

# A Water Balance Analysis to Support Sustainable River Basin Management in Desert River Luni, India

Report of Researcher Exchange June 2019

August 2020



INDIA-UK  
Water Centre  
भारत-यूके  
जल केन्द्र

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[www.iukwc.org](http://www.iukwc.org)

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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

*Front cover image: Groundwater exposed in scour hole of bed of Luni river during dry season.  
Photograph courtesy of Professor Paul Carling*

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# Executive Summary

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This report represents an overview of the activities carried out under a Senior Researcher Exchange funded by the India-UK Water Centre (IUKWC) on the topic of “A water balance analysis to support sustainable river basin management in desert River Luni, India”. The exchange was undertaken by Dr. Padmini Pani, Jawaharlal Nehru University, New Delhi, from 2<sup>nd</sup> June to 23<sup>rd</sup> June 2019 and was hosted by Professor Paul Carling from University of Lancaster, UK.

This researcher exchange aimed to contribute to the development of a balanced and sustainable river basin ecosystem support system to fulfil the basic water needs of stakeholders of the Luni river basin. This involved development of rainfall-runoff statistical models for translation of floods of different recurrence intervals in the Luni River to determine water availability during and post monsoon season. The collaborators in particular, aimed to determine the quantity of loss of surface water through evaporation and transmission to the groundwater.

# 1. Activity Leads

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

**Lead Researcher**

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**Host Researcher**

Professor Paul A Carling

Lancaster Environment Centre

Lancaster University

United Kingdom

The Exchange was held at Lancaster Environment Centre, Lancaster University, United Kingdom between 2<sup>nd</sup> June and 23<sup>rd</sup> June 2019.

## 2. Aims

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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.

Improved and sustainable water resource management has the potential to positively influence the Water–Energy–Food nexus and sustain the integrity of natural ecosystems. Further, improved water use efficiency directly impacts majority of livelihood practices like agricultural, energy, forestry, industry, etc.

The Luni river system is one of the major river systems in Rajasthan and forms the only integrated drainage basin (34866 km<sup>2</sup>) in northwest arid India (Thar desert region; Pechlivanidis 2015). This Researcher Exchange aimed to contribute to the development of a balanced and sustainable river basin ecosystem support system to fulfil the basic water needs of stakeholders of the Luni river basin. This involved development of rainfall-runoff statistical models for translation of floods of different recurrence intervals in the Luni River to determine water availability during and after the monsoon season. The collaborators in particular, aimed to determine the quantity of loss of surface water through evaporation and transmission to the groundwater.

The main objectives of the project were to:

- Develop a project proposal on sustainable river management of River Luni
- Identify and obtain hydro meteorological data (precipitation, air temperature and evaporation) for the Luni Basin along with determination of river flow data
- Explore collaboration options with Lancaster University for analysis of the Luni river basin data (the University of Lancaster is a leader in statistical and modelling of rainfall runoff)
- Conduct preliminary analysis of obtained data sets to be used as ‘proof-of-concept’ for further funding application.

Apart from the above objectives, the authors also aimed to develop a network of researchers with varied expertise and disciplinary focus, and stakeholders (including local authorities and institutions that control data repositories and are key beneficiaries of the project outputs). They further developed cross-sectoral collaborations during Prof Carling’s visit to India in 2019.

## 3. Structure

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The major focus of the Exchange during its first phase was to develop an understanding of the nature of the hydro – meteorological data that was collected from different organisations. Understanding the scale issues and chronological orientation of the data was found to be quite time consuming. Data for more than five decades has been classified and arranged during this three week programme along with other activities.

A significant duration of the Exchange period was dedicated to developing a baseline understanding of the selected basin; this included literature surveys, procurement of secondary data, the acquisition of missing data or data gaps, and the scale issues of the different sources of data and data arrangement for the water balance analysis to support sustainable river basin management. Regular discussions with the Host provided an enriching experience for the Lead researcher to get an opportunity to learn, to understand the data, and to develop a systematic scientific approach towards understanding a river system.

The Exchange also offered the Lead Researcher opportunities to interact and discuss with academicians of relevant research expertise; discussions with Professor Wlodek Tych (Principal, Furness College) and Professor Andrew Binley (Lancaster Environment Centre), in particular,

were thought to be very helpful. Professor Binley, a specialist in estimation and reduction of uncertainty in hydrological models, gave some insightful and inspiring thoughts regarding the hydro geophysics and scale issues. The discussions also revolved around techniques available to conduct hydraulic conductivity and permeability studies in the different lithologies; issues associated with mapping of ground water and surface water interactions; and plant-soil interactions.

Professor Wlodek Tych, an expert in time and spatial data series analysis, closely examined the collected data of the study basin; discussions with him centred on the feasibility of developing a dynamic data-based model using these data sets. It was found that the data sets did not currently represent an adequate spatial coverage for such models to be applied. However, it was thought that water balance analysis could be done using total evaporation estimates with these data sets. Though this would be an evolving process, a research paper could be prepared based on runoff, evaporation and water balance study in the near future.

Realising the scope of collaborative efforts similar to this Exchange, the Lead researcher and the Host have agreed to spend some more time to work further on this topic and to develop a post-exchange plan to carry forward research ideas generated.

Indepth brainstorming discussion sessions held with the Host and the dean, Professor Peter Atkinson, Lancaster Environment Centre, helped layout the scope, task division and follow-up action of the Exchange. A plan for a research project focusing on river sustainability and socio-economic development of the region involving the participants was chalked out, as a follow-up action to the Exchange. Funding sources and options for the above potential project were also discussed.

The above discussions also led to the formulation of a broad framework for a research paper; the plan being to use time series cross section data to understand river bed dynamics. The relationship between rainfall and discharge over six decades, combined with the land-use land-cover change analysis for the last 70 years is expected to provide the background understanding for this paper. The paper will address the anticipated outcomes of the initial project proposal, i.e. to develop sophisticated approaches to identify impacts of multidimensional responses of physical changes in the river and its landscape. Due consideration will be given to balancing the needs of people and developing a practical and economical solution to minimise the degree of changes of the river basin. The outcome of this research would help policy makers to develop resilience towards climate change induced uncertainties, and balance policy with strategies for sustainable river basin management.

To conclude the Exchange, the Lead Researcher gained further insight about sustainable river system and water balance, through interactions, meetings, visiting laboratories, etc. The knowledge and skills acquired during this visit will prove to be useful to the lead to train and supervise M.Phil and PhD students in India. In spite of an insufficient timeframe, the Exchange indeed proved to be an important learning opportunity for the Lead researcher.

## **4. Conclusions and Outputs**

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Activities conducted during this Research Exchange offered a common outlook to discuss integration of decades of data and rainfall runoff relationships to address research gaps in water balance and river systems research. It is felt that a sustainable river system approach, integrating ecosystem services, needs to be adopted for long-term sustainability.

### **4.1. Key outcomes arising**

The most valuable contribution of this Exchange was the effort to develop a new approach to facilitate the fusion of hydrological and geophysical data to achieve improved river system





*Sandy bed of Luni River during dry season (Photograph courtesy of: Professor Paul Carling)*

management. It is indeed a practical and useful methodology for understanding groundwater-surface water interactions in an arid area. Integration of socio-economic data with surface water and climate data proved to be extremely useful for unravelling complexities of this vulnerable ecosystem. This mixed method approach complimented by RS & GIS, can be used for vulnerable flood zone analysis and for developing localised river basin management solutions.

Another significant outcome of this Research Exchange is the framework for a paper which will be co-authored with the newly developed collaborations from this Exchange. The paper is planned to be a preliminary step towards building a research proposal to further the outcomes of this Exchange in the form of a project. Last but not the least, if the above soon to be developed research proposal is able to get funding for future research, the impact and application of this Exchange will increase immensely in various ways:

- Young researchers, scientists and varied levels of stakeholders will benefit from training and exposure through different project activities, including workshops .
- Baseline data generation on the study basin will have an impact on quality of future research projects and will also be helpful to undertake informed decision making and to design customised policy instruments for the region.
- The outcome of the research would help further proper management practice and decision-making, as well as helping to develop an improved approach for better water resource management in the study region.

## 4.2. Conclusions

This Researcher Exchange provided a valuable learning opportunity for the Lead researcher, as this exposure certainly increased understanding of the current state of knowledge of the subject concerned. This fresh and improved perspective will enable the Lead researcher to train young researchers through her teaching at post graduate and M.Phil scale, and in her supervision of PhD students. The Host Prof. Paul Carling is a renowned river scientist who has worked for



decades on sedimentology and large river systems; given his experience and expertise, the interactions with the Lead researcher and associated knowledge exchange in regards to the study area has the potential to contribute much, not only towards creating extremely useful baseline data, but also to overall improvement in management of the desert river system.

The exchange visit has provided the researchers with an opportunity for developing a long-term collaborative research project on the River Luni, and associated desert river system. This research proposal, if successful in getting the required funding, will create the scope for sustained collaboration between researchers based in the UK and in India.

## References

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Pechlivanidis, I., Olsson, J., Sharma, D., Bosshard, T. and Sharma, K.C., 2015. Assessment of the climate change impacts on the water resources of the Luni region, India. *Global NEST Journal*, 17(1), pp.29-40.

## 5. Annexes

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### Annex A: Agenda

<b>Date</b>	<b>Agenda item</b>
03/06/2019 05/06/2019	<ul style="list-style-type: none"><li>• Meeting with office staff for library access, and for other formalities,</li><li>• Literature collections and review</li></ul>
06/06/2019 07/06/2019	<ul style="list-style-type: none"><li>• Work Plan with the host Professor</li><li>• Data procurement and preparation</li><li>• Meeting with host professor and Dean, Land and Environment Centre, Lancaster University</li></ul>
10/06/2019 14/06/2019	<ul style="list-style-type: none"><li>• Meeting with Professors</li><li>• Data Preparation</li><li>• Data analysis</li><li>• Working on possible models for case study</li></ul>
17/06/2019 21/06/2019	<ul style="list-style-type: none"><li>• Working on possible models for case study</li><li>• Data Preparation</li><li>• Meeting with host</li><li>• Discussion on research paper framework</li><li>• Working on Research paper framework</li><li>• Visit Lancaster environment Centre Research laboratories</li></ul>

*Back cover image: Groundwater exposed in scour hole of bed of Luni river during dry season.  
Photograph courtesy of Professor Paul Carling*



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