



## **Groundwater resources in the Indo-Gangetic Basin: resilience to climate and abstraction**

***Project workshop meeting, Delhi, 4-7 November 2013***

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### **Workshop report**

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**Bibliographical reference:** Bonsor HC and MacDonald AM 2013. Groundwater resources in the Indo-Gangetic Basin: resilience to climate and abstraction. Project workshop meeting, Delhi, 4-7 November 2013. British Geological Survey Internal Report IR/13/060

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This report is an output from the project *Groundwater resilience to climate change and abstraction in the Indo-Gangetic basin*

**Groundwater resilience to climate change and abstraction in the Indo-Gangetic basin** is a two-year (2012-14) DFID-funded research project strengthening the evidence-base linking groundwater resources, climate variability and abstraction in the Indo-Gangetic basin. This project has been commissioned by the DFID South Asia research hub and is led by the British Geological Survey. The project has two main aims:

- To develop a strategic overview assessment of the occurrence and status of groundwater resources in the Indo-Gangetic basin and develop a map of groundwater typologies spanning the groundwater system
- To strengthen the evidence-base linking groundwater resources, climate and abstraction through a series of four targeted case studies in the basin.

The project team involves researchers from the British Geological Survey, IIT Kharagpur, ISET-Nepal, ISET International, Meta-Meta, National Institute of Hydrology (Roorkee), Overseas Development Institute, University College London, University of Dhaka and Bangladesh Water Development Board.

<http://www.bgs.ac.uk/research/groundwater/international/SEAsiaGroundwater/>



## Overview and aims of the workshop

The **DFID-funded project** is aimed at providing an improved understanding of how resilient groundwater resources in the Indo-Gangetic basin are to changes in climate and abstraction and to provide a robust scientific base to help guide policy development for groundwater development and management within the basin. The project is being undertaken by a team of established researchers in India, Bangladesh, Pakistan and Nepal and is led by the British Geological Survey.

**The project is now over half way through its work programme.** The two main work components of the project are: (1) a basin wide assessment using a combination of existing data from the four countries and interpretation of remotely sensed data; and (2) targeted field studies in strategic parts of the basin to investigate specific under-researched issues.

**The main objective of the four day workshop** was to bring together all the project partners to enable detailed discussions on the different components of the project - in particular to agree the draft groundwater typologies and data required to complete the basinwide assessment.

**The workshop was held within the Habitat Centre in New Delhi**, from 4<sup>th</sup> to 7<sup>th</sup> November 2013. A full list of workshop attendees and the workshop schedule are shown in Tables 1 and 2.

**A meeting of the International Project Steering Committee (IPSC)** was held in parallel with the workshop meeting on Wednesday 6<sup>th</sup> November, within the Habitat Centre. This steering group provide advice on implementation and quality control for the project as well as providing a critical route for disseminating key messages from the project to policy makers. An IPSC meeting was held in Delhi to enable fuller discussions with the steering group members based in the region as video conferencing has proved difficult. Holding the meeting in parallel to the workshop also provided the opportunity for some of the steering group members (Drs. Sardar Tariq and Cliff Voss) to attend the rest of the workshop.



*Project workshop attendees at the Habitat Centre, Delhi. From left to right: Mohammad Shamsudduha, Kamrul Islam, Abhijit Mukherjee, Kazi Matin Ahmed, Willy Burgess, Josie Tucker, Lenneke Knoop, Gopal Krishan, Frank van Steenbergen, Helen Bonsor, Marcus Moench, Ajaya Dixit, Fraser Sugden, Shova Yadav, Cliff Voss, Yuba Raj Satyal, Andrew McKenzie, Alan MacDonald, Sardar Tariq and Someshwar Rao.*

Table 1 – Full list of the project workshop attendees.

Name	Location	Affiliation
<b>Project workshop attendees</b>		
Dr William Burgess	London, UK	UCL
Dr Mohammad Shamsudduha	London, UK	UCL
Prof Kazi Matin Ahmed	Dhaka, Bangladesh	Dhaka University
Kamrul Islam	Bangladesh	Prev. BWDB
Dr Abhijit Mukherjee	Kharagpur	IIT-Kharagpur
Ajaya Dixit	Nepal	ISET-Nepal
Shova Yadav	Nepal	ISET-Nepal
Yuba Raj Satyal	Nepal	ISET-Nepal
Marcus Moench	Denver USA	ISET
Dr. M. Someshwar Rao	Roorkee, India	NIH
Dr Gopal Krishan	Roorkee, India	NIH
Dr Frank van Steenberg	Netherlands	MetaMeta
Lenneke Knoop	Netherlands	MetaMeta
Josie Tucker	London, UK	ODI
Andrew McKenzie	Wallingford, UK	BGS
Alan MacDonald	Edinburgh, UK	BGS
Helen Bonsor	Edinburgh, UK	BGS
Dr Brindha Karthikeyan	India	IMWI
Fraser Sugden	Nepal	IMWI
<b>IPSC meeting attendees</b>		
Jean Marion Aitken	Delhi, India	DFID
Prof Ashvin Gosain	Delhi, India	IIT Delhi
Dr Vidisha Samarasekara	Delhi, India	ADB
Prof Feroze Ahmed	Bangladesh	BUET
Dr Sardar Tariq	Islamabad, Pakistan	GAP-SAS
Dr Cliff Voss	USA	USGS

*Table 2 – Project workshop schedule, 4-7 November 2013, within the Habitat Centre, Delhi*

	10-11am	11-11.15 am	11.15-12 pm	12-1 pm	1-2pm	2-3 pm	3-3.30 pm	3.30-3.45 pm	3.45-5.15pm
Mon				<b>Project overview and workshop aims</b>	Lunch	<b>Case study presentations</b> Nepal India		Tea	Pakistan Bangladesh
Tues	<b>Introduction to typologies</b>	Tea	<b>Working groups – I</b> Draft typologies and 3D geometry			<b>Working groups -II</b> Climate and Dynamic response of these typologies			Outputs and wrap up Guest lecture (Cliff Voss-USGS)
Wed	Introduction to steering committee		<b>Working groups - III</b> Typologies and Groundwater Governance			<b>Discussions and Working Groups – IV</b> Groundwater chemistry			Outputs and wrap up Guest lecture (Fraser Sugden) IWMI (Andy McKenzie) BGS
			Steering Group			Steering Group			
Thurs	Feedback from steering group & discussion		Outputs, dissemination of the Project and finalizing the timelines for typologies			Finalizing case studies –Time lines Final feedback and roundup			

## Presentation and discussion of Case studies

The project contains four targeted case studies to collect primary field data on specific under-researched groundwater issues in the Indo-Gangetic basin. Presentations were made by each of the project partners leading the case studies to workshop, to provide an overview of each of field study, and the work completed to date. PDFs of each presentation are available as an Appendix.

Alan MacDonald presented the **Nepal case study** investigating groundwater resources and water usage in two middle hill catchments, and the likely impact of climate change to springs in these regions. This case study is being led by ISET-Nepal and BGS.



Dr K Gopal and Dr S Rao presented work so far on the **Indian case study**, examining the impact of intensive abstraction on groundwater resources, and investigating the role of groundwater-surface water interactions. This is being led by NIH and BGS.

Dr Frank van Steenburgen presented the **Pakistan case study**, which is providing a review of groundwater salinity issues, controlling mechanisms. This is being led by BGS and MetaMeta.



Dr Willy Burgess, Prof Kazi Ahmed Matin, Dr Mohammad Shamsudduha, Dr Abhijit Mukherjee and Kamrul Islam, presented the **Bengal Basin case study**, investigating the impacts of abstraction and climate change on the deep groundwater resource. This study is being led by UCL and Dhaka University with support from BGS.



### Discussions

There were detailed discussions of the work plans for each case study, deliverables and how the work of each case study might be continued in the future beyond this current project.

### Agreed actions

The case study leaders and Alan MacDonald are to agree finalised work plans of the case studies for the remaining project by end of November.

Case studies reports presenting the methods, main results and key messages of the studies to be delivered by July 2014. This is for inclusion of findings in final reports and outputs.

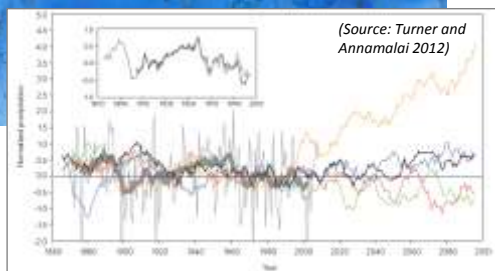
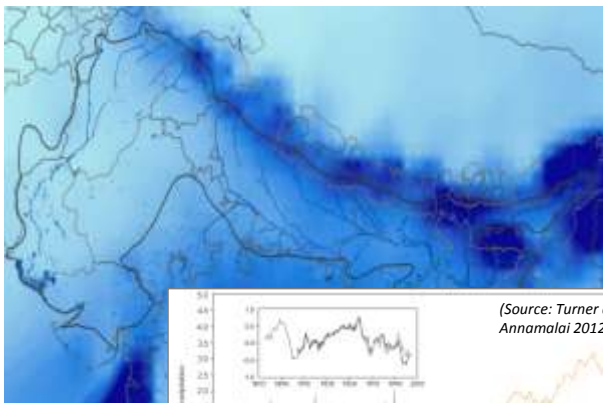
Scientific papers are likely to follow beyond the end of the project in September 14, each project team should look for opportunities to continue monitoring beyond the project end date



## Groundwater typologies

Alan MacDonald and Helen Bonsor presented an overview of the use of typologies to help map groundwater bodies with different resilience to climate and abstraction; and also presented progress in the development of draft typologies of aquifer properties in the basin. The aquifer properties typologies are the fundamental layer of a series of data layers which will feed into the final typologies developed of groundwater resilience. The remaining layers to be developed are: water quality, typologies of recharge types; land use and management practices. Each typology will then be characterised by data on the response of groundwater levels and quality to changes in rainfall and abstraction. A copy of the presentations is available as an Appendix.

A series of four workgroup sessions over two days enabled focused discussion within the project team of the key components of the typology work. Expertise within the upper, middle and distal areas of the basin were brought together within three separate discussion groups in the workshops.



Time series groundwater-level and groundwater chemistry datasets are required to analyse different dynamic responses in the basin, in different settings of recharge and abstraction. Monthly gridded rainfall data has already been obtained by the project from the region.

Significant time was spent by the discussion groups to identify key available datasets which would be accessible to the project within the remaining timeframe. These are to be sourced by the project team before February 2014.

### a. Detailed discussion of draft typologies

There was general agreement on the classification of the draft aquifer properties typologies, with small changes to the position of boundaries between typologies.

It was proposed that a second map illustrating the aquifer properties and groundwater typologies at 100-200 m depth should be produced.

There was significant discussion as to how the groundwater chemistry should be displayed. It was agreed that key contaminants which affect groundwater-use at a basin-scale, such as arsenic and salinity, should be shown explicitly within the maps where the contaminants are widely above guideline or threshold values.

### b. Dynamic response of groundwater to climate and abstraction

A key component of the final typologies of groundwater is the current and historic dynamic response of groundwater resources in the basin to climate and abstraction.

### c. Governance and land use

Josie Tucker (ODI) and Marcus Moench presented a timeline of groundwater use and governance strategies in the basin.

Key land and groundwater use issues within the upper, middle and lower regions of the basin were discussed within the groups, together with long term trends.

Available datasets on land use (e.g. cropping patterns, land use), demand (e.g. population data, irrigation abstraction volumes) and long-term trends were identified for different areas.

There was discussion about developing a series of four time slices of the groundwater system: pre development (pre-1850s); canals only (pre-1950s), mainly shallow pumping (current), deep pumping (potential future).



### d. Data required to finalise groundwater typologies

A significant amount of data is still required to be collated for the project to develop the final typologies of groundwater resilience, and the underlying typologies of aquifer properties, dynamic response and governance. The data so far collated by the project are shown in Figure 1.



#### **Key outstanding data sets to collect**

- Aquifer properties datasets still missing – to be delivered by December 2013
- Snapshot of Groundwater chemistry data on key contaminants – Arsenic and salinity
- Time series groundwater-level and groundwater chemistry datasets from different basin areas, and field station time series rainfall data
- Irrigation abstraction data, land use data (including cropping type and intensity), demand data (including population data)
- Governance and management practices.



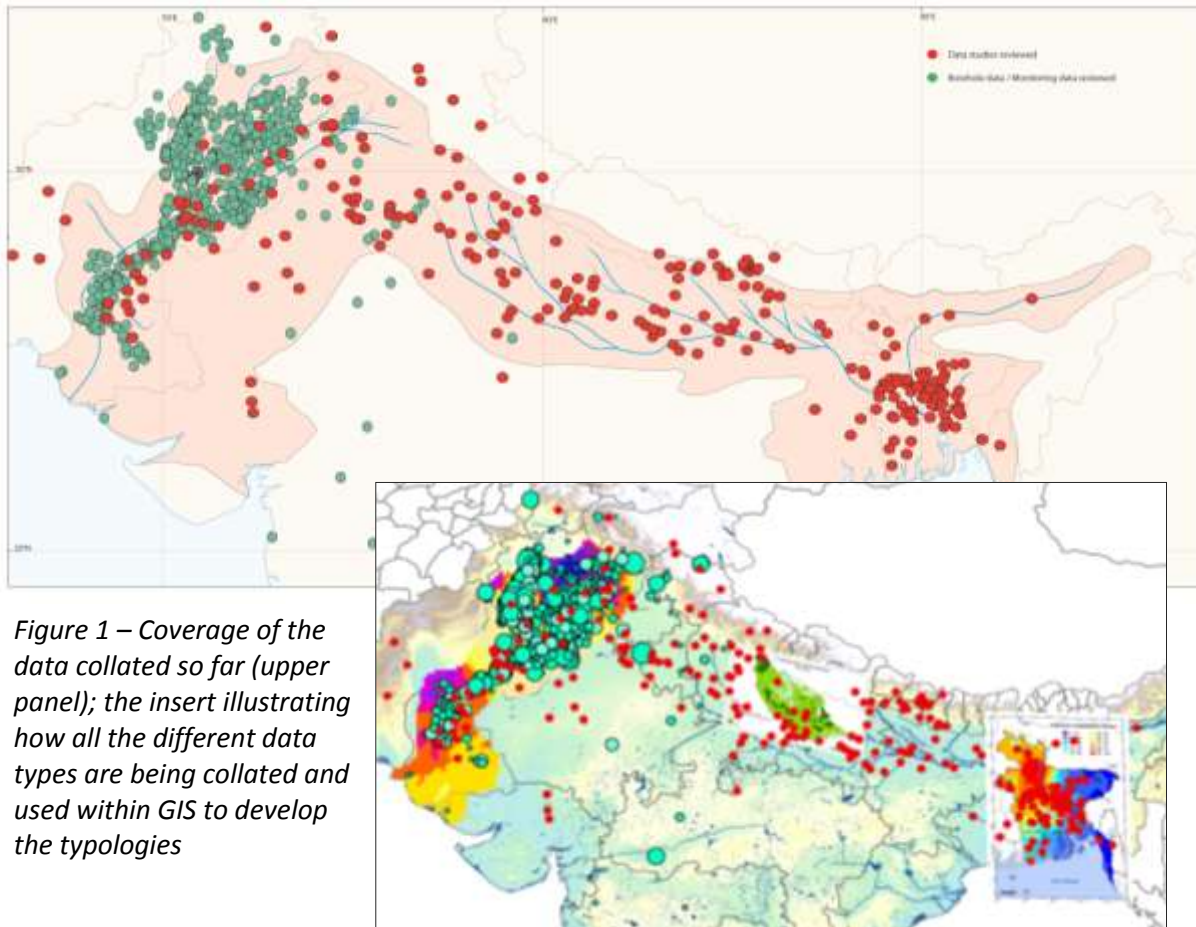


Figure 1 – Coverage of the data collated so far (upper panel); the insert illustrating how all the different data types are being collated and used within GIS to develop the typologies

#### e. Discussion of format of final typologies

The final map of typologies of groundwater resilience within the Indo-Gangetic basin is to be used at A3 scale. The typologies should *identify the essence of the current groundwater system*, and in particular how they respond to climate or pumping. Details about each typology, including any significant variations within the typologies (e.g. significant local groundwater quality issues) will be provided within the accompanying basin assessment report. This report will be a fundamental output from the project, providing an authoritative assessment of groundwater resources across the whole basin. The report will follow hydrogeological boundaries rather than political country boundaries.

Each of the data layers of the typologies (aquifer properties, groundwater quality, recharge and dynamic response) will be available as a discrete series of map layers from the project website.

Other maps, such as aquifer properties 100-200 m below ground surface, or the evolution of the groundwater system could be of significant value to the project.

Key contaminants which affect groundwater-use at a basin-scale, such as arsenic and salinity, should be shown explicitly.

Consideration should be given to making the input data available to other researchers. This can only be done where the copyright and IPR issues are straightforward, and pre-existing channels for data delivery within each country should be used where possibility.

## Guest lectures

Guest lectures were given over the course of the workshop by Cliff Voss (USGS), Fraser Sugden (IWMI Nepal) and Andy McKenzie (BGS) providing an overview of several other projects examining groundwater resources within the Indo-Gangetic basin, within key areas, from the Terai to the Bengal basin.

**Cliff Voss (USGS)** presented work by the USGS and others within the Bengal and Ganges basin, examining:

- Arsenic contamination and regional groundwater flow in the Bengal basin
- Mechanisms of seawater intrusion and potential impacts of sea-level rise on coastal groundwater resources
- Three different strategies of conjunctive use of groundwater and surface water within the central Ganges basin.



**Fraser Sugden (IWMI Nepal)** provided an overview of groundwater use in the Eastern Gangetic Plains, and described new research in 2014 which will examine the potential of utilising surface water storage for irrigation and conjunctive use with groundwater.



**Andy McKenzie (BGS)** presented an overview of the lessons and opportunities learnt from the India Hydrology Project 2 (2007-2013) – a project which was aimed at improving the knowledge base for water management in India. Capacity issues within institutions, data access, and lack of long-term records were highlighted as key constraints, while significant opportunities were also present with new technology, mapping projects, and increased recognition of the need for aquifer management.

## **Publications and dissemination strategy**

The basin assessment report, which will partner the typology maps, will be a fundamental output from the project, providing an authoritative assessment of groundwater resources across the whole basin. The report will form the basis for other outputs from the project, such as policy briefs, as well as delivering key project messages. The date of production is September 2014.

Reports will also be made for the individual case studies by July 2014.

The project website will be the key mechanism for distributing reports and hosting data and map downloads.

DFID has an open access data policy. Therefore, any primary data collected during the project should be made available to all within 2 years of the project end date.

There will be 2-page policy briefs developed at the end of the project with the help of the steering committee to help get the key messages to those that need to hear them.

Opportunities will also be sought to present the project findings to a range of stakeholders within the region, as guided by the steering committee and DFID.

### **Guiding principles for peer-reviewed publications within the project**

- Publications within high impact international journals are encouraged
- It will be important to wait until typologies and case studies have complete datasets and sufficient analysis before publishing to enable the papers to have the greatest chance of success in good journals. This may occur after the project end date.
- All potential publications should be submitted to the project manager (Alan MacDonald), to ensure all publications are coordinated and that coherent messages are presented. This will only apply for publications which directly stem from the project, and does not apply to subsequent indirect publications from the project and data.
- The source of any data which has been brought to the project will be respected when publishing, and permission sought to use any data.
- First authors of papers should be those project members undertaking and leading the work and writing.
- DFID have an open access policy. Therefore, open access journals are to be preferred.

## **Important Project Dates**

December 2013 – Final cut-off for remaining aquifer properties data to be reported to BGS (e.g. groundwater chemistry data, missing data from India, salinity data in Pakistan)

February 2014 – Long term high resolution time-series groundwater-level and groundwater-chemistry data to be deposited with BGS for development of final typologies.

May 2014 – Agreement of final typology map(s) between the project team and draft basin assessment report for editing by project team.

July 2014 – Case study teams to provide final report on case studies.

September 2014 – final version of basin assessment report to be agreed by project team and released.



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