Water quality management and source protection in West Bengal

Report of Grassroots Field Exposure Session December 2018

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INDIA-UK
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The India-UK Water Centre promotes cooperation and collaboration between the complementary priorities of NERC-MoES water security research.

भारत-ब्रिटेन जल कें द्र एमओईएस-एनईसीआरसी(यूके) जल सुरक्षा अनुसंधान के पूरक प्राथमिकताओ के बीच सहयोग और सहयोग को बढ़ावा देने के लिए करना है

Front cover image: Kolkata, India (Photo credit Emma Bennett, IUKWC)

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Executive Summary

In December 2018 The James Hutton Institute in partnership with the Indian Institute of Technology, Kharagpur and the Indian Institute of Tropical Meteorology and Centre for Ecology and Hydrology; funded by the India UK Water Centre; delivered a "Grassroots Field Exposure Session" (GFES), which explored real-world opportunities for research collaborations focused on water source protection and quality management. This GFES was part of an ongoing series of initiatives between the UK and India designed to strengthen knowledge sharing in water management and deliver world class policy-led science and engineering that addresses international challenges as set out in the Sustainable Development Goals.

The three-day event hosted in Kolkata, West Bengal was attended by 19 multi-disciplinary scientists from the water science sector from India and the UK. The GFES achieved its objectives to develop a common understanding of the challenges relating to water source protection in and around the city of Kolkata, West Bengal. The links and themes developed through the workshop have crystallised thinking around a range of strategically important research areas, which will be further developed into deliverable projects to be initiated in 2019/20. Common themes included:

- Development of low-cost analytical tools;
- Development of GIS-based modelling of the systems;
- Use and deployment of decentralised wastewater treatment systems;
- Planning systems for groundwater remediation for fluoride and arsenic;
- Modelling of groundwater flows;
- Development of management strategies that take account of local preferences;
- Establishment of an integrated monitoring framework for the region;
- Wider studies on the impact of water pollution on the ecosystem and biodiversity.

In order to maintain momentum and capitalise on the emerging issues, three project areas were identified for immediate support:

- Development of modelling capabilities;
- An integrated assessment of the ecosystems and impact of anthropogenic activity on the system;
- Development of an integrated monitoring framework, which considers a system approach.

Overall, there was strong consensus that there was a need for excellence in science delivered through partnership between India and the UK that underpins and informs policy making. There was much discussion on further research and technology exchange between the two countries to meet the challenge of addressing the Sustainable Development Goals for water, pollution control, land use and communities. There was a recognition that there is an urgency to develop research strategies in collaboration with the policy makers in India that will address these priority challenges.

1. Activity Leads

The Workshop was convened by the India-UK Water Centre (IUKWC) and led by the Activity Leads:

Indian Lead:

Dr. Manoj Kumar Tiwari

Assistant Professor

Indian Institute of Technology Kharagpur

Kharagpur

West Bengal

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India

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UK Lead:

Dr. Richard Allan

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The GFES was held in Kolkata, West Bengal, India from 13th to 15th December 2018.

2. Introduction

The India UK Water Centre (IUKWC) supports, amongst other things, the collaboration between India-UK water users and researchers in the early stages of design and development of water science research and initiatives through GFES. These sessions promote the assimilation of local knowledge and users experiences to progress the concept of co-production and co-design and facilitate user feedback into science and policy and aims to promote co-design of activities that will form a complimentary instrument to another one of the IUKWC's activities, the User Engagement Initiatives.

This GFES brought together leading freshwater and terrestrial scientists from across India and the United Kingdom to:

- Explore the future scientific needs and challenges, which underpin the sustainable management of water resources in Kolkata district of West Bengal;
- Develope ideas for future scientific and technological collaborations between the UK and India that address key knowledge gaps in our understanding of water quality management and source protection;
- Deliver a platform for networking, awareness raising and idea sharing, which aims to enable the start of future co-design of joint India – UK scientific projects and proposals;
- Focus on the management of Arsenic and Fluoride in groundwater together with the catchment scale management of industrial pollution.

The water quality issues in the Kolkata district of West Bengal need to be addressed as a matter of urgency. Therefore, the GFES outputs are critical to defining existing and future research needs that support West Bengal water management policy. This report sets out the findings of the GFES and highlights the strategically important research needs to address the water pollution management challenges in overall in West Bengal.

3. Background

The UN Sustainable Development Goal 6 "Ensure access to water and sanitation for all" recognises the right of citizens to access safe water and sanitation. Water scarcity, poor water quality and inadequate sanitation have a measurable negative impact on energy and food security. By 2050, it is predicted that one in four people are likely to live in a country affected by chronic or reoccurring shortages of water.

Within the global context, India has a population of 1.2 billion with a growing global economy but also faces high variability in water availability with an over-exploitation of resources, such that the country is facing emerging water resource and quality issues. Under current predictions of monsoonal variability and other hydro-climatic events it is anticipated that the problem of water availability for users will worsen into the future. Over-exploitation of groundwater for agriculture (supported by subsidised power supplied from the State) has resulted in decreasing water-tables and loss of resource. Water use efficiencies are also sub-optimal and interventions to improve water use efficiency in agriculture are urgently needed. In many locations the shift towards water-intensive high value agricultural, and particularly horticultural crops, has exacerbated the problem.

Food, water, energy security and ultimately resource efficiency (and the circular economy principles) represent an interlinked and increasingly important factor in sustainability with presently about 80% of abstracted water being used in irrigated agriculture, which also consumes approximately

30% of total Indian energy. A growing urban population with associated industrialisation is rapidly increasing the water demands of towns and cities such that many urban areas are facing severe water-shortages, poor peri-urban potable water quality and associated health concerns. Further, the untreated discharge of wastewater is impacting both surface and groundwater in many regions of the country.

Within the Indian context, West Bengal is one of the relatively richer states in India in terms of water availability. However, the state is facing alarming issues with the deteriorating quality of surface- as well as groundwater. The major issues include groundwater contamination by arsenic, fluoride, iron and a few other hazardous elements, and untreated or partially treated industrial effluents and municipal sewage polluting surface waters including rivers.

Arsenic and iron contamination in groundwater pose serious threats to districts of southern Bengal with North 24 Parganas followed by Nadia and Murshidabad being the worst affected districts . On the other hand, fluoride contamination is more prominent in south western part of the State where Purulia, followed by Bankura and Birbhum, being the worst affected districts . Excessive exploitation of groundwater is further worsening the problems.

Additionally, untreated wastewater released in uncontrolled fashion from unplanned housing and industrial sectors is increasingly polluting various rivers and other surface water sources. The industrial hub of tanneries, textile, and other industries located in catchment basins of the Ganga (Hoogly), Damodar and Subarnarekha Rivers release chemicals, fertilizers, pesticides and insecticides, polluting the river water and posing a serious threat to the aquifer and river biodiversity[3].

Additionally, untreated wastewater released in uncontrolled fashion from unplanned housing and industrial sectors is increasingly polluting various rivers and other surface water sources. The industrial hub of tanneries, textile, and other industries located in catchment basins of the Ganga (Hoogly), Damodar and Subarnarekha Rivers release chemicals, fertilizers, pesticides and insecticides, polluting the river water and posing a serious threat to the aquifer and river biodiversity.

There is recognition that there is a significant hydro climatic variation across India and there is a need to define monitoring and quality standards that can accommodate such variation while ensuring that water quality and quantity is adequately safeguarded from future pollution impact while at the same time addressing the existing levels of contamination. West Bengal is home to 8% of the national population[4] within 2.7% of the geographic area of the country. High population density (1028/Sq Km, 2011[5]), development needs, uncontrolled growth of population, extensive irrigation due to an agriculture-based economy and the resulting deterioration of water quality, has created water stress in West Bengal.

The GFES sought to better understand the waste generation and pollution regimes in the Kolkata region and explore how different drainage of river systems and wetlands can help in the design of ecosystem-oriented water quality management measures. Furthermore, the event considered current ground level water quality monitoring and management measures with a view to helping identify the scope for adoption of new technologies. The team of multi-disciplinary scientists from the fields of hydrology, meteorology, ecology, chemistry, geology and sociology amongst others worked in collaboration over the 3 days to develop a common understanding of the underpinning issues which put pressure on the water systems. The team went on to identify priority research areas for water resource management in the region.

[1] Bhuin, Pijus Kanti. “Sustainable Water Resource Management in West Bengal: A Review.”

[2] https://www.census2011.co.in/census/state/west+bengal.html

[3]Goel, P.K., 2006. Water pollution: causes, effects and control. New Age International.

[4]Bhuin, P.K., Sustainable Water Resource Management in West Bengal: A Review.

[5]https://www.census2011.co.in/census/state/west+bengal.html

4. Participants

The GFES was attended by 10 representatives from the UK and a further 9 from India, the delegation comprised of:

Table 1: List of delegates attending the GFES December 2018.

Name	Institution
UK	
	Dr Richard Allan (UK Lead) The James Hutton Institute
	Dr Rachel Helliwell The James Hutton Institute
	Professor John McArthur University College, London
	Dr Mark Everard University of West England
	Dr Diganta Das Loughborough University
	Prof Iwan Jones Queen Mary University, London

	Dr Debpriya Mondal University of Salford
	Dr Indrani Roy University of Exeter
	Dr Devendra Saroj University of Surrey
	Prof Harry Dixon (IUKWC Coordinator) UK Centre for Ecology & Hydrology
INDIA	
	Dr Manoj Tiwari (India Lead) Indian Institute of Technology, Kharagpur
	Dr Priyanka Jamwal Ashoka Trust for Research in Ecology and Environment, Bangalore
	Dr Rajiv Kangabam Assam Agricultural University
	Dr Gopal Krishan National Institute of Hydrology, Roorkee

	Dr Surajit Chakraborty Indian Institute of Social Welfare and Business Management, Kolkata
	Prof Pradip Sikdar Indian Institute of Social Welfare and Business Management, Kolkata
	Dr Rajeev Pratap Singh Banaras Hindu University
	Shri. Sunil Singh PETCI, Dhanbad
	Dr Shivaraju Puttaiah JSSAHER, Mysuru
	Dr Rajib Chattopadhyay Indian Institute of Tropical Meteorology, Pune
	Dr Sambuddha Misra Indian Institute of Science, Bangalore

5. Workshop Programme

Over the three days of the event there were a range of field visits, presentations and discussions, principally focused on water source protection. The core of the GFES was a range of field trips, which allowed the participants a chance to experience the challenges first hand and to interact with the stakeholders. The inclusion of these field trips meant that the researchers had a richer experience and were able to have a deeper interaction with the stakeholder groups. The field trips included:

- A boat trip on the Hooghly River, to observe the nature and extent of polluting sources;
- A visit to a Hindustan Unilever (https://www.hul.co.in/), to observe industrial waste treatment facilities at a personal care product factory;
- A visit to a beverage production site run by Diamond Beverages (http://dbplko.com/), to observe industrial waste treatment facilities at a food product factory;
- A tour of the East Kolkata wetlands, to observe fish farming and agriculture using domestic waste water from Kolkata via the canal.

These field excursions and other meetings included discussions with the representatives of the West Bengal Pollution Control Board (WBPCB) and the Ministry of Environment, Forest and Climate Change. The delegates also interacted with local fisherman, farmers and local government officials in the East Kolkata wetland as well as senior management and technical staff at both the Unilever and Diamond Beverages sites.

The field trips were supplemented by round table discussions to evaluate the challenges. The delegates were split into 5 sub-team who focused on individual topics within the Water Quality Source Protection theme. These teams were:

1. Industrial Pollution: related issues and its control
2. Natural pollution by arsenic and fluoride
3. Sewage reuse for aqua-farming
4. Fate, Transport and Remediation of contaminants
5. Wetland ecosystem services in West Bengal

During the course of the discussion, the delegates were asked to consider a range of strategic questions that helped identify a number of tangible outputs and research deliverables. These questions included:

1. How is the water supply demand balance changing across West Bengal? What are the influencing factors (for example, climate change, farming, urban creep, industrial change and economic growth)?
2. How is water quality changing? What are the main contributing factors that influence raw water quality deterioration?
3. What is the existing nutrient load (as N and P) within raw water and how does this impact on water quality, water security and the environment/ecosystem?
4. How does activity in the catchments influence and effect the raw water quality and security? Do we know enough about how such activities impact on water security, quality and ultimately the protection of public health?
5. What water quality monitoring programs are in place in West Bengal? Where are the knowledge gaps in terms of understanding the water quality and the source of contaminants?
6. What coverage of wastewater treatment is in place? How can improvements in wastewater treatment at a local level safeguard raw water source?
7. What management practises are in place to address diffuse pollution issues? What modelling needs to be done and to what scale (Catchment and or farm scale)?
8. What are the consequences for future land and water management? How does this potentially impact on ecosystem services?
9. How can the sustainable rural community approach support local resource management?

By exploring these questions and others, the session identified strategic challenges for water management research in West Bengal over the next 10 years. Delegates considered the feasibility

of meeting such scientific priorities and, in particular, what was needed to enable the required research. The following sections discuss the topic-specific output from each of the five working group.

6. Conclusions and Recommendations

The three day workshop in West Bengal achieved its objectives in identifying a range of challenges relating to water source protection and, importantly, recognised a range of opportunities for collaborative research which could address the local, regional and potentially some national priorities. The emerging research agenda is also very much aligned to the Sustainable Development Goals and in particular Goal No 6 "Ensure availability and sustainable management of water and sanitation for all". Through the course of the three days there were a number of themes identified which support existing thinking around the benefits to the science-policy interface and re-enforced the benefits of a strengthening India-UK collaboration. The strategic themes included:

- Scientific collaboration between India and the UK provides a platform for policy led research which is a vital component of securing water source protection.
- There is a clear need to support the development of an integrated approach to water quality monitoring. This includes upskilling laboratories; identifying appropriate parameters; setting national limits; implementation along with a developing agenda of water quality improvement through catchment management principles.
- Spatial-temporal modelling is a specific emerging need at a regional and national level and should build on the Indian research based in the study catchments.
- Demonstration sites for low cost resource efficient water and wastewater treatment are needed to test the applicability of such systems in the local context.
- Consideration should be given to developing an integrated approach to sustainable rural communities which very much includes engagement with the communities and economic impacts.
- Improvements to wetland ecosystem services assessment are critical to understanding the value of the whole system and to identify best practise management measure which will ensure the sustainability of such sensitive systems for future benefit.

The workshop comprehensively considered all aspects of water source protection in both the UK and India and explored national modelling, ground water, surface waters, local and regional challenges, governance, treatment and monitoring strategies.

While there is clearly scope for a range of activities and research opportunities, it was agreed that a number of priority areas should be identified through which to address merging societal challenges associated with water quality and to maintain momentum with India-UK research collaboration. Some important areas for development were identified as:

1. Development of ground and surface water transport and fate modelling of pollutants. The importance and impact of a range of pollutants in the environment and their agricultural sources and loss was identified in the field studies and through interaction with the stakeholders. It should be possible to establish a project between India and the UK to benchmark models with the aim of informing policy making regionally. It may be possible

to adapt the output of such a project to a national scale in India.

2. Establish a demonstration of decentralised modular wastewater treatment. There is a clear opportunity to identify and pilot a range of novel innovative modular wastewater treatment systems that address rural access to safe sanitation.
3. Capacity building for analytical capabilities in India. Many of the delegates made reference to the need for a more consistent approach to analysis and monitoring of the aquatic systems in India. While national standards do exist, it would be desirable to assess the effectiveness of implementation and the appropriateness of the selected parameters along with their associated regulatory limits. This should be supplemented by a series of laboratory based workshop and demonstrations of laboratory techniques. It may also be beneficial to establish an inter-laboratory testing scheme to help upskilling of laboratory staff.
4. Implementation of catchment management principles. Consideration should be given to evaluating frameworks such as the Water Framework Directive as a benchmark approach to environmental regulation, standard setting and implementation. This might benefit from the lessons learnt from implementation in the UK, and potential transposition of some key guiding principle into the wider Indian context.
5. Implementation of ecosystem evaluation tools such as RAWES to better evaluate the wetland systems in West Bengal. This will enable more informed decisions about the level of anthropogenic activity allowed in the wetland system and highlight the possible impacts of such activities. Adoption of a systematic approach will enable better strategic choices and act as a mechanism that supports a more sustainable management practice.

As well as these research priorities there were a range of other opportunities that could be developed in partnership over time. These included:

- Strategy for tariff setting and financial regulation;
- Community engagement strategies;
- Development and refinement of industrial pollution controls and regulation;

As part of the next steps the partner organisations in India and the UK could work together to develop project proposals in the identified areas and set out plans for delivery beyond 2019.

Finally, it is hoped that the delegates of the GFES benefited from the experience and the networking opportunity that the event provided. The participating scientists from India and UK gained a great insight into the water research and technology agenda in West Bengal and were very much impressed by the depth and quality of research that has been delivered at the ground level. There are clear opportunities to work in partnership to deliver projects which benefit the UK or India, while providing solutions that can be applied internationally to address the global strategic objectives set out in the Sustainable Development Goals. Delegates from both the countries seemed very keen to continue collaborating on the valuable ideas that arose from the discussions at the GFES.

7. Participant Feedback

Overall the GFES structure and design was very well received by participants; the exposure to the actual environment on field and discussions with stakeholders representing both public sector and operational water managers was especially appreciated.

At the conclusion of the GFES a feedback form was circulated to participants who were asked to provide comments on: the GFES structure and content; the meeting venue and organisation; networking opportunities; and an overall score out of 10 for the workshop.

Participants fed back positively on the content and structure of the session including field exposure, interaction sessions with stakeholders, cross disciplinary theme and focus areas and the mix of participants (researchers/stakeholders and differing scientific backgrounds). They reported that possible changes to enhance the session might include representation of more local governmental stakeholders and more time for associated interactions; representation of local media and scientists from social, political and economic backgrounds.

Logistical organisation and delivery of any workshop are of high importance to participants' enjoyment and participants at this workshop were on the whole complementary about the meeting space, field trip arrangements and hospitality provided. Recommendations, with respect to, provision of maps for field visits to help orient the participants as well as bi-lingual name tags to help engage with local stakeholders was felt.

A key goal of the India-UK Water Centre is to provide a platform for bringing together users, researchers and stakeholders in water science; it was thus pleasing to note that 100% of the respondents stated that they had made new contacts as a result of the GFES for knowledge exchange and with potential opportunities for future collaboration with the new contacts.

Further feedback from participants also resulted in requests to conduct similar events in different geographic regions of India (especially the remote North East India) involving multiple local stakeholders as well as to bring in scientists and stakeholders from varied sectors of WRM under the IUKWC umbrella.

Overall participants scored the workshop on average 9/10

Annex 1: Workshop Agenda

IUKWC Grassroots Field Exposure Session 2: Water Quality – Source Protection; Focus on Arsenic and Fluoride in groundwater together with the management of industrial pollution in West Bengal, India

13th – 15th December, 2018

Agenda:

Date	Time	Activity
13th December 2018	08.30	Registration
	09.00 – 12.30	Visit to industrial effluent disposal sites and meeting various local stakeholders in and around Kolkata
	13.00 – 14.00	Lunch at IndiSmart Hotel
	14.00 – 16.30	1. Poster Presentation [on arsenic, fluoride and other water quality issues in West Bengal]. 2. Discussion with invited stakeholders from Arsenic and fluoride affected area [Gram Panchayat Representatives and NGOs officials]
	16.30 – 18.30	Tea followed by time for Working Group Discussions
	20.00	Dinner at IndiSmart Hotel
14th December 2018	08.45 – 13.00	Depart for the East Kolkata Wetlands and meeting local stakeholders
	13.00 – 14.00	Lunch
	14.00 – 17.00	A Ferry/Boat trip in river ganga identifying nature and extent of polluting sources
	17.30	Return to Hotel and time for Working Group discussions
	19.30	Dinner at IndiSmart Hotel
15th December 2018	10.00 – 13.00	Plenary Session : Working Group Presentations, discussions, Conclusion and way forward
	13.00 – 14.00	Lunch
End of Session * Note: Since this is a field based event the agenda is subject to last minute changes		

Working groups:

The GFES session on water quality will be spread out over three days and will involve discussions with various stakeholders involved in the monitoring and management of water quality in and around Kolkata. The stakeholders will represent 4 key issues in the Water quality management sector in the region. To facilitate discussions with the stakeholders, the scientific team shortlisted for the session has been divided into four groups based on their expertise and research interests. The groups are as below

WG I Theme	**Industrial Pollution Study Group (Industrial pollution related issues and its control)**
Members	Dr. Gopal Krishan, National Institute of Hydrology, Roorkee Prof. John Iwan Jones, Queen Mary University of London Dr. Indrani Roy, University of Exeter Dr. Shivaraju Puttaiah, Jagadguru Sri Shivarathreeeshwara University Dr. A.K.Sahai, IITM, Pune
WG II Theme	**Geogenic Contamination Study Group (Arsenic and Fluoride pollution features and control)**
Members	Prof. Pradip Sikdar, Indian Institute of Social Welfare and Business Management, Kolkata Prof. John McArthur, University college London Dr. Surajit Chakraborty, Indian Institute of Social Welfare and Business Management Dr. Mark Everard, University of West England
WG III Theme	**Sewage Reuse for Aqua-farming Study Group (Health risk assessment and minimization)**
Members	Dr. Rajiv Kangabam, Assam Agricultural University Dr. Debpriya Mondal, University of Salford Dr. Alison Parker, Cranfield University Dr. Rajeev Pratap Singh, Banaras Hindu University, India
WG IV Theme	**Contaminant Transport Study Group (Contaminant transport to off-site locations)**
Members	Dr. Priyanka Jamwal, ATREE Dr. Rachel Helliwell, James Hutton Institute Dr. Suryachandra Rao, IITM Dr. Diganta Das, Loughborough University Mr. Sunil Singh, PETCI NGO Dr. Devendra Saroj, University of Surrey

Each group would be expected to take a lead in discussions with stakeholders relevant to their group theme and aim to understand the current and potential uptake of scientific outputs at the ground level. Some key questions to consider could be:

- What is the nature and magnitude of the issue(s)?
- How well do we understand and assess the potential impacts?
- What management options are there for control?
- What data/tools needed to provide supporting analysis options?
- What are the key research needs: data, synthesis, scenarios, support of policy?

Ideas for Discussion

We hope the GFES will include some active discussion sessions with stakeholders. To help energise these discussions, delegates may like to consider the following issues/questions ahead of the GFES:

1. How is the water supply demand balance changing across West Bengal? What are the influencing factors (for example, climate change, farming, urban creep, industrial change and economic growth)?
2. How is water quality changing? What are the main contributing factors that influence raw water quality deterioration with respect to Fluoride, Arsenic and other industrial pollution?
3. What is the existing contamination load within raw water and how does this impact on water quality, water security, public health and the environment/ecosystem?
4. How does activity in the catchments influence and effect the raw water quality and security? Do we know enough about how such activities impact on water security, quality and ultimately the protection of public health and the environment?
5. What research initiatives are already in place in West Bengal? Where are the knowledge gaps in terms of understanding the water quality and the source of contaminants? How does this influence water management policy at a local level and catchment scale in West Bengal?
6. What coverage of wastewater treatment is in place? How can improvements in wastewater treatment at a local and regional level safeguard raw water sources in West Bengal and surrounding regions that feed into the West Bengal water system?
7. What management practises are in place to address diffuse pollution issues? What modelling needs to be done and to what scale?
8. What are the consequences for future anthropogenic activity and ecosystem services in West Bengal?

By exploring these questions and others, the GFES will aim to identify strategic challenges for water management research in West Bengal over the next 10 to 20 years. Delegates are asked to consider the feasibility of meeting such scientific priorities and what is needed to enable the required research.

Expectation of group members:

- The group members will be expected to interact with each other prior to the workshop and identify key discussion themes and questions for the stakeholders
- The group members would be expected to take a lead in both formal and informal communication with relevant stakeholders and identify the scope for collaboration
- All group members would be expected to contribute fully to the discussions and attend all sessions of the event

- We would like each sub-group to facilitate the sessions and self – select a rapporteur to collect notes that can be reported back at the plenary to the wider group and used as the basis for the formal GFES report.

Group outputs

The groups would be expected to deliver a joint presentation at the plenary session on day 3 of the event and highlight key observations, conclusions, and ideas for future joint research and scope for future collaborations with the stakeholders. Post the event the groups would be expected to submit a brief working group report highlighting the group activity over 3 days and conclusions of the event. The document needs to be submitted to IUKWC no later than 60 days post the event.

Back cover image: Kolkata, India (Photo credit Emma Bennett, IUKWC)

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