

ANNEX-1: Proposed indicators for groundwater sustainability components. The components are also briefly described

Index	Component	Indicator	Description
Groundwater Sustainability Infrastructure Index (GSII)	1. Groundwater monitoring (GwM)	1.1 Groundwater level 1.2 Groundwater extraction 1.3 Groundwater quality 1.4 Land subsidence	GwM enable a long-term understanding of groundwater availability and anthropogenic effects on groundwater resources. It helps protect groundwater environment
	2. Knowledge generation and dissemination (KgD)	2.1 Knowledge generation 2.2 Knowledge/data CSM 2.3 Provision for KID	KgD help facilitate groundwater resources evaluation, planning and management. KgD also help build 'mutual trust' among the stakeholders to achieve the goal of sustainability
	3. Regulatory interventions (ReI)	3.1 Groundwater rights 3.2 Groundwater licensing 3.3 Economic instruments	ReI aim to ensure sustainability through interventions like licensing, tax/subsidy, trading groundwater rights, etc.
	4. Public participation (PuP)	4.1 Awareness 4.2 Interest to participate 4.3 Availability of mechanism	PuP help safeguard social wellbeing through sustainable use of the resource. It helps for informed decision making, conflict prevention and maximizing benefits (social, economic and technical)
	5. Institutional responsibility (InR)	5.1 Availability of authority 5.2 Legal framework 5.3 Institutional capacity	InR empowered with clear mandate, sufficient resources and legal framework increases strength of institutional leadership in groundwater management

'CSM' is compilation, storage and management; 'KID' is knowledge integration and dissemination

Annex-2: Proposed indicators for DPSIR analysis



Annex-3: Plan of Implementation (PO)

S.N.	Activities	Schedule	Output
1	E-discussion 1 (based on background document)	20-30 Oct, 2013	Tentative framework of groundwater sustainability, including its indicators and rating criteria
2	Data collection, compilation, processing and analysis	30 Oct – 25 Nov, 2013	Values for groundwater sustainability indicators
3	E-discussion 2	25 Nov – 15 Dec, 2013	Discussion on the indicator values for all the cities, revise rating criteria (if necessary) and develop strategy for comparative analysis
4	Regional workshop 1 (@ AIT, Bangkok)	19-20 Dec, 2013	Workshop proceeding, strategy for compiling the results, tentative framework and content of the reports/papers to be produced

The time schedule for the duration after 27 December, 2013 will be finalized in the regional workshop 1.

Annex-4: Papers on GWSII and DPSIR analysis of groundwater environment

- **2011.06**: Pandey V.P., Shrestha S., Chapagain S.K., Kazama F. A framework for measuring groundwater sustainability. *Environmental Science & Policy*, 14(4), 396-407.
- **2010.04**: Pandey V.P., Chapagain S.K., Kazama F. Evaluation of groundwater environment of Kathmandu Valley. *Environmental Earth Sciences*, 60(6), 1329-1342.

Annex-5: Glossary of terminologies

- **Groundwater sustainability**: 'Groundwater sustainability' may refer to the development and use of the resource in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences (Alley et al., 1999). The sustainability represents an optimal state; however, this is neither fixed nor constant but rather time- and space dependent.

- **Groundwater sustainability infrastructures**: It refers not to the physical infrastructures (e.g., engineering constructions) but to the knowledge, practices and institutions whose adequate strengthening may help achieve groundwater sustainability.