

# India-UK Water Security Exchange Initiative - February 2016 Visit

## Final Report



# Hosts

The initiative is being coordinated by:



The visit is being managed by:



**Centre for  
Ecology & Hydrology**

NATURAL ENVIRONMENT RESEARCH COUNCIL

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HR Wallingford



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## Preface

This report outlines the conclusions of a visit by senior Indian water managers and decision makers to the UK in February 2016. The report is intended for India-UK Water Security Exchange Initiative participants and stakeholders. The document was authored by Harry Dixon (Natural Environment Research Council's (NERC) Centre for Ecology & Hydrology (CEH)), Gwyn Rees (CEH) and Martin Griffiths (Pillon Ltd) with input from other members of the visit Steering Group.

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# Acknowledgements

The initiative was coordinated by the UK Water Partnership, with financial and in-kind support from a range of organisations in both the UK and India. Thanks are extended to all those organisations and individuals who participated in the visit and were involved in its organisation. Particular acknowledgement is extended to Melissa Else at the UK High Commission in Delhi and the Government of India's Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Environment, Forest and Climate Change.

The concept and initial communications regarding the visit were channelled through the UK Water Partnership, identifying funding opportunities and potential content. Mark Lane and Martin Griffiths promoted the initiative through this and other channels. The Centre for Ecology & Hydrology (CEH) provided project management support and significant input into the initiative, with Harry Dixon, Gwyn Rees and Sandie Clemas responsible for much of the delivery and organisation.

This initiative could not have taken place without the funding from three primary sponsors: firstly, the UK Foreign and Commonwealth Office, specifically through the Prosperity Fund, administered via the UK High Commission in Delhi; secondly, the Natural Environment Research Council (NERC); and thirdly, the Scottish Government. Costain Group PLC provided additional financial support to the initiative.

The Department for Environment, Food and Rural Affairs (Defra) provided the room and hospitality for the Monday session and took leadership of the day. Particular thanks are extended to Alison Maydom and Hannah Le Pla. Pinsent Masons provided a room and hospitality for Tuesday and took the lead with organisation through Mark Lane and Eluned Watson. CEH provided rooms and hospitality for the week's remaining three days. HR Wallingford and the Environment Agency are thanked for the tour and demonstration the visiting delegation received on the Wednesday afternoon.

A project Steering Group was formed to oversee the visit, agree the agenda and identify speakers. They advised on risk and opportunity and took the lead on key aspects. Thanks are extended to Steering Group members who included Barry Greig, of the Scottish Government, Bob Ferrier, from the James Hutton Institute, and Perry Guess, of NERC.

All UK delegates, speakers and contributors are thanked for their input.

Finally, our thanks are extended to the Indian delegates and their organisations that released them to take part in the visit. We hope all will have benefited significantly and that networks and future opportunities are opened up as a result of this unique initiative.

# Executive summary

In February 2016 the UK invited a delegation of seven senior water managers and decision makers to take part in a high level exchange initiative to share knowledge on water security and the Ganga clean-up. A seven-day visit to the UK took place from 13<sup>th</sup>-20<sup>th</sup> February 2016, coordinated by the UK Water Partnership and funded by several UK organisations.

The initiative was announced in the [joint statement](#) between the India and UK following Prime Minister Modi and Prime Minister Cameron's meeting in London in November 2015, and was developed in response to an initial request for co-operation in the Ganga clean-up.

The Indian delegation comprised representatives of: the Central Water Commission, Central Groundwater Board, National Mission for Clean Ganges; Central Pollution Control Board Delhi Jal Board Patna University and the Indian Institute of Technology Roorkee.

The Initiative achieved its objective to develop knowledge-sharing links with key UK policymakers, regulators, researchers and water industry specialists. The links developed through this initiative will help UK and Indian organisations and companies build collaborations which will be beneficial to both the UK and India. Throughout the visit a number of areas for future India-UK collaboration were identified, as outlined in this report. The initiative concluded that the key cross-cutting themes for collaboration (see page 20) were:

1. Monitoring and Data
2. Decision Support Systems
3. Rural and Urban Water Management
4. Best practice in water law and regulation

A wide range of potential interventions were identified in each of these areas (see pages 22-26), along with possible UK and India organisations who could be involved.

To capitalise on the visit and maintain momentum in India-UK Water Security Exchange Initiative this report recommends the following specific actions are taken forward immediately (see page 27):

1. **Explore options for consolidating and formalising the links between the Indian Ministry of Water Resources (and specifically the National Mission for Clean Ganga) and the UK (specifically NERC, CEH and Defra).**
2. **Develop a framework for linking UK commercial water companies with potential Indian customers and partners.**
3. **Investigate options for a capacity building programme in water law and policy under the Scottish Hydro National agenda.**
4. **Consider ways of testing the applicability of Scottish approaches to rural water management in India.**
5. **Investigate the potential for corporate water reporting to assist in the delivery of water security in India.**

In order to capitalise on the visit and maintain momentum in development of India-UK partnerships around Water Security, it is recommended that the progress, if taking forward the potential collaborations and relationships highlighted in this report, is reviewed after six months (August 2016). The UK High Commission in Delhi will take the lead on this, setting up review meetings and/or an India-UK working groups as appropriate (see page 28).

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# Introduction

In February 2016 the UK invited a delegation of seven senior water managers and decision makers to take part in a high level exchange initiative to share knowledge on water security and the Ganga clean-up. A seven-day visit to the UK took place from 13<sup>th</sup>-20<sup>th</sup> February 2016, coordinated by the UK Water Partnership and funded by several UK organisations. This report provides an overview of the visit and outlines a number of areas where India-UK collaboration could be expanded in the field of water and catchment management. A series of key recommendations are made regarding the future development of the India-UK Water Security Exchange Initiative.

The initiative was announced in the [joint statement](#) between the India and UK following Prime Minister Modi and Prime Minister Cameron's meeting in London in November 2015, and was developed in response to an initial request for co-operation in the Ganga clean-up. It followed a fact-finding mission by the UK to India in March 2015.

## Visit coordination and funding

The visit was coordinated by the UK Water Partnership and supported by a number of organisations. It was managed by the NERC [Centre for Ecology & Hydrology](#) (CEH) with support from funders (UK Foreign & Commonwealth Office, Scottish Government (specifically through the [Hydro Nation initiative](#), NERC and Costain Group), the [Department for Environment, Food and Rural Affairs](#) (Defra) and the [James Hutton Institute](#) (JHI).

A Project Steering Group was established to coordinate the visit, details of its membership are given in Annex 1.

## Background

Prime Minister Modi has made the clean-up of India's rivers a priority for action. The showpiece is the clean-up of the River Ganga and the National Mission for Clean Ganga (NMCG). Responsibility for the river's management lies with the Ministry of Water Resources, River Development and Ganga Rejuvenation and the Honourable Minister Uma Bharati. The most recent version of Ganga River Basin Management Plan (2015) sets out an action plan for short-term (3 years), medium-term (5 years) and long-term (10 years +) to clean the river.

Water management is an area of UK commercial and policy expertise and the River Thames experience is widely cited in India as a model for successful river clean-up. A UK mission to India in March 2015 identified potential areas of collaboration in governance and regulation, potential ongoing science and innovation links and significant opportunities for India-UK engagement in the water sector. The UK has many skills in these areas, not least due to similarity of its administrative and legal systems. Water planning and protection capability in the UK has resulted in significant improvements in water quality and water security, and strengthening India-UK links in this area is considered likely to bring significant benefits to India and opportunities for partnership with the UK water sector.

The India-UK Water Security Exchange Initiative aims to increase Indian water management capability to plan and implement the Ganga Action Plan and other water activities. If water infrastructure is improved, impacts will be seen in terms of improved public health, improved water supply and sewage treatment. Ultimately, enhanced water security and improvements to the water environment will be achieved.

In 2015, the UK Water Partnership, working with other organisations in the UK water sector, initiated the idea and sought then to develop a progressive and informative agenda for a visit by senior Indian water managers and decision makers to the UK. The visit was designed to bring together UK key policymakers, regulators, researchers and water industry specialists to engage with Indian counterparts. The initiative aimed to promote direct engagement between UK and Indian water planners and implementers, so as to exchange knowledge on governance and regulation, science and innovation, and UK water sector capability.

## Visit structure

The initiative brought seven influential water managers and decision makers from India to the UK in February 2016 for a one week intensive exposure to the UK water sector. The visit's intention was to raise awareness amongst the Indian delegation with a view to ultimately helping India strengthen its competences and capabilities in freshwater and wastewater management. This would be achieved through presentation of UK approaches to regulation, permitting and enforcement. In addition, it aimed to consolidate water research links and provide an opportunity to demonstrate innovation and implementation of research findings into policy and strategy. The visit included a number of specific components:

1. **A national perspectives day** exploring UK and EU water strategies, including a focus on the clean-up of the River Thames and other UK rivers. This was London-based and included contributions from Defra, Pinsent Masons, Scottish Hydro Nation and the UK Water Partnership. Diplomatic and government contributions welcomed delegates and set the context.
2. **A core workshop on strategic water planning, governance and regulatory best practice.** Held over two days, the workshop explored technical, social and legal issues. UK experts presented regulatory principles of water strategy, permitting, enforcement and stakeholder communication. The workshop brought experts from the Environment Agency, Thames Water, consultancies and other key disciplines together with Indian delegates to develop and consider options for India.
3. An **innovation forum** focusing on what NERC (and RCUK) science innovation and research can contribute to sustainable water management in India. The one-day event drew on the experiences of those already involved in technical development and research activities in a full day of networking and interaction. The forum involved UK water scientists and practitioners, as well as commercial innovation companies/organisations having interests in India.
4. A **final wrap-up day and forward look** was facilitated, allowing Indian and UK experts to work together to consider options for improving water security and future collaboration.

The visit was managed by the CEH, with the first part of the week based in London, at Defra and [Pinsent Mason's](#) headquarters, and the latter part of the week at CEH's offices in Wallingford. Throughout the visit, two way interaction was encouraged and Indian experts were invited to outline key gaps and needs for improving water security in India. While such presentations were focussed on the clean-up of the Ganga, other examples were sought.

# Participants

## Indian delegation

To ensure a broad spectrum of experts from the key organisations that influence water security development and implementation in India, the Indian Ministries of Water Resources, River Development and Ganga Rejuvenation and Ministry of Environment and Forests were invited by the British High Commission, New Delhi to nominate individuals to partake in the visit.

Delegate selection guidance was developed with a aim to include senior scientists, engineers or managers (of around the level of Scientist 'G', Chief Engineer or Director) who are actively working on institutional aspects, regulator instruments and policy formulation related to water resources management at national or state level.

The support of nominating organisations meant that a delegation of seven Indian experts from the above organisations and some additional bodies was identified and permitted to travel to the UK for the visit. The delegation comprised:

Name	Title	Organisation
Mr M.P. Singh	Chief Engineer (P)	Central Water Commission
Dr Dipankar Saha	Member (SAM)	Central Groundwater Board
Mr Hari Har Mishra	Director (Finance)	National Mission for Clean Ganga
Mr Suneel Dave	Additional Director	Central Pollution Control Board
Mr Radhey Shyam Tyagi	Member Water	Delhi Jal Board
Prof. Ravindra Kumar Sinha	University Professor and Head of Zoology Department, Environmental Biology Laboratory	Patna University
Prof. Arun Kumar	Professor and MNRE Chair Professor, Alternate Hydro Energy Centre	Indian Institute of Technology Roorkee



**Figure 1** Indian Delegation (Left to Right: Mr M P Singh, Mr Hari Har Mishra, Prof. R K Sinha, Mr R S Tyagi, Mr Dipankar Saha, Mr Suneel Dave, Prof. Arun Kumar).

## UK participants

A wide range of UK individuals and organisations were invited to participate in the visit. Over the course of the week, the Indian delegation had the opportunity to meet with 75 different individuals from 39 organisations. The broad spectrum of participants from the research, commercial, regulatory, legal and government sectors ensured that the delegation were able to explore opportunities for future India-UK collaboration in many fields. A full list of UK delegates is given in Annex 2.



**Figure 2** Participants in Wallingford on Day 5 of the visit.

## Visit programme

The following table provides an outline of the agenda and activities undertaken during the week. A full agenda and details of speakers, presentations and other attendees is provided in Annex 3.

Day	Programme	Venue
<b>Monday 15 February 2016</b>	<b>National Perspectives Introductory Day:</b> This one day meeting explored key water security issues. High level presentations were given by policy makers from UK and India outlining key challenges and opportunities for international collaboration. The day was hosted by Defra at their head offices in Whitehall.	Defra Headquarters, Whitehall, London
<b>Tuesday 16 February 2016</b>	<b>Regulatory Workshop (Day 1):</b> The first day of the workshop provided an industry focus, allowing delegates to meet senior consultants, water lawyers and other businesses. The afternoon included an initial training session on water regulation, strategy and governance and an opportunity to meet water industry representatives. The day was hosted by Pinsent Masons at their head offices in the City of London.	Pinsent Mason Headquarters, City of London
<b>Wednesday 17 February 2016</b>	<b>Regulatory Workshop (Day 2):</b> The second day of the workshop included interactive sessions on regulation, focusing on both water quality & water quantity. Presentations were made by UK regulatory authorities, water companies and engineering consultancies. A demonstration of field monitoring capabilities and tour of HR Wallingford's hydraulic modelling laboratories was provided. The day was hosted by CEH at their head offices in Wallingford.	CEH Headquarters, Wallingford, Oxfordshire
<b>Thursday 18 February 2016</b>	<b>Research and Innovation Forum:</b> The forum included presentations by UK water scientists. Discussions focused on how UK environmental science and innovation can contribute to meeting India's water security needs. The day was hosted by CEH at their head offices in Wallingford.	CEH Headquarters, Wallingford, Oxfordshire
<b>Friday 19 February 2016</b>	<b>Future Collaboration Wrap-up Day:</b> Key contributors to the visit were brought together to review the week and explore options to build on the visit to further enhance India-UK collaboration. The day was hosted by the CEH at their head offices in Wallingford.	CEH Headquarters, Wallingford, Oxfordshire

## Presentations

All presentations from the week can be found online at: <http://www.ceh.ac.uk/news-and-media/blogs/india-uk-water-security-exchange-initiative-report>

# Overview of issues and opportunities by sector

This section of the report provides details of the discussions and presentations across the key sectors covered during the first four days of the visit. The first day focussed on national perspectives, the second on legal/regulatory issues and commercial capability, the third on catchment management and implementation and the fourth day focussed on research and innovation. For each sector the report outlines the key elements of the programme and areas identified for future engagement and assistance between the UK and India on Water Security issues.

## National perspectives

### Key Outcomes, Forward Steps and Contacts

- Potential to consolidate and formalise links between the Indian Ministry of Water Resources and Defra  
Key UK contact: Alison Maydom (Defra);
- The UK Water Partnership can help in linking Indian and UK organisations/individuals  
Key UK contact: Mark Lane (UK Water Partnership);
- The Scottish Government's Hydro Nation agenda can help develop India-Scotland project and initiatives  
Key UK contact: Barry Greig (Scottish Government);
- Potential MoU between the Indian Ministry of Water Resources and UK Natural Environment Research Council  
Key UK contact: Ruth Kelman (NERC).

The first day of the visit allowed delegates to gain an overview of key issues and provided context of the visit. It gave an understanding of the importance of governance and regulation in driving water protection and clean-up.

Sonia Phippard (Defra) and Paul Leinster (Cranfield University and ex-Chief Executive of the Environment Agency) gave an overview of UK Water regulation and governance: specifically, the relationships between government and the need for independence in the Environment Agency in acting as government's agent in delivering water planning and regulation. In terms of UK to Indian government interaction Defra is the lead department on these issues. Ashley Holt, from Defra, has been working on the UK Catchment Based Approach and provided a powerful argument for social engagement in changing attitudes and local responsibility and action. Defra will be a core link for India for sharing expertise and best practice for innovative approaches and regulation of the water sector.

The UK's environmental regulators are a key knowledge resource in this area and links were made to the Environment Agency for England and to the Scottish Environment Protection Agency (SEPA). Natural Resources Wales and Northern Ireland Environment Agency also take this role in the devolved government organisations. Paul Leinster, former Chief Executive of the Environment Agency and now a Professor at Cranfield University, conveyed his significant personal knowledge of regulation in his presentation and his access to university teaching resources may provide a route to capability development.

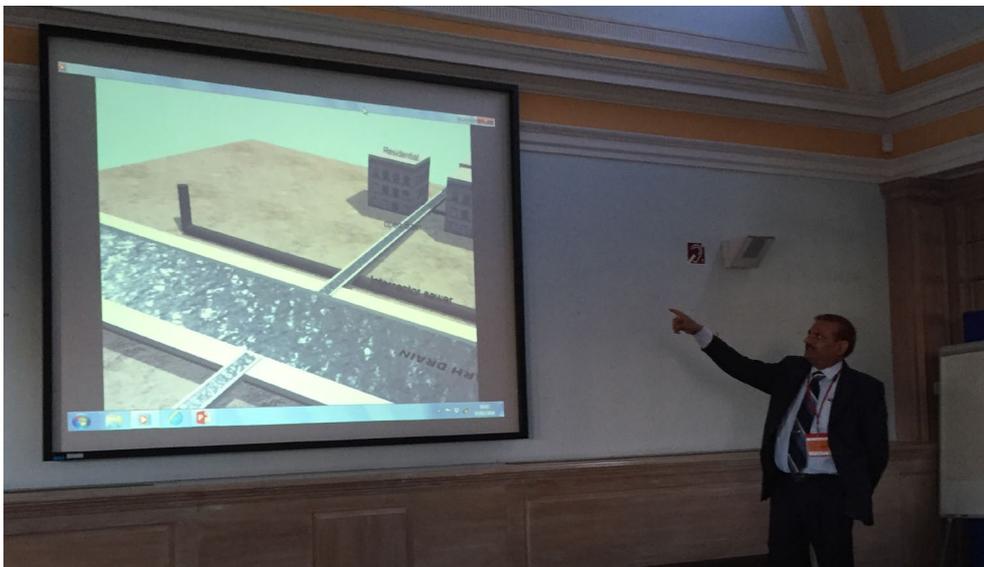
Director Hari Har Mishra (National Mission for Clean Ganga) gave an excellent overview of the National Mission for Clean Ganga, giving priorities and a progress report. This gave useful information for the UK presenters and UK businesses needing to understand the needs in India.

The UK Water Partnership was outlined by Mark Lane (UK Water Partnership). This is an important cross sectoral initiative bringing together water expertise. This visit is an example of how this can bring the wide range of disciplines together to help solve specific issues. The UK Water Partnership will be an

important link for India and should be able to suggest individuals, teams, engineering companies and research organisations needed by India.

The Scottish Government's Hydro Nation agenda is a powerful model for focussing on water resource development and value across Scotland, and also supports knowledge exchange internationally. The initiative was outlined by Bob Irvine (Scottish Government). Hydro Nation will be a key contact point for India in accessing the knowledge, skills and infrastructure development potential offered by Scotland. The Scottish Government is sponsoring this development initiative and Barry Greig (Scottish Government) will be a key contact here. Hydro Nation brings together central government working closely with Scotland's Centre of Expertise on Waters (CREW) - which links all of Scotland's universities and research bodies - and economic development agencies, particularly Scottish Development International through their offices in country to strengthen links with India. The Scottish Government's International Development Strategy identifies India as a key territory and promotes the development of projects which will build on existing links and contribute to improving the lives of people in India

NERC is progressing the research and innovation initiatives in India on behalf of the UK universities and research centres, including CEH and the British Geological Survey (BGS). Ruth Kelman (NERC) provided an overview of current and future water initiatives and the intention to focus additional resources into India. This includes the proposed NERC/Indian Ministry of Earth Sciences Virtual Joint Centre Water Security and the Newton-Bhabha funded research programme entitled "Sustaining Water Resources for Food, Energy & Ecosystem Services in India". Ruth Kelman will be a key contact in this and may be able to secure an enhanced MOU on these subjects. She will be visiting India soon and will follow this up.



**Figure 3** R S Tyagi of the Delhi Jal Board presenting details of the Yamuna Action Plan.

Chatham House has undertaken studies in India and have specific skills on negotiation and mediation, especially on cross international border rivers and other water security issues. An outline of these projects was provided by Glada Lahn (Chatham House). Chatham House may be a useful contact as the Ganga Clean-up Plan develops.

British Water is a membership based organisation supporting a wide range of commercial companies, big and small, that may help in infrastructure development, monitoring and optimisation. Paul Mullord (British Water) attended the visit. They are a useful contact point for accessing equipment and water engineering capability.

Finally, there was a session on the development of interceptor sewers in Delhi to protect the Yamuna River and in London to protect the Tidal Thames. Rahhey Shyam Tyagi (Delhi Jal Board) and Martin Griffiths (Pillon Ltd) provided this understanding on these key initiatives to improve public health and the environment. There is significant capability and ongoing need to optimise and further develop this essential infrastructure. The final phase of the Thames 'super-sewer' is being implemented in London by Thames Water over the next five years. This sewer tunnelling capability may be useful for India and the links can be made if required.

## Legal/regulatory issues and commercial capability

### Key Outcomes, Forward Steps and Contacts

- Significant capability in water law exists in the UK which could be beneficial to India  
Key UK contacts: Mark Lane (UK Water Partnership), Eluned Watson (Pinsent Masons), Fiona Parker (Shepherd and Wedderburn);
- Clear potential to develop a capacity building programme in water law and policy under the Scottish Hydro National agenda  
Key UK contacts: Barry Greig (Scottish Government), Alan Sutherland (Water Industry Commission for Scotland); Andrew Allan (University of Dundee);
- UK commercial water companies already operate extensively in India but there is significant potential for them to offer addition/expanded services. A framework for connecting Indian customers to UK companies is needed  
Key UK contact: Mark Lane (UK Water Partnership);
- Corporate water reporting has the potential to assist in the delivery of water security in India  
Key UK contact: Kate Lamb (CDP).

The second day of the visit was aimed at introducing delegates to the legal capability and the regulatory governance structures in the UK and their potential application in India. The day formed the first part of the core two-day workshop on regulation management. The afternoon of day two added an industry focus providing the opportunity to meet senior consultants and other water businesses with presentations and discussion sessions.



**Figure 4** Eluned Watson from Pinsent Masons providing an overview of approaches to water law and regulation in the UK and EU.

Paul Rice (Pinsent Masons) and Eluned Watson (Pinsent Masons) gave an overview of Pinsent Masons, legal capability and views on current and future UK and international water law developments. Mark Lane (UK Water Partnership) added the water innovation perspective and the legal opportunities needed to secure investment and bringing innovation to market. This is a significant capability offered by Pinsent Masons and this can be accessed via Mark Lane and the UK Water Partnership or directly with Pinsent Masons.

Suneel Dave (Central Pollution Control Board) provided an overview of areas of interest in India in relation to water legislation, highlighting a number of challenges in relation to water quality issues in particular.

A successful and informative workshop session was undertaken by Alan Sutherland, [Water Industry Commissioner for Scotland](#) (WICS) and Fiona Parker from Scottish law firm, [Shepherd and Wedderburn](#). This provided a first principles view of water industry regulation as applied to Scottish Water, a government owned water company. Many of these principles are directly relevant to India and provide future models to drive water investment and build and optimise water infrastructure.

During the session presentation on the Tuesday and again during the wrap-up session on the Friday, Alan Sutherland sought to emphasise the importance of having a clear strategic vision for water. This vision needs to be clearly articulated and to have a series of very well-defined and measurable way points. It is important to understand the resources that will be required to achieve each of these specific and measurable outcomes. This is the role that a regulatory office can usefully play. The regulator can act as the repository of consistent and well-defined information that allows performance against the objectives to be measured and scrutiny maintained on the costs of making progress.

The creation of a 'regulatory' function of this type will only be fully effective if there is clear governance of the water sector (in a broadly defined sense). From discussions during the visit, it is clear that, in the Indian context, this would be likely to mean water resources, supply, drainage and flooding well beyond the normal function of a traditional water utility. There will be many different actors and there needs to be a clear and well-defined governance process that allows each interested party to contribute and to take responsibility. Critically, these interested parties will have to be prepared to delegate responsibility for delivery to an entity (or even an individual) who is sufficiently empowered to get what it/he/she needs from the actors with a role in the system. For this to work, the monitoring of performance/delivery will need to be robust. This in turn requires the capture of the well-defined and specific information referred to earlier. It underlines the potential importance of an organisation delivering this 'regulatory' function. In the WICS view, in order to define, collect and analyse the information that will support effective delivery, there needs to be substantial competence in maintaining a strategic overview. This will require the 'regulatory' function to work very closely (even if at arm's length) with the policy owners in Government. In light of the Indian delegation's interest in this areas and expertise available in the UK, particularly in Scotland, this area will be followed up via the Scottish Hydro Nation contacts. A visit to India (New Delhi) by WICS and Shepherd and Wedderburn in April 2016 will link to the Scottish Hydro Nation programme.

Andrew Allen of Dundee University's UNESCO [Centre for Water Law, Policy and Science](#) provided an overview of their work in developing trans-boundary water law in Asia. This was seen as especially relevant to the Indian issues and there is likely to be direct follow up from the Indian delegation. Links can also be made via Scotland's Hydro Nation programme.

The principles of water permitting and regulation were developed by Chris Chubb (Chris Chubb Environmental Policy Consultancy) and Martin Griffiths (Pillon Ltd), former water policy experts from the Environment Agency. The regulatory cycle was discussed and issues of setting permit standards, compliance assessment, enforcement and prosecution were explored. More information and possible training could be accessed either via Defra and the Environment Agencies, or via potential training courses at Cranfield University. The book 'Regulation for Water Quality' was given to delegates for future reference and access to the hyperlinks via the free online book available on the Foundation for Water Research web site at <http://www.fwr.org/WQreg/index.htm>.



**Figure 5** Delegates on Day 2.

An afternoon water industry session allowed a number of UK consultants, contractors and businesses to meet the Indian delegation and give short presentations on their capabilities. The companies presenting included:

- [Costain Group](#) – A leading engineering solutions provider;
- [Arup](#) – A global firm of consulting engineers;
- [Mott McDonald](#) – A global engineering, management and development consultancy;
- [Syrinx](#) – A provider of intelligent pipeline monitoring;
- [Mfatech](#) – Produces of the Water Advisory Demand Evaluation & Resources Toolkit (WADER);
- [Brunel University](#) – Partners in a new project entitled INTCATCH 2020;
- [CDP](#) – An NGO who aim to driver sustainable economies.

All can be contacted directly or via the [UK Water Partnership](#).

The CDP presentation, by Cate Lamb, on company corporate responsibility was seen as particularly relevant and this is likely to be followed up from India.

Mfatech are keen to find someone to help move forward their WADER project, which was presented during the visit, so that they can deploy WADER into the Indian market. They are looking to set up a link with a University and an IT company who could act as a distributor and to work with NGO's in the region using WADER as a tool for Epidemiological research. At a Government level Mfatech have made contact with Dipankar Saha and would like an opportunity to discuss things further with him.

## Catchment management and implementation

### Key Outcomes, Forward Steps and Contacts

- The UK's experience in implementing the EU Water Framework Directive offers potential models/methods/solutions which could be translated into India;
- The applicability of Scottish approaches to rural water management could be tested in India  
Key UK contacts: David Harley (SEPA), Bob Ferrier (JHI);
- Aspects of UK capability developed in relation to the management of the Thames catchment are directly transferable to the Ganga  
Key UK contacts: Steve Tuck/Sarah-Jane Westlake (Thames Water), Ben Piper (Atkins).

The third day of the visit covered the practical issues of water catchment management, the EU Water Framework Directive, monitoring, community engagement and decision making, in England and Scotland. Sessions focussing on water quality, conservation, water quantity and water security were given by [Thames Water](#) and [Atkins](#). [HR Wallingford](#) gave an overview of their capability. The [Environment Agency](#) gave a field demonstration of flow monitoring using ADCPs mounted on remote control boats (a joint venture with the HR Wallingford). A visit to the HR Wallingford physical models used for structural engineering and testing infrastructure was given.

Mark Bailey, CEH Director, welcomed delegates to Wallingford and outlined CEH's mission and objectives. He described CEH's long tradition of conducting research in India, reaffirmed CEH's continuing commitment to India, and expressed his wish to see yet further mutually beneficial engagements between CEH and Indian organisations in future.

The development and implementation of the EU Water Framework Directive forms the basis for water planning across the EU and in the UK. Most of the presentations explored elements of this implementation across the UK.

- Alistair Driver (Environment Agency) gave a presentation on the work by the Environment Agency in the River Thames. This focussed on his work on river and habitat restoration, including the use of the Thames River Prize to assist in river conservation in India. Synergies were identified with this work and the restoration work being considered for the River Yamuna.
- Tony Warn (Independent) considered the information needed for decision making in water protection and improvement. It included his work on SIMCAT and the need for statistical understanding of the risks and variables. Much of this work has direct potential for optimising and prioritising clean-up work on the Ganga.
- David Harley ([Scottish Environment Protection Agency](#), SEPA) gave a complementary presentation on WFD implementation in Scotland. His focus on diffuse pollution and working with small farmers and rural communities struck a chord. The Indian delegates were keen to follow this up, via Scottish Hydro Nation.

Professor Sinha (Patna University) gave a presentation on conservation and biodiversity issues on the Ganges, with special focus on his work on the freshwater dolphins. This directly aligns with the biological and ecological approaches taken by the EU Water Framework Directive. Exchanges on biological databases, indexes and assessment methods would be of direct interest.

Two presentations from Thames Water representatives Steve Tuck and Sarah-Jane Westlake gave a view of water resources and water quality from a regulated, privatised water company's perspective. Thames Water's capability for infrastructure delivery, optimisation and water resource planning for the Thames catchment, including London, is relevant to Delhi, and some aspects will be directly transferable. The links to planning for water security for London and the input from Atkins and other consultants is critical to delivery by

Thames Water. Ben Piper gave a useful overview of Atkins capability in this field. The close links between CEH, Atkins and Thames Water at informal and formal level shows the advantages of close collaborative working within these fields.

HR Wallingford is a specialist consultancy situated next door to CEH. Initially a government research organisation, this shows a model for privatisation and the formation of a specialist niche company. Andy Brown gave an overview of HR Wallingford capability and its physical modelling capability. The Environment Agency (South East Region) is co-located on the HR Wallingford site and was able to demonstrate their hydro-acoustic (ADCP) remote-controlled boats for accurate monitoring of river flows. With HR Wallingford and Brunel University, the EA are exploring the potential of the boat also being a platform for water quality monitoring. Delegates thought such technology would be useful in India.



**Figure 6** Demonstration of the Environment Agency's ADCP river flow monitoring capabilities on the River Thames.



**Figure 7** Demonstration of of HR Wallingford's Froude Hydraulic Modelling Laboratories.

### Key Outcomes, Forward Steps and Contacts

- NERC and the India Ministry of Earth Sciences are planning to launch a Joint Virtual Centre for Water Security  
Key UK contact: Ruth Kelman (NERC);
- CEH is committed to building further science collaborations with Indian organisations  
Key UK contact: Alan Jenkins (CEH);
- Significant science collaborations exist between India and the UK, including joint programmes. There is potential to expand these collaborations  
Key UK contact: Ruth Kelman (NERC);
- UK experience in fostering innovation and transferring research into commercial opportunities could be useful in India  
Key UK contact: Jonathan Abra (KTN).

The aim of the Innovation Day at CEH was to focus on what NERC science innovation and research can contribute to sustainable water management in India. It drew on the experiences of many who already are actively involved in technical development and research activities in a full day of networking and interaction. A series of scientific and technical presentations were made and a variety of posters were displayed around the room, all with the aim to prompt and provide stimulus for facilitated break-out and plenary discussions later in the afternoon. Commercial innovation companies and organisations with interests in India also attended and exhibited products.

The 40, or so, participants from industry and academia were welcomed by the chair, Perry Guess, Head of Knowledge Exchange at NERC, who also set-out the day's programme. Indian delegation member, Arun Kumar, of IIT Roorkee, gave a keynote lecture on the challenges in India and presented a list of research needs, which included research into:

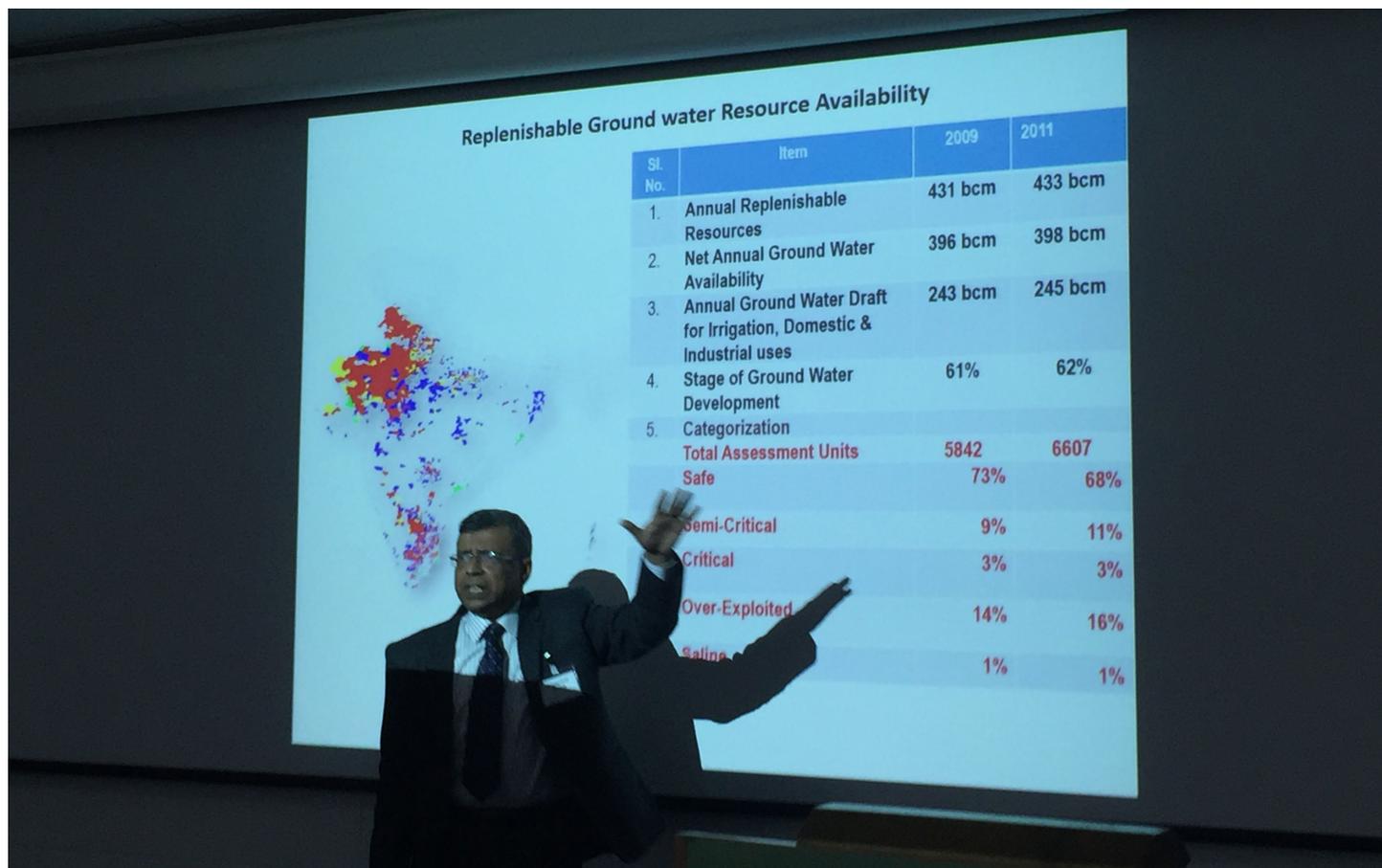
- Improved irrigation and agricultural water use;
- Improved and cost-effective sewage treatment;
- The effects of urbanisation, land-use and climate change;
- Environmental flow requirements;
- Assessment of point and non-point source pollution;
- Bio-monitoring technologies.

Ruth Kelman, Head of Freshwater Science at NERC, described the various programmes and initiatives NERC have been supporting in India, mostly in collaboration with the Government of India Ministry of Earth Sciences (MoES), including the Changing Water Cycle and the South Asian Monsoon programmes. She drew attention to the new Newton-Bhabha NERC-MoES-funded Sustainable Water Resources programme, which is about to start in April 2016 with three projects, in the Upper- and Lower-Ganges and Peninsular India respectively, and the proposed new India-UK Joint Virtual Centre for Water Security research, on which an announcement would be made shortly. Gwyn Rees, Science Area Lead for Water Resources at CEH, gave a brief presentation on CEH's extensive interests and activity in India, which range from E-flows modelling in the Narmada Basin and bio-monitoring in the Ganges to modelling the impacts of climate change on glacier-fed river flows and the South Asian monsoon. Andrew McKenzie, of BGS, similarly gave an account of his organisation's activity in India, including their work on groundwater resilience to climate change and abstraction in the Indo-Gangetic basin, the monitoring of groundwater levels and recharge in the Punjab, and links between sanitation and groundwater pollution in Bihar.

A series of short presentations then followed from representatives of NERC-funded projects in India: Nick Chappell, Lancaster University, on "Hydrologic and carbon services in the Western Ghats: Response of forests & agro-ecosystems to extreme rainfall events"; Inrani Roy, Exeter University, on "South Asian Precipitation: A Seamless Assessment (SAPRISE)"; Paul Whitehead, University of Oxford, on "Impacts of

Climate Change and Socioeconomic Change on flows and nutrients in the Ganges”; Alex Dunsmore, Durham University, on “The structure and dynamics of groundwater systems in north western India”.

Richard Allan of the [James Hutton Institute](#) (JHI) and Scotland’s [Centre of Expertise for Waters](#) (CREW) presented his organisation’s work on “Sustainable Rural Communities: Research and Innovation” and described the challenges of involving communities in local water management, of optimising nutrient use, and of providing low-cost solutions to waste management.



**Figure 8** Dipankar Saha, CGWB, presenting “India’s Aquifer Mapping Programme” on the Innovation Day.

In the second keynote, delegate Dipankar Saha, of India’s Ministry of Water Resources, River Development and Ganga Rejuvenation, Central Groundwater Board (CGWB) gave a comprehensive description of “India’s Aquifer Mapping Programme”. Providing the context for the Programme, he set out the key groundwater management challenges that the country faces, including over-exploitation, limited availability and unregulated abstraction of groundwater, its under-utilisation in eastern parts, water-logging, contamination and climate change.

The final presentation was given by Jonathan Abra, Theme Leader, Water & Wastewater, of the Innovate UK Knowledge Transfer Network (KTN). Through examples and case studies, he outlined the opportunities and support available (e.g. UK Science Innovation Network) for the promotion and implementation of commercial initiatives and product development between the UK and India.

The afternoon of Day 4 featured three facilitated breakout-discussions and a concluding plenary discussion. The breakouts focussed on the same pair of questions:

1. “What are the research questions where India needs or wants UK/International help?”, and
2. “What are the research questions where UK/International community believe they can offer support/advise”.

At least two members of the Indian delegation and equal numbers of UK participants joined each breakout. The raw notes from each breakout are shown in Annex 4. In summary, the challenges that Day 4 participants generally thought UK expertise in research and innovation could help India tackle were:

- Provision of safe, clean drinking water from both surface and groundwater sources;
- Understanding the effects of abstractions and the over-exploitation of surface and groundwater;
- Managing the water demand and improving water-use efficiency, especially in agriculture and irrigation;
- Appropriate, affordable and readily available technologies for wastewater treatment, including rural community scale systems;
- Understanding point- and diffuse-sources of pollution and the fate of pollutants and contaminants in the environment;
- Defining or establishing realistic/appropriate targets for environmental flow to protect and restore freshwater ecosystems;
- Engaging stakeholders and communities in policy and decision making and in addressing local water management and ecosystem protection issues;
- Understanding the effects of climate change and the development of models and suitable scenarios of change;
- Rapid deployment of new energy- & cost-efficient technologies - instruments, methods, tools – e.g. eDNA, low-cost sensors;
- Environmental monitoring and data management and generation of added-value data products and information;
- Knowledge transfer and capacity building e.g. specialist training, tertiary education, secondments, bilateral collaborations.



**Figure 9** Facilitator Anita Jobson, of CEH, presenting discussions and conclusions from one of the three breakout groups.

# Cross-cutting themes for future collaboration

The fifth day of the visit reviewed the week to ensure that future actions and opportunities were identified. This aimed to allow clear access for India to UK water capability and cement ongoing partnerships. Alan Jenkins, Deputy-Director and Director of Water and Pollution Science at CEH facilitated the session to and enabled open and progressive discussions. The sessions were designed to allow the development of this final report, which will be published and shared widely.

Four cross-cutting themes for future India-UK collaboration were identified to complement the daily overviews above:

1. **Monitoring and Data** (particular areas of focus included: SMART monitoring systems, surface and groundwater monitoring networks, effluent and pollution monitoring, collection of abstraction data and biodiversity observations);
2. **Decision Support Systems** (including hydrological modelling, the setting of environmental flows, agricultural water use and climate change impact assessment);
3. **Rural and Urban Water Management** (including: approaches to rural water supply and sustainable rural communities, urban infrastructure optimisation, sustainable urban drainage systems and river restoration);
4. **Best practice in water law and regulation** (including: design of national and interstate law and regulation, environmental protection and improvement through regulation, implementation of permits and regulatory options, economic assessment, financial and business planning).

The meeting considered each of these areas in turn, identifying the key expertise and experience which could be exchanged between the two countries and the potential interventions which could provide vehicles for collaboration. Where possible the organisation(s) in India and the UK best placed to take forward collaboration were identified.



**Figure 10** Mark Lane from the UK Water Partnership concluding the visit at CEH in Wallingford on Day 5.



**Figure 11** Hari Har Mishra from the National Mission for Clean Ganga introducing a film produced by the National Mission to highlight the importance of the river to the general public.

The tables below summarise the ideas put forward at the meeting. The tables are an initial assessment of issues for future development and interaction and contain examples of possible interventions and partners. They were not designed to reflect all potential India-UK activities or all possible organisations which may be involved as India-UK collaboration grows. Over coming months the ideas contained in the tables should be developed further by both sides.

## Monitoring and data

Area of Expertise/Experience to be Exchanged	Potential Intervention	Potential Organisations to Involve
<p><b>Pollution Monitoring</b></p> <p>Including: Methods for studying pollution load from fertilisers and pesticides (including POPs, PCBs, pharmaceuticals and other emerging contaminants); establishing baseline data (for example on industrial chemicals, heavy metals and faecal loads); developing understanding of the interaction of pollutants between aquifers, rivers and surrounding river banks; biodiversity monitoring; understanding the impacts of changing farming practice and management.</p>	<ul style="list-style-type: none"> <li>• Collaborative isotopic studies (especially in relation to nutrients);</li> <li>• Joint efforts to establish baselines;</li> <li>• Sharing experience and lessons learnt in the design of cost effective frameworks for monitoring, the telemetry/storage/management of data and information analysis. Sharing technical solutions for data collection/analysis/archival/publication;</li> <li>• Joint assessment of existing datasets and monitoring practices to collate information on which organisations are collecting data, for what reason and what data policies are employed. Advice on the use of data from the private sector.</li> </ul>	<p>India: CPCB (in relation to pollution loads), CGWB (in relation to groundwater), ICAR</p> <p>UK: CEH and JHI (in relation to research), SEPA (in relation to Scottish regulation and operation monitoring practices)</p>
<p><b>Surface and groundwater interactions</b></p>	<ul style="list-style-type: none"> <li>• Research studies to improve the understanding of surface-groundwater interactions across India.</li> </ul>	<p>India: CWC, GBWB</p> <p>UK: CEH, BGS</p>
<p><b>Collection and use of socio-economic data to inform water management</b></p>	<ul style="list-style-type: none"> <li>• Possible future initiative involving SEPA on linking environmental and social data</li> </ul>	<p>India: National Mission for Clean Ganga</p> <p>UK: SEPA</p>
<p><b>Water use efficiency</b></p>	<ul style="list-style-type: none"> <li>• Collaborative research to improve understanding of agricultural water use efficiency. UK experience in relation to new methods of soil moisture measurement (COSMOS) could be a particular focus.</li> </ul>	<p>India: Ministry of Water Resources</p> <p>UK: Atkins, CEH</p>

## Decision support systems

Area of Expertise/Experience to be Exchanged	Potential Intervention	Potential Organisations to Involve
<p><b>Water Quality and Quantity Modelling</b> Including: National scale water quality modelling tools to help understand and manage water demands and influences (both in relation to water quantity and quality); challenges and opportunities in relation to data collation and access (surface and remote sensed); modelling frameworks at different scales (upscaling/downscaling).</p>	<ul style="list-style-type: none"> <li>• Joint initiative to explore the possible role for SAGIS in Ganga basin;</li> <li>• Joint development of models adapted to right amount of data (e.g. Load Apportionment Model);</li> <li>• Sharing of best practice and examples of moving tools from research programme to stakeholders (for example those tools developed under the NERC Macronutrient Cycle Programme and other UK research programmes). Including methods of engaging users of models in the development process to ensure the tool is fit for purpose.</li> </ul>	<p>India: NMCG, CWC, CPCB</p> <p>UK: CEH, EA</p>
<p><b>Data Dissemination and Analysis Tools</b> Including the development of web-based portals for data dissemination and user driven analysis.</p>	<ul style="list-style-type: none"> <li>• Joint development of tools</li> <li>• Sharing of UK expertise and technical solutions</li> </ul>	<p>India: CWC, CPCB</p> <p>UK: CEH</p>
<p><b>Future Rainfall Prediction</b> Including: seasonal outlooks; improving observation systems; climate change scenario assessment.</p>	<ul style="list-style-type: none"> <li>• Extension of current research programmes.</li> </ul>	<p>India: IMD</p> <p>UK: NERC, CEH, BGS</p>
<p><b>Agricultural Water Management and Water Use Efficiency</b> Including: the use of unconventional water sources; closed loop cycles (using as much water as possible before discharge); efficient pumping technologies; monitoring and legislative reporting of water use efficiency; incentivising businesses and communities to change practice.</p>	<ul style="list-style-type: none"> <li>• Joint demonstration projects. A current India-UK joint demonstration project is underway looking at different irrigation systems and crop rotation changes.</li> <li>• Exploration of corporate reporting as a method to driver water use efficiency.</li> </ul>	<p>India: CWC</p> <p>UK: CEH, Mott MacDonald, Atkins, Thames Water, SMEs (in relation to technological solutions); CDP (in relation to corporate reporting)</p>
<p><b>Transferring Research into Practice</b> Including: operationalising tools to move from models to decision support systems; moving research findings into operational practice.</p>	<ul style="list-style-type: none"> <li>• Sharing experiences in transferring research into operation.</li> </ul>	<p>India: NMCG, CWC, CGWB, CPCP</p> <p>UK: KTN, NERC, CREW</p>

## Decision support systems (contd)

Area of Expertise/Experience to be Exchanged	Potential Intervention	Potential Organisations to Involve
<b>Setting of Environmental Flows</b>	<ul style="list-style-type: none"> <li>• Development of a common India-UK understanding of environmental flows through sharing of current understanding.</li> <li>• Series of joint India-UK initiatives to aid politicians and policy makers in their definition of what ecosystem services rivers in India should be providing in future. Aimed at developing dialogue between science and policy communities. Potential use of scenario based decision making to allow stakeholders to develop requirements.</li> </ul>	India: National Institute of Hydrology, MOEF, CWC, NMCG  UK: CEH
<b>Catchment Management Planning</b>	<ul style="list-style-type: none"> <li>• Sharing of UK expertise in the development of catchment management plans under the EU Water Framework Directive. Particular areas of focus to include: implementation of catchment management plans and the incremental progress approach;</li> <li>• Pilot application of UK experiences in stakeholder engagement at difference scales and in rural vs. urban environments.</li> </ul>	India: NMCG  UK: EA and SEPA
<b>Developing the Role of Communities in Decision Making</b>	<ul style="list-style-type: none"> <li>• Sharing experiences and lessons learnt in the development of River Trusts.</li> </ul>	India: NMCG  UK: SEPA, EA, Defra, Cranfield University.
<b>Economic Assessments of Cost Effectiveness in the Water Sector</b>	<ul style="list-style-type: none"> <li>• Training and capacity development interventions by UK experts to build framework for economic assessments.</li> </ul>	India: Ministry of Water Resources, River Development and Ganga Rejuvenation  UK: WICS, Scottish Government

## Rural and urban water management

Area of Expertise/Experience to be Exchanged	Potential Intervention	Potential Organisations to Involve
<p><b>Water Treatment Technologies</b> Including: STP treatments for organic/biological pollutants; consequences of treatment technology (e.g. chlorination); treatment technologies for inorganic pollutants (consideration of reducing source rather than treating wastewater as solution).</p>	<ul style="list-style-type: none"> <li>Demonstration projects in six villages/catchments to test the applicability of the Scottish model for rural sanitation.</li> </ul>	<p>India: NMCG, IITs (Roorkee, Delhi, Kanpur, Varanasi, Patna and Kharagpur)</p> <p>UK: JHI</p>
<p><b>Rural/Agricultural pollution</b> Including: pesticides and fertilisers; bioremediation options; sustainable rural sanitation systems; household drainage and sanitation networks)</p>	<ul style="list-style-type: none"> <li>Demonstration projects.</li> </ul>	<p>India: To be confirmed</p> <p>UK: JHI, CEH, BGS</p>
<p><b>Urban pollution</b> Including: industrial pollution; sewage treatment solutions (vertical STPs, interception and diversion solutions)</p>	<ul style="list-style-type: none"> <li>Initiatives to connect UK and India commercial and innovation sectors, particularly in relation to the development of drainage systems in Ganga basin.</li> </ul>	<p>India: NMCG, Delhi Jal Board</p> <p>UK: UK Water Partnership</p>

## Regulation and governance

Area of Expertise/Experience to be Exchanged	Potential Intervention	Potential Organisations to Involve
<p><b>Water Resources Policy Development</b> Including: water resource planning; setting objectives (e.g. fixing environmental outcomes in law); linking regulation to social need; improving local scale engagement (bottom-up and top-down approaches).</p>	<ul style="list-style-type: none"> <li>• Capacity building through experience sharing and participation of UK experts in helping develop options;</li> <li>• Knowledge Exchange and capacity building initiatives related to EU Water Framework Directive approaches. Guidance on possible adaptation for Indian situation.</li> <li>• Sharing Defra's Local Action Project work which will provide outputs about the benefits of green infrastructure along with methods to help communities build consensus, facilitate local decision making and secure funding.</li> </ul>	<p>India: CPCB, NMCG</p> <p>UK: Defra, EA, SEPA, Cranfield University</p>
<p><b>Monitoring and Regulation of Water Law</b> Including: permitting and risk management; compliance assessment; self-monitoring (conventional and online monitoring); permit enforcement prosecution policy; communications.</p>	<ul style="list-style-type: none"> <li>• Capacity building exchanges to share knowledge on the UK system and experiences of how different institutions work together;</li> <li>• Use of IMPEL Regulatory cycle and similar approaches as a model for developing Indian approaches.</li> </ul>	<p>India: CPCB, NMCG</p> <p>UK: Defra, EA, SEPA, Cranfield University</p>
<p><b>Improve engagement in water management at all levels</b> Including: addressing regional/local problems (what is the model to implement policy in variable enviro/social situations); sharing tools and experience for stakeholder engagement and understanding; promoting understanding of environmental economics/ecosystem services/natural capital assets which are not currently recognised in India.</p>	<ul style="list-style-type: none"> <li>• Investigate options for making UK decision support tools/models available to stakeholders in India;</li> <li>• Capacity building initiatives to share stakeholder engagement techniques used in implementing the EU Water Framework Directive;</li> <li>• Sharing Defra's Local Action Project work. This is likely to include methods, interventions toolbox, cost-benefit tools, case studies, communication tools and best practice for enhancing new ecosystem services in urban areas.</li> <li>• Joint exploration of environmental economics and ecosystem services approaches. There are examples in India of good practice driven by individual enterprises but questions around broadening and optimising these.</li> </ul>	<p>India: CPCB, NMCG</p> <p>UK: Defra, EA, SEPA, Cranfield University (in relation to Water Framework Directive); CEH and UK consultants (in relation to environmental economics and decision support).</p>
<p><b>Water utility models and optimisation</b> Including: comparisons between UK private investment and Indian ownership models; efficiency, business models, cost optimisation.</p>	<ul style="list-style-type: none"> <li>• Knowledge exchange on investment models and privatisation options - especially focus on setting and driving environmental programmes/efficiency/service levels/costs – CAPEX and OPEX.</li> </ul>	<p>India: CPCB, NMCG</p> <p>UK: WICS, SEPA, OFWAT, EA, UK Water Partnership, use of consultants in assisting the process.</p>

# Conclusions and recommendations

The week-long visit to the UK by the Indian delegation of senior civil servants and research leaders with responsibility for the water sector achieved its objective to develop knowledge-sharing links with key UK policymakers, regulators, researchers and water industry specialists. The links developed through this initiative will help UK organisations and companies build collaborations which will be beneficial to both the UK and India.

Throughout the visit a number of areas for future India-UK collaboration were identified, as outlined in this report. Furthermore, as the visit provided opportunities for UK organisations and individuals to develop a better understanding of current priorities and activities in India and establish first contracts with members of the Indian delegation, we anticipate a number of subsequent follow-up activities to develop over time.

## Recommendations

In addition to the wide range of potential and planned future collaborations, this report recommends the following specific actions are taken forward immediately to capitalise on the visit and maintain momentum in India-UK Water Security Exchange Initiative:

1. Explore options for consolidating and formalising the links between the Indian Ministry of Water Resources (and specifically the National Mission for Clean Ganga) and the UK (specifically NERC, CEH and Defra). The visit clearly demonstrated the potential to develop a lasting, high-level relationship between the UK and India to support the National Mission for Clean Ganga. This should include elements of water governance and regulation, specifically strategic water planning and implementation linked to the EU Water Framework Directive, legal requirement and processes, permit setting, compliance assessment and enforcement options. The exact mechanisms should be explored further. Indian counterparts are seeking advice and agreement from the Ministry of Water Resources. Defra, NERC and CEH are also seeking to consolidate ideas and consider the most effective mechanisms to continue dialogue and provide support to the National Mission for Clean Ganga/Ministry of Water Resources.
2. Develop a framework for linking UK commercial water companies with potential Indian customers and partners. A number of commercial companies who engaged in the visit have expressed an interest in further developing relationship within India. In relation to infrastructure development, equipment and commercial opportunities we recommend that UK Water Partnership act as a conduit for specific enquiries and explore options for further building India-UK trade in the sector, in conjunction with other bodies as appropriate. The potential for a trade mission(s) to India by UK companies and science organisations should be explored.
3. Investigate options for a capacity building programme in water law and policy under the Scottish Hydro National agenda. This should be linked to the governance requirements outlined above. Throughout the visit there were a number of issues around water law and policy identified by the Scottish participants which were of particular interest to the Indian delegation. These included water utilities models and options for India. Opportunities for further training in India by the Water Industry Commission for Scotland and Shepherd and Wedderburn should be explored. Representatives will be on mission in Delhi in late April 2016 and at time of writing aim to be in touch with delegates with a view to further discussions. Assistance on legal issues was identified and the possibility for the University of Dundee signing a letter of intent with NMCG to develop such a relationship should be furthered.
4. Consider ways of testing the applicability of Scottish approaches to rural water management in India. The Indian delegation saw merit in exploring the applicability of some of the techniques being employed in Scotland in relation to sustainable rural water supply and sanitation and approaches to rural engagement. There is a clear opportunity for the JHI and SEPA to explore capacity building initiatives and joint research in this area.
5. Investigate the potential for corporate water reporting to assist in the delivery of water security in India. CDP are to explore corporate water reporting with the National Mission for Clean Ganga.

## Current follow-up activities

At the time of writing, a number of activities are being taken forward as initial follow-up initiatives as a direct result of the visit:

1. Proposed visit to UK by Shri Shashi Shekhar, Secretary of the Ministry of Water Resources, River Development and Ganga Rejuvenation and Chairman of the National Mission for Clean Ganga;
2. Legal and Regulatory Visit to India by the Water Industry Commission for Scotland and Shepherd and Wedderburn linked to the Scottish Hydro Nation agenda (20<sup>th</sup>-22<sup>nd</sup> April 2016);
3. Discussions around potential MoUs between the Ministry of Water Resources, River Development and Ganga Rejuvenation and NERC;
4. Consideration of a Letter of Intent between the University of Dundee Centre for Water Law, Policy and Science and the National Mission for Clean Ganga;
5. Discussions amongst the project Steering Group of the potential for developing a multi-year project proposal to take forward some of the interventions identified during the visit.

In addition, a number of related India-UK initiatives continue to be developed which could provide routes to furthering some of the issues identified in this report. For example, the NERC-MoES implementation of Newton-Bhabha-funded UK-India Joint Virtual Centre for Water Research, to facilitate bilateral, sector-relevant research and development, is expected to be announced in May 2016.

## Next steps

In order to capitalise on the visit and maintain momentum in development of India-UK partnerships around Water Security, it is recommended that the progress in taking forward the potential collaborations and relationships highlighted in this report is reviewed after six months (August 2016). The UK High Commission in Delhi will take the lead on this, setting up review meetings and/or an India-UK working groups as appropriate.

## Potential future funding

A wide range of potential funding routes could be explored to facilitate implementation of those activities identified in this report. We have been made aware of changes to the UK Prosperity Fund. This is to be extended in scope and focus and a transition is currently underway. Initial views are that this initiative could be developed to meet the new criteria which could be used to extend the networks and further this Indian/UK co-operation in water security. This should be explored by interested organisations in partnership with an invited consultant. A draft proposal should be outlined and tested with the Prosperity Team who are currently developing the new criteria.

## Wider geographical potential

At the UKTI Environment and Water Sector Advisory Group, held in London in March 2016, this project and the opportunities arising were discussed. It was seen as innovative and applicable to other situations which might benefit UK and other target countries. The close links between governance, research and business were acknowledged as important for creating UK trade opportunity. Similar requests for engagement on water security issues have been made, specifically from Turkey. With UK Water Partnership an appropriate proposal might be considered, based on this experience. It is hoped that the steering group could assist in developing additional opportunities.

## Concluding comments

Finally, this initiative was experimental, bringing together key expertise from India and the UK to assist in the Ganga clean-up and other water security issues in India. The UK Water Partnership facilitated the initial UK networks, project scope and funding providing a useful model across the water sector. The project management was provided by CEH and the steering group maintained an effective overview resulting in the balanced and wide ranging agenda.

It is hoped that Indian delegates benefited from their exposure to a wide range of ideas and approaches to key water issues and potential solutions to the protection and clean-up of the River Ganga and other Indian rivers. Taking part in itself should have increased confidence in decision making and driving the clean-up agenda forward. The Indian team gained a unique insight to UK methods and approaches and firm contacts have been established with UK counterparts. From the UK perspective, significant gains were made from working together, networks extended and opportunities for further engagement made. We all hope that we can build on this model, within UK, with India and other countries that might benefit from UK approaches and expertise across the water sector. We hope that this makes a small contribution to the clean-up of the River Ganga and the approach taken may be applied to similar situations worldwide.

# Annex 1 - Project steering group

The project is being managed by the NERC Centre for Ecology & Hydrology. Guidance was provided by a Technical Steering Group comprising:

- Gwyn Rees            Project Leader, Centre for Ecology & Hydrology (CEH)
- Martin Griffiths    Project Consultant, Pillon Ltd
- Harry Dixon        Project Manager, CEH
- Perry Guess        Natural Environment Research Council (NERC)
- Bob Ferrier        Scottish Government Representative
- Melissa Else        British High Commission New Delhi
- Barry Greig        Scottish Government
- Alison Maydom    Defra
- Mark Lane         UK Water Partnership

# Annex 2 - UK delegate list

## Day 1

Name		Organisation
Harry	Dixon	Centre for Ecology & Hydrology
Bob	Ferrier	James Hutton Institute
Barry	Greig	Scottish Government
Martin	Griffiths	Pillon Ltd
Sanjeev	Gupta	Imperial College
Valerie	Haines	UK Trade & Investment
Mark	Hervey	Department for International Development
Ashley	Holt	Department for the Environment, Food and Rural Affairs
Bob	Irvine	Scottish Government
Alan	Jenkins	Centre for Ecology & Hydrology
Ruth	Kelman	Natural Environment Research Council
Glada	Lahn	Chatham House
Mark	Lane	UK Water Partnership
Hannah	Le Pla	Department for the Environment, Food and Rural Affairs
Paul	Leinster	Cranfield University
Alison	Maydom	Department for the Environment, Food and Rural Affairs
Paul	Mullord	British Water
Sonia	Phippard	Department for the Environment, Food and Rural Affairs
Gwyn	Rees	Centre for Ecology & Hydrology

## Day 2

Name		Organisation
Andrew	Allan	University of Dundee
Marcus	Ambler	MFAttech Wader
Ian	Barker	MFAttech Wader
Kevin	Bradley	Shepherd & Wedderburn
Geoff	Brighty	Brunel University London
Chris	Chubb	Chris Chubb Environmental Policy Consultancy
Harry	Dixon	Centre for Ecology & Hydrology
James	Dunning	Syrinix
Steve	Fozard	Costain
Martin	Griffiths	Pillon Ltd
Valerie	Haines	UK Trade and Investment
Matthew	Harris	Costain
Bob	Irvine	Scottish Government
Cate	Lamb	CDP
Mark	Lane	UK Water Partnership
Andrea	Mancini	Water Industry Commission for Scotland
Fiona	Parker	Shepherd & Wedderburn
Tony	Rachwall	UK Water Partnership
Gwyn	Rees	Centre for Ecology & Hydrology
Paul	Rice	Pinsent Masons
Martin	Shouler	Arup
Alan	Sutherland	Water Industry Commission for Scotland
David	Thomas	Mott MacDonald
Eluned	Watson	Pinsent Masons

## Day 3

Name		Organisation
Richard	Allan	James Hutton Institute
Mark	Bailey	Centre for Ecology & Hydrology
Andy	Brown	HR Wallingford
Harry	Dixon	Centre for Ecology & Hydrology
Alastair	Driver	Environment Agency
Nick	Everard	Environment Agency
David	Fraser	Centre for Ecology & Hydrology
Craig	Goff	HR Wallingford
Martin	Griffiths	Pillon Ltd
David	Harley	Scottish Environment Protection Agency
Sarah-Jane	Westlake	Thames Water
Sarah	Moxon	HR Wallingford
Tony	Owen	Thames Water
Ben	Piper	Atkins
Paul	Raven	Environment Agency
Gwyn	Rees	Centre for Ecology & Hydrology
Steve	Tuck	Thames Water
Tony	Warn	Tony Warn Environmental Consultancy

## Day 4

Name		Organisation
Jonathan	Abra	Knowledge Transfer Network
Mike	Acreman	Centre for Ecology & Hydrology
Richard	Allan	James Hutton Institute
Emily	Barbour	University of Oxford
Mike	Bowes	Centre for Ecology & Hydrology
Nick	Chappell	Lancaster University
Mike	Dearnaley	HR Wallingford
Alex	Densmore	Durham University
Harry	Dixon	Centre for Ecology & Hydrology
Egon	Dumont	Centre for Ecology & Hydrology
Jonathan	Evans	Centre for Ecology & Hydrology
Nick	Everard	Environment Agency
David	Fraser	Centre for Ecology & Hydrology
Perry	Guess	Natural Environment Research Council
Helen	Houghton-Carr	Centre for Ecology & Hydrology
Mike	Hutchins	Centre for Ecology & Hydrology
Nick	Jackson	Centre for Ecology & Hydrology
Anita	Jobson	Centre for Ecology & Hydrology
Ruth	Kelman	Natural Environment Research Council
Andrew	McKenzie	British Geological Survey
Arathy	Menon	University of Reading
Simon	Moulds	Imperial College
Paula	Nickson	Downstream Solutions CIC
Ant	Parsons	Downstream Solutions CIC
Ragab	Ragab	Centre for Ecology & Hydrology
David	Ramsbottom	HR Wallingford
Gwyn	Rees	Centre for Ecology & Hydrology
Indrani	Roy	Exeter University
Paul	Whitehead	University of Oxford

## Day 5

Name		Organisation
Jonathan	Abra	Knowledge Transfer Network
Emily	Barbour	University of Oxford
Ian	Barker	MFAtech Wader
Mike	Bowes	Centre for Ecology & Hydrology
Nick	Chappell	Lancaster University
Simon	Dadson	University of Oxford
Alex	Densmore	Durham University
Harry	Dixon	Centre for Ecology & Hydrology
Bob	Ferrier	James Hutton Institute
David	Fraser	Centre for Ecology & Hydrology
Barry	Greig	Scottish Government
Martin	Griffiths	Pillon Ltd
Perry	Guess	Natural Environment Research Council
Sanjeev	Gupta	Imperial College
Alan	Jenkins	Centre for Ecology & Hydrology
Anita	Jobson	Centre for Ecology & Hydrology
Ruth	Kelman	Natural Environment Research Council
Cate	Lamb	CDP
Mark	Lane	UK Water Partnership
Andrew	McKenzie	British Geological Survey
Ben	Piper	Atkins
Ragab	Ragab	Centre for Ecology & Hydrology
David	Ramsbottom	HR Wallingford
Gwyn	Rees	Centre for Ecology & Hydrology
Indrani	Roy	Exeter University
Alan	Sutherland	Water Industry Commission for Scotland
Paul	Whitehead	University of Oxford

# Annex 3 - Programme

## Day 1 - Monday 15<sup>th</sup> February

### National Perspectives Introductory Day

Venue: Department for Environment Food & Rural Affairs (Defra), Nobel House, 17 Smith Square, London, SW1P 3JR

Chair: Alison Maydom (Defra)

Time		Speaker
09:15	Arrival, tea and coffee	
09:30	Welcome and opening remarks	<b>Sonia Phippard</b> Director General, Policy Delivery, Defra
09:50	An overview of regulation and its importance in river basin management	<b>Paul Leinster</b> Cranfield University
10:20	An introduction to the UK Water Partnership	<b>Mark Lane</b> Director, UK Water Partnership
10:40	Tea and coffee	
11:10	Introduction to the week and feedback from the March 2015 scoping visit to India	<b>Gwyn Rees</b> Science Area Lead for Water Resources, Centre for Ecology & Hydrology (CEH)
11:20	Overview of India priorities and needs - River Ganga rejuvenation	<b>Hari Har Mishra</b> Director (Finance), National Mission for Clean Ganga
11:50	An introduction to the Scotland Hydro Nation agenda	<b>Bob Irvine</b> Deputy Director of Climate Change and Water Industry, Scottish Government
12:20	UK-India collaboration in hydrological sciences	<b>Ruth Kelman</b> Head of Freshwater Science, Natural Environment Research Council (NERC)
12:45	Lunch	
13:45	Water as a focus for regional relations and sustainable resource economies – Chatham House’s work with partners in India	<b>Glada Lahn</b> Senior Research Fellow, Chatham House
14:15	British Water - UK water supply chain, innovation and opportunities	<b>Paul Mullord</b> UK Director, British Water
14:45	Technical presentation from Defra	<b>Ashley Holt</b> Water Quality Project Manager, Defra
15:30	Tea and coffee	
15:45	River Yamuna Action Plan	<b>Radhey Shyam Tyagi</b> Member Water, Delhi Jal Board
16:15	Overview of the Thames clean-up within the context of the week	<b>Martin Griffiths</b> Pillon Ltd
17:00	Close	

## Day 2 - Tuesday 16<sup>th</sup> February

### Regulatory Workshop (Part 1)

Venue: Pinsent Masons, 30 Crown Place, Earl Street, London, EC2A 4ES

Chair: Mark Lane (UK Water Partnership)

Time		Speaker
09:00	Arrival, tea and coffee	
09:30	Welcome and opening remarks	<b>Paul Rice</b> Partner, Pinsent Masons
09:40	Overview of approaches to water law and regulation in the UK and EU	<b>Eluned Watson</b> Associate, Pinsent Masons
10:05	Overview of approaches to water law and regulation in India	<b>Suneel Dave</b> Central Pollution Control Board
10:25	Water and innovation	<b>Mark Lane</b> Director, UK Water Partnership
10:40	Tea and coffee	
11:00	Facilitated workshop session on water regulation and governance	<b>Alan Sutherland</b> Chief Executive, Water Industry Commission for Scotland <b>Fiona Parker</b> Shepherd & Wedderburn
12:45	Lunch	
13:30	Law on water resources management: global best practice and challenges for implementation	<b>Andrew Allan</b> Centre for Water Law, Policy and Science, University of Dundee
14:00	An introduction to water regulation	<b>Martin Griffiths</b> Pillon Ltd
14:30	Implementing UK regulation	<b>Chris Chubb</b> Chris Chubb Environmental Policy Consultancy
15:00	Tea and coffee	
15:30	Water industry session	A number of companies will present
17:30	UK Water Partnership drinks reception	
19:00	Close	

## Day 3 - Wednesday 17<sup>th</sup> February

### Regulatory Workshop (Part 2)

Venue: NERC Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB

Chair: Martin Griffiths (Pillon Ltd)

Time		Speaker
09:00	Arrival, tea and coffee	
09:15	Welcome and opening remarks	<b>Mark Bailey</b> Director, Centre for Ecology & Hydrology
09:20	An overview of the Water Framework Directive	<b>Martin Griffiths</b> Pillon Ltd
09:40	Catchment management in India	<b>M P Singh</b> Central Water Commission
10:00	India's aquifer mapping and management programme	<b>Dipankar Saha</b> Member (SAM), Central Groundwater Board, India
10:20	Tea and coffee	
10:45	Thames river restoration	<b>Alastair Driver</b> Environment Agency
11:15	Water quality planning: modelling for investment and decision making	<b>Tony Warn</b> Independent
11:35	River basin management planning in Scotland	<b>David Harley</b> Scottish Environment Protection Agency
12:00	Lunch	
13:00	Water security and water resources management - scene setting presentation for workshop	<b>Ben Piper</b> Technical Director for Water Resources, Atkins
13:25	Water resources planning and management	<b>Steve Tuck</b> Abstraction Manager, Thames Water
13:50	Thames Water's approach to wastewater management	<b>Sarah-Jane Westlake</b> Thames Water
14:15	An overview of HR Wallingford Ltd	<b>Andy Brown</b> Business Development Director, HR Wallingford Ltd
14:30	Tea and coffee	
14:45	Depart CEH and walk to HR Wallingford Ltd	
15:00	Demonstration of Environment Agency flow monitoring capabilities	<b>Nick Everard</b> Technical Adviser, Hydro-Acoustics, Environment Agency
15:30	Tour of HR Wallingford's Froude Hydraulic Modelling Laboratories	<b>Sarah Moxon</b> HR Wallingford Ltd
16:30	Demonstration of UK Ship Simulation Centre	<b>Mark McBride</b> HR Wallingford Ltd
17:15	Return to CEH	

## Day 4 - Thursday 18<sup>th</sup> February

### Research and Innovation Forum

Venue: NERC Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB

Chair: Perry Guess (NERC)

Time		Speaker
09:00	Arrival, tea and coffee	
09:15	Welcome and opening remarks	<b>Perry Guess</b> Head of Knowledge Exchange, NERC
09:20	India's water science priorities and needs	<b>Arun Kumar</b> Professor, Indian Institute of Technology, Roorkee
09:45	An overview of NERC science innovation in India	<b>Ruth Kelman</b> Head of Freshwater Sciences, NERC
10:05	CEH and India: summary of relevant expertise and activity	<b>Gwyn Rees</b> Science Area Lead for Water Resources, Centre for Ecology & Hydrology (CEH)
10:25	BGS and India: summary of relevant expertise and activity	<b>Andrew McKenzie</b> British Geological Survey
10:45	Tea and coffee	
11:15	Results of recent UK-India research projects	
11:15	The hydrologic and carbon services in the Western Ghats Project	<b>Nick Chappell</b> Lancaster University
11:30	The South Asian Precipitation, a Seamless Assessment Project (SAPRISE)	<b>Inrani Roy</b> Exeter University
12:45	Modelling flow and water quality in the Ganga catchment	<b>Paul Whitehead</b> University of Oxford
12:00	The structure and dynamics of groundwater systems in northwestern India	<b>Alexander Densmore</b> Durham University
12:15	Research and innovation for sustainable rural communities	<b>Richard Allan</b> James Hutton Institute
12:45	Conservation of the River Ganga's biodiversity	<b>Ravinda Kumar Sinha</b> Professor, Patna University
13:00	Lunch and posters	
14:00	UK-India support for research and innovation	<b>Jonathan Abra</b> Knowledge Transfer Manager - Theme Lead, Water, Knowledge Transfer Network
14:20	Breakout discussion on how UK environmental science and innovation can contribute to India's water security	Facilitated by: <b>Anita Jobson, Anita Weatherby, Nick Jackson</b> Centre for Ecology & Hydrology
15:30	Tea and coffee	
15:50	Feedback from breakout groups and plenary discussions	
16:50	Concluding remarks	<b>Perry Guess</b> Head of Knowledge Exchange, NERC
17:00	Close	

## Day 5 - Friday 19<sup>th</sup> February

### Future Collaboration Wrap-up Day

Venue: NERC Centre for Ecology & Hydrology, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB

Chair: Alan Jenkins (CEH)

Time		Speaker
09:00	Arrival, tea and coffee	
09:30	Welcome and opening remarks	<b>Alan Jenkins</b> Deputy Director and Science Director for Water & Pollution Science, Centre for Ecology & Hydrology (CEH)
09:45	Introduction to the wrap-up	<b>Gwyn Rees</b> Science Area Lead for Water Resources, CEH <b>Martin Griffiths</b> Pillon Ltd
10:00	Key response from Indian delegation: lessons learnt from visit and priorities for future partnership	Member of Indian delegation
10:30	Tea and coffee	
11:00	Discussion on key issues and priorities	Facilitated by: <b>Anita Jobson, Nick Jackson</b> CEH
13:15	Final wrap-up and thanks	<b>Alan Jenkins</b> Deputy Director and Science Director for Water & Pollution Science, CEH
13:30	Buffet lunch reception	
16:00	Close	

# Annex 4 - Day 4 breakout session notes

## Breakout group 1

### Q1: INDIA REQUIREMENTS FOR UK/INTERNATIONAL SUPPORT - RESEARCH AND INNOVATION

#### Water security

- Year-round sustainable supply of surface water.
  - Seasonal variation in rainfall, low flows.
  - How? - Storage of the seasonal deluge to release during dry season/groundwater recharge? Wetlands, flexible dams, restore old canal system? Volume of water can be an issue during wet season.
  - Regulation is disjointed, need smart monitoring.
- Clean water/Safe water.
- Urban areas – isolating wastewater from supply etc.
- Arsenic pollution and removal – deep wells?
- Wastewater treatment.
- Seen as lower priority at all levels of governance/public; priority is drinking water/irrigation etc
- Mixtures - sewage, chemicals.
- Need cost effective treatments, energy/electricity supply in many areas is limiting factor. Rural areas it is extremely important.
- Central STP or localized solutions?

#### Future climate variability

- Monsoon prediction – which year H/L rainfall, storage for year round supply (see above).

#### Efficient water use

- Irrigation uses ~80% water, drinking water is ~20%. Perception/priority is given same weighting. Need to focus more on irrigation efficiency.
- Technology solutions? Can we have water-efficient technology?

#### Underpinning all issues/priorities

- Multiple authorities - governance, regulation and monitoring for compliance.
- Cost effectiveness of solutions.
- Smart vs human operation.
- Low E requirements.
- Regional, tailored solutions.
- Capacity building – all stakeholders, state, public.

### Q2: UK SUGGESTIONS FOR RESEARCH/INNOVATION SUPPORT

#### Water storage

- UK Water companies have a lot of expertise in water management, storage design.
- CEH research and models such as PROTEC.
- Natural water retention measures (part of EU legislation) - this tends to be many small scale storage options (NB dams are less popular in India now, much large volume of water to store in India - not suitable for small and many option. Also natural storage options can prove difficulty with availability of land in India. Feasibility assessments needed.).

#### Flood research

- UK research into inundation reduction in flood events - may have beneficial lessons for India if applied to storage of water?

## STP

- UK has expertise in identification of source of pollution.
- Catchment scale assessment of source and fate of pollutants.
- JHI example of local wastewater treatment options could be applied in India?

## Monitoring

- UK technology/UK expertise in monitoring; expertise in Network design; data, curation, management etc.

## Media/Stakeholder engagement

- UK expertise in engaging stakeholders, public awareness and education.

## Future Climate

- Climate modelling and scenario assessment.
- Rainfall prediction, hydrological models.
- Outlooks, seasonal forecasts.

## Regulation

- UK have expertise – but query over translation to Indian system.
- Models in decision making.

## Breakout group 2

### Q1: INDIA REQUIREMENTS FOR UK/INTERNATIONAL SUPPORT - RESEARCH AND INNOVATION

Grouped loosely under two areas:

- i. Policy/stakeholder understanding
  - Regulation → support to look if penalties/incentives → policy research level → and involvement of the public.
  - What value does society place on a clean river?
  - Links between farming and river pollution → understanding trade-offs.
  - Better education/understanding of the implications/details of the hydrological cycle → understanding trade offs.
- ii. Using water & waste water
  - Making stakeholders see the long-term implications of activities (e.g. over abstraction).
  - Management/use of poor quality water → identify different types of p.q. water → guidelines to follow.
  - Relationship between energy and water → free/subdivided energy removes incentive to reduce pumping.
  - Define response (thresholds) between flow and river ecosystem condition.

### Q2: UK SUGGESTIONS FOR RESEARCH/INNOVATION SUPPORT

Grouped loosely under four areas:

- i. Groundwater issues:
  - Groundwater contamination simulation/modelling and flow simulation.
  - Understanding the 3rd dimension in groundwater/recharge mechanisms for GW.
  - How waste water quality improves as passes through the unsaturated zone.
- ii. Water Use efficiency:
  - Water availability modelling → projections
    - [www.Water4crops.org](http://www.Water4crops.org)
    - Crop water efficiency research.
    - Water availability modelling → projections.
    - Water use efficiency – scheduling → difficulty of managing schedules → what is the incentive?

- iii. Ecosystem Services and Remediation:
  - Bio/phytoremediation expertise (UK & International).
  - Ecosystem services research - water quality index.
  - bioremediation - how much can be achieved with nature-based solutions and how much depends on technology?
- iv. Use of Technology
  - Sensor development and deployment (e.g. COSMOS, pollution sensors, coliforms).
  - Getting models to talk to each other.
  - eDNA → biometrics for freshwater systems → modelling (to optimise network).
  - Capacity-building and training in new areas.
  - Technology transfer for sewerage treatment and business model.
  - Increased efficiency of pumps - renewable/solar pumps.

## Breakout group 3

### Q1: INDIA REQUIREMENTS FOR UK/INTERNATIONAL SUPPORT - RESEARCH AND INNOVATION

Red dots indicate the issues members of this breakout group thought were most important.

- Developing baseline data (quantity, quality, ecological, social, economic water use) to enable water management - including real-time water quality. •
- How much e-flow required to maintain ecology integrity? •••• including function biodiversity assiml cap.) •••
- Understanding the special quality of Ganga Water. •
- How to manage water demand •, especially for irrigation •.
- Software for data management, DSS MIS.
- How to manage degradation of soils.
- Improving legal framework for water management in India. •••
- How to assess the value of water (cost v benefit). •
- Appropriate sewage treatment technologies. •••
- Understanding trade-offs - human v environment v farmers v other users/ short-term objectives v long-term goals. •
- Evaluating ecosystem services. •
- •• How to evaluate the water-use efficiency of crops.
- New technology need for sensors to detect toxins and heavy metals etc.
- Modelling water quality and e-flows at different scales. •

### Q2: UK SUGGESTIONS FOR RESEARCH/INNOVATION SUPPORT

- Identify teams/experts who can help with e-flows.
- UK has much expertise and tools/methods.
- Proper/sustained capacity building and training.
- Technology demo projects with view to long-term operational application O & M and **speedy results!!** - Achievable careful selection/definition.
- UK - India work together to **identify technology that works**.
- Reconnecting "communities to rivers" - e.g. farmers/ people – make people/water users aware of their impact on the environment/river. How to incentivise? Ownership of rivers? (See the UK's River Trusts, for example.)
- Develop and establish of legal/regulatory frameworks.
- Note Technical Innovations conference in Delhi 24<sup>th</sup> February 2016!



[www.ceh.ac.uk](http://www.ceh.ac.uk)

