

Post facto assessment of dams in Maharashtra, India in collaboration with FutureDams Consortium UK

Report of Researcher Exchange May 2019

April 2020



INDIA-UK
Water Centre
भारत-यूके
जल केन्द्र

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India-UK Water Centre

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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 केंद्र एमओईएस-एनईसीआरसी (यूके) जल सुरक्षा अनुसंधान के पूरक प्राथमिकताओं के बीच सहयोग और सहयोग को बढ़ावा देने के लिए करना है

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Executive Summary

This report represents an overview of the activities and conclusions of a Junior Researcher Exchange undertaken at University of Manchester, UK (07-19 May 2019) and UK Centre for Ecology & Hydrology, Wallingford, UK (20-26 May 2019). The Exchange was convened by India UK Water Centre and the activity lead was Ms Amruta Pradhan (Ashoka Trust for Research in Ecology and Environment, India), while her host was Dr Timothy Foster (University of Manchester, UK). The report outlines the aims of the exchange, describes the programme and the activities developed to meet the objectives, and details the outputs generated, as well as the ongoing and future collaboration. Finally, it assesses the support received from the IUKWC through the Researcher Exchange Scheme. The present report is intended for India-UK Water Centre members and water security stakeholders.

1. Activity Leads

The Researcher Exchange was convened by the India-UK Water Centre (IUKWC) and led by:

Lead Researcher

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The Exchange was held at the University of Manchester, UK (07-19 May 2019) and UK Centre for Ecology & Hydrology, Wallingford, UK (20-26 May 2019).

2. Activity Aims

The India-UK Water Centre is based around five key cross-sectoral themes and aims to deliver a portfolio of activities across these themes. This activity focused on the theme: Using new scientific knowledge to help stakeholders set objectives for freshwater management.

The lead researcher is a PhD student at ATREE researching the ecological and social impacts of dams in India and their overall governance. The proposed visit was aimed at building research collaborations and expanding the lead researcher's network to exploit complementarities between her PhD research and the work being done as a part of GCRF: Dams 2.0 project led by Global Development Institute, University of Manchester. The project involves an integrated assessment of dams by modelling trade-offs between water-energy-food-environment. India is a secondary named case study of FutureDams. The visit was an opportunity to closely understand the work of FutureDams, their plans for India, and to share the lead researcher's experience of environmental governance processes on dam construction and operation in India. The researcher aspired to get acquainted with the nuances of latest global debate on dams.

This exchange also aimed at expanding the existing collaboration between ATREE and UK Centre for Ecology & Hydrology (UKCEH) on river ecology.

3. Activity Structure

Planning for the visit was carried out from Feb-April 2019 through Skype calls. It was decided that the host, Dr Timothy Foster, would be collaborating with the researcher on the post facto evaluation of agricultural benefits of the dams and Dr Cedric Laize (UKCEH) would collaborate with the researcher on the ecological impacts of dams. In pre-visit discussions, the overall aim, objectives and research approach for the PhD was discussed at length. It was decided that the overall approach would be to quantify agricultural productivity in the command area of the dam vis-a-vis a counterfactual scenario. A concept note and literature review conducted by the researcher during the course of her PhD was shared with the host, Dr Foster, who provided further reading materials to facilitate the work during visit. The understanding between the leads was that the visit would contribute to the PhD research proposal (synopsis).

Early during the visit, a seminar was given by the researcher on 'Environmental Governance of Dams: Experience from Maharashtra, India'. Since India is the third largest dam building country, and has seen significant struggle over social and environmental impacts of dams, FutureDams has a particular interest in Indian dams. The presentation was attended by 20 members of FutureDams team (including PhD students at Global Development Institute) along with Dr David Hulme who is the Principle Investigator of the GCRF Dams 2.0 project. Case studies presented by the researcher were found to be interesting and informing by the attendees.

Series of discussions were carried out with Dr Foster about the overall research approach and detailed methodology to be used for assessment of impact of dams on agricultural productivity. With consent from researcher's PhD Supervisor, it was decided that Dr Foster would join the Doctoral Advisory Committee. The funding proposals for research would be written jointly between researcher and Dr Foster. Funding possibilities from FutureDams would be explored. Such prolonged engagement of the host could facilitate FutureDams' work in India in the near future. Through introductions to the other team members of FutureDams, the networking process was also facilitated.

Detailed discussions were held with Dr Thomas Higginbottom, a Post Doc from Dams 2.0 project, on the use of remote sensing in the impact assessment on agricultural productivity. Use of online platforms such as 'My Survey Solutions' was discussed at length with the host, for collecting and storing the primary data, which is to be collected from farmers on agricultural productivity.

Statistical techniques that could be used to process the data were also discussed. A discussion with Dr Johan Oldecop was particularly useful for the ecological impact component of the PhD work. The problem of confounding variables while determining the impact of dams on forests was particularly discussed. He offered some good insights into the statistical techniques that could be employed to tackle the confounders. He also suggested relevant literature.

The researcher had an opportunity to attend a technical meeting with the team of modellers from FutureDams, working on basin scale hydrological models to model the water-energy-food-environment trade-offs. The day-long meeting was a good opportunity to understand how such hydrological modelling is approached, what kind of data is looked at, what technological platforms are used etc. It also gave the researcher some insight into the dynamics of different sectors associated with dams.

A series of discussions were carried out with host from UKCEH, Dr Cedric Laize along with Dr Gwyn Rees (Science Area Head, Water Resources, UKCEH), Dr Andrew McKenzie (Groundwater Information Manager, British Geological Survey) and other researchers from UPSCAPE project based at UKCEH. Although there was not much overlap between the researchers interest in impact of dams on forests and work done at the UKCEH, post visit discussions are ongoing.

4. Activity Conclusions and Outputs

The researcher was keen to understand the global canvas of impact assessment of dams. The visit provided an excellent opportunity to understand the cutting edge work done in the field of integrated impact assessment of dams. The visit was also useful to establish a network in FutureDams consortium, which will be beneficial in all the future collaborations. The visit has shaped her PhD proposal (synopsis) a great deal. Key findings, specific knowledge and data gaps regarding post facto impact evaluation of (irrigation) dams synthesised after the visit are summarised below.

4.1. Key findings

India is the third largest dam building country in the world, with over five thousand large dams (ICOLD, Undated)¹; India has spent approximately ₹400,000 crore (400 billion) on major and medium dams since Independence (CGWB, 2016). Despite this expenditure, the actual area irrigated by canals is showing an overall decline since 1991 (IWMI, 2009; SANDRP, 2010; Planning Commission, 2011). More than 60% of India's irrigation now happens through ground water (CGWB, 2016). Maharashtra state is on the forefront of building dams with 36% of India's large dams (over 1800) being in Maharashtra alone (NRLD, 2018). The state spent ₹72,000 crore (72 billion) on irrigation projects between 2000 and 2010, yet the increase in the irrigated area of the state was only 0.1% during that period (DES, 2012)². These statistics allude to a diminished link between the process of planning and design, and the real needs and accessibility challenges on the ground.

¹ Definition of Large Dam by International Commission on Large Dams (ICOLD): A large dam is classified as one with a maximum height of more than 15 metres from its deepest foundation to the crest. Additionally, a dam between 10 and 15 metres in height from its deepest foundation considered as a large dam provided it complies with one of the following conditions:

(a) length of crest of the dam is not less than 500 metres or (b) capacity of the reservoir formed by the dam is not less than one million cubic metres or (c) the maximum flood discharge dealt with by the dam is not less than 2000 cubic metres per second or (d) the dam has specially difficult foundation problems, or (e) the dam is of unusual design

² In absolute numbers increase in gross irrigated area was 2 Lakh Ha. Increase in gross irrigated area by canal has not been mentioned.

Institutions necessary for dams to perform as designed are largely absent; important acts like Maharashtra Irrigation Act (1976), Maharashtra Water Resources Regulatory Authority Act (2005), have no rules till date. A number of cases have been reported that show that the state government has violated the environmental impact assessment (EIA) process while building dams (CAG, 2014), with these violations being overlooked by central committees like the Expert Appraisal Committee (CAG, 2012; CAG, 2014; CAG, 2016). Despite these reports, there is an engineering-focus towards water provision, with a heavy reliance on dams even within ecologically sensitive regions, such as Wainganga basin in Vidarbha region of Maharashtra. Submergence of this basin associated with building the dam and dam canals have fragmented the forest tracts and wildlife corridors of this critical tiger habitat. On the other hand, several government reports indicate that these dams have been underperforming in terms of agricultural benefits (CAG, 2014; CAG, 2016; GoM, 2014).

The combined effect of continued dam building in the name of irrigation, weak institutional capability to monitor operations and environmental impacts in times of climate change, could have severe implications for the forests of Wainganga basin. Scientific literature in natural as well as social sciences outside India, as well as journalistic reports from the field have mounting evidence about the undelivered benefits and exacerbated environmental impacts of large dams (Ansar *et al.*, 2013). Despite this, there has been no comprehensive post facto evaluation of the dams in India undertaken, either in terms of the agricultural productivity or environmental impacts.

4.2. Specific knowledge and data gaps

Most of the integrative (interdisciplinary) frameworks developed globally for impact evaluation of the dams have been designed as *ex ante* frameworks³. A framework specifically designed for post facto impact evaluation still remains a research gap.

The studies which have attempted post facto evaluation are discipline-specific and can be categorized broadly into studies of bio-physical impacts and of socio-economic impacts. The bio-physical studies include assessment of hydrologic impacts (on flow) (Richter *et al.*, 1996; Richter *et al.*, 1997), geomorphological impacts (Ligon *et al.*, 1995) and ecological impacts (on aquatic species and riparian vegetation) (Poff and Zimmerman, 2010; Bunn and Arthington, 2002). Studies on socio-economic impacts include, social impacts (Kirchherr, J., Charles, K.J., 2016a; Kirchherr, J.; Charles, K.J., 2016b), agricultural impacts (Duflo and Pande, 2007) and hydropower impacts (Ansar *et al.*, 2013). There is a need for development of an integrative framework, for post facto assessment, which will study the impact of dams from cost as well as benefit side, embracing two or more of the above stated themes. The framework needs to effectively combine the natural science methods and social science methods to study linkages between ecological, hydrological, agricultural and social impacts.

An important ecological feature of the proposed PhD study area of Wainganga basin in Maharashtra State, is the complex trade-offs between forests and agriculture. There are no studies which explore what role dams have played in these trade-offs; whether they intensify it, or shift them in a particular direction, etc. Existing studies on impacts of dams on vegetation have focused on comparing upstream versus downstream, first order impacts, on riparian vegetation such as altered population structures and potential successional shifts in riparian community composition (Smith, S. D., *et al.*, 1991; Bunn and Arthington, 2002). Studies focusing on the impacts of dams and canals on forest fragmentation, deforestation and degradation have not been able to establish the causal correlation (Zhao *et al.* 2012). Impact of changed soil moisture

³ Some of the frameworks include—Function Evaluation Framework by Sloomweg *et al.* (2001); Integrative Dams Assessment Model (IDAM) by Kibler *et al.* (2012); Eco-engineering Decision Scaling by Poff *et al.* (2015) and node and link models currently being developed by FutureDams Consortium UK.

distribution due to impoundment of the flowing river can extend beyond the riparian zone and affect the forests of the basin. There are no studies focusing on this second order impact; spatio-temporal impacts on forests due to changes in soil moisture distribution triggered by dams, is thought to be an important research gap.

Existing body of research about impacts of dams on agricultural productivity has focused on comparison of upstream versus downstream. However, looking at the underperformance of dams of Wainganga basin, there would be significant heterogeneity in terms of agricultural impacts within the command area of the dam. Underlying causes of this heterogeneity remain relatively unexplored.

The existing studies which assess the impacts of dams on agricultural productivity do so in comparison with the irrigation promised as a part of the project (Dharmadhikari, S. 2005; Jagadeesan, S., Dinesh Kumar, M. 2015). However, there are no studies which compare the contribution of dams to agricultural productivity with a counterfactual scenario like a small scale irrigation tank or ground water etc. In that sense there are no studies that assess whether dams have been useful at all in increasing the agricultural productivity.

There has been no systematic post facto assessment of deviations in the planning, design, execution and operations of the existing dams. Even though government agencies like Comptroller and Auditor General have brought out several cases (CAG, 2014; CAG, 2012; CAG, 2016) there has been no in depth study of underlying causes of these deviations, political and economic interests, interstate water politics, instruments used to materialize the deviations etc. Even though there is a significant body of literature about the political economy of the dams, there has been no study which ties all the above aspects in the political economy framework.

In response to these knowledge gaps, the lead researcher hopes to address the following questions during her PhD:

1. What were the deviations during planning, design, construction and operations of the dam? Mapping why and how they happened.
2. How do agricultural productivity, profitability and vulnerability differ within and between command area of the dam and command area of small scale decentralized irrigation systems?
3. How have dams impacted riparian and non-riparian forests in Wainganga basin?
4. How can the proposed research be synthesized to develop an integrative framework for post facto assessment of (irrigation) dams?

The first research question about deviations will be explored with help of content analysis and key informant interviews. Second research question about agricultural productivity and profitability will be answered by conducting household surveys from 300 households (150 from the command area of a selected dam and 150 from outside the command area but from the same district). Third research question about the impact on riparian forests will be answered by conducting time series analysis of NDVI and soil moisture regime with help of satellite imagery.

4.3. Key themes and outcomes arising

One of the important outcomes has been the inclusion of the host Dr Timothy Foster, as a member of researcher's Doctoral Advisory Committee. This long term engagement will lay the foundation for FutureDams' work in India. This collaboration will also make it possible to tap into funding opportunities from UK as well as India.

The visit has shaped the researcher's PhD proposal a great deal. The visit has ensured that the proposal is aligned with the cutting edge research on integrated assessment of dams being conducted in UK and USA.

After attending the researcher's seminar, Dr David Hulme, the Principle Investigator of the GCRF Dams2.0 project, has offered to write a joint paper on Political Economy of Dams in Maharashtra.

The visit also gave the Researcher an opportunity to get acquainted with the latest hydrological modelling done for water-food-energy-environment nexus. The visit has also highlighted several areas where institutes from India such as ATREE can collaborate with FutureDams consortium on the assessment of dams.

4.4. Conclusions and next steps/recommendations from the activity

Overall, the Researcher Exchange was immensely beneficial for the lead researcher and the host in terms of deepening the understanding of mutual research interest, and has laid a solid foundation for future collaboration. Additionally, the visit has been beneficial for the PhD proposal of the researcher. It has been a fantastic opportunity at the early stage of her PhD. She has been able to establish her own network which will benefit her for future research collaborations.

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6. Annexes

Annex A: Agenda

Date	Agenda item
Tuesday 7 th May	Work planning meeting with the host Introductions to various team members of FutureDams Administrative formalities at the University of Manchester
Wednesday 8 th May	Discussion with the Host about the PhD proposal, study site etc. Preparation for the Seminar to be presented
Thursday 9 th May	Seminar at the Global Development Institute in front of FutureDams team
Friday 10 th May	Discussion with the Host on Ghana case study of FutureDams GCRF Dams 2.0 project Discussion on outputs of the visit
Monday 13 th May	Call with PhD Supervisor along with the Host to discuss the parallels between Ghana Case Study and proposed PhD research in Maharashtra, India
Tuesday 14 th May	Worked on the mini proposal to be written for the PhD research
Wednesday 15 th May	Discussion with Dr. Thomas Higginbottom on use of Remote Sensing in assessing the impacts of dams on agricultural productivity
Thursday 16 th May	Discussion with the Host on use of My Survey Solutions for house hold survey proposed during PhD research
Friday 17 th May	Discussion with Dr. Johan Oldecop on the statistical techniques to be used for assessing impact of dams on forests
Monday 20 th May	Introductory talk with Dr. Francois Edwards about the visit to CEH (Host at the CEH Dr. Cedric Laize could not come due to family emergency)
Tuesday 21 st May	Discussion with Dr. Gwyn Rees on UPSCAPE project of CEH
Wednesday 22 nd May	Attended the technical team meeting of the hydrology modellers of the GCRF Dams 2.0 Project in London
Thursday 23 rd May	Updated Sunita Sarkar on the Researcher Exchange Progress Discussion with Dr. Charlie Stratford on assessment of impacts of dams on forests
Friday 24 th May	Discussion with Dr. Andrew McKenzie about the role of groundwater in catchment of dam

Annex B: Brochure for the Seminar

The brochure features a background of blue water with ripples. At the top, the title 'FutureDAMS Lecture Series' is written in large, bold, white sans-serif font. Below the title, there are several paragraphs of text in a smaller white font, providing details about the series and listing five individual lectures with their dates, times, and speakers. At the bottom, there is a logo for 'Future DAMS' where 'Future' is in a light blue font and 'DAMS' is in a darker blue font, both enclosed in white wavy brackets. Below the logo, the text 'Design and Assessment of water-energy-food-environment Mega-Systems' is written in a small, white, sans-serif font.

FutureDAMS Lecture Series

More than 3,700 large dams are planned or under construction, many in the Global South.

FutureDAMS is a GCRF funded inter-disciplinary research and capacity development partnership that unites academics, practitioners and policy makers to improve the planning and governance of dams.

Wednesday, March 13th 2019, 4:00 -5:30 pm, University Place 3.204:
Dale Whittington, University of North Carolina, Chapel Hill and University of Manchester

Tuesday, March 26th 2019, 12:00 -1:00 pm, University Place 1.219:
Emanuele Fantini, IHE Delft Institute for Water Education

Tuesday, April 30th 2019, 4:00 – 5:30 pm, University Place 2.220:
Anna Mdee, University of Leeds

Thursday, May 9th 2019 at 12:00 – 1:00 pm, Congo Room, 2nd floor, Arthur Lewis Building:
Amruta Pradhan, Ashoka Trust for Research in Ecology and the Environment, India
(Work in Progress Seminar)

Wednesday, May 15th 2019, 4:00 – 5:30 pm, Humanities Bridgeford Street, G32:
Frauke Urban, KTH Royal Institute of Technology

Lectures are free and open to all.
For more information visit www.futuredams.org
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water-energy-food-environment
Mega-Systems

Annex C: Abstract for the Seminar

Environmental Governance of Dams: Experience of Maharashtra, India



Amruta Pradhan

Bio: Amruta Pradhan is a PhD student at Ashoka Trust for Research in Ecology and Environment (ATREE), Bangalore, India. Her PhD research topic revolves around ecological & social impacts of dams and their overall governance. Prior to joining ATREE, she worked for four years as Assistant Coordinator at South Asia Network in Dams, Rivers and People, SANDRP where she developed field experience in research and advocacy around dams in India. Her PhD research focuses on conducting post-facto assessments of dams in ecologically sensitive landscapes. This presentation is aimed at presenting the context of her research to explore possible collaborative research with the GCRF Future Dams project.

Abstract

India is the third largest dam building country in the world with over 5000 large dams. When it comes to dams, Maharashtra state in western India is a very peculiar case. 36% of India's large dams (over 1800) are in Maharashtra alone. The state spent 72,000 Cr (INR) on irrigation projects in the 2000-2010 decade, yet the increase in the irrigated area of the state was dismal at 0.1%. In Maharashtra, dams are a strong expression of political economy. From planning and design of the dams to discharge of water for irrigation—nearly all the processes are taken over to serve the political and economic interests of a few.

In India, Environmental Clearance (EC) from the Ministry of Environment Forest and Climate Change (MoEFCC) is the only window for scrutiny of the environmental and social impacts of the dams. An Expert Appraisal Committee (EAC) constituted by the MoEFCC is responsible for scrutinising the projects based on Environmental Impact Assessment Reports (EIA). The EIAs commissioned by the project proponent (typically the state governments), and prepared by EIA consultants, are often of poor quality. In absence of any thresholds for environmental impacts as well as robust methods for assessing them—the decision to recommend the project for EC often comes across as highly subjective without any scientific basis. Violations and irregularities are often overlooked. Thus EAC, which is supposed to guard against the adverse environmental impacts of dams, instead acts as a facilitator.

While the political economy of planning has been investigated, there has been no performance assessment of dams studying how dams have delivered the promised benefits and how far have been their environmental impacts, making it impossible to learn from past mistakes

Her research focuses on the Wainganga river basin (14,298 sq km) in Maharashtra. Here the trade-offs between environment and development are particularly sharp. Despite the region having high rainfall and small scale irrigation facilities built 400 years ago; pushing dams continues to be seen as the only solution in this forested landscape, which is a critical tiger habitat. The need for irrigation conflicts with forest conservation. Yet, Maharashtra state continues to build more dams even in this ecologically sensitive landscape.

Through my research, she hopes to develop robust methodological tools to assess the costs and benefits of dams, looking at both irrigation and conservation, so as to inform the EIA process.



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