Final Evaluation Report

Your Details	
Full Name	Suman Raja Jumani
Project Title	An Index-Based Approach for Basin-Wide River Conservation and Restoration Planning
Application ID	28427-2
Grant Amount	£6,000
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1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
1. Development and validation of an index-based approach to assess the impacts of existing and proposed river infrastructure projects				
1.1 Off-field data collection and development of the theoretical framework				We have proposed two new indices of river network fragmentation – the Catchment Area-based Fragmentation Index (CAFI) and the Catchment Area- and Rainfall-based Fragmentation Index (CARFI). These indices have further been applied in simulated and actual catchments to further illustrate their properties and applications. This is now being submitted as a manuscript to the journal *Ecological Indicators* for publication.
1.2 On-field data collection				Field data collection for index validation was conducted between January and March 2021. However, sampling was restricted to only freshwater fish communities, and did not include macroinvertebrates as originally planned.
2. Data analysis and validation of index-based approach				Field data has been analysed, and the results indicate that the CAFI is a good predictor of fish functional connectivity. This supports the application of the metric across spatial scales to infer loss of network connectivity, even in data-deficit riverscapes such as those in India.
3. Assessing trade-offs of river infrastructure development under various scenarios of dam development				The CAFI has been applied to the Netravathi River Basin, India and the Klamath River Basin, USA to inform basin-wide conservation and development planning. In the Netravathi, where dam building is still ongoing, prioritisation and sensitivity analyses were conducted to determine which of the proposed dams are 'good' (dams with low impact and high utility) and 'bad' (dams with high impact and low utility). Conversely, in the Klamath, the index was applied to determine priority sites for dam removal and mitigation. We are currently working

				on expanding these analyses across all river basins in the Western Ghats in India.
4. Develop a measure of flow alteration in collaboration with Mr. Pradeep Koulgi				Due to issues like cloud cover, patchy and inadequate coverage of Landsat data over space and time, the JRC Monthly Water History dataset was characterised by large proportions of missing data. This and its monthly frequency precluded the development of an effective flow alteration metric. Instead, the JRC surface water dataset was used to create a time series (1991-2018) of surface water trends for rivers and river basins across India. Outputs include a Google Earth Engine website that will allow users to visualise and download a time series of surface water area for rivers and basins across India (https://pradeepkoulgi.users.earthengine.app/view/india-changing-rivers-and-basins)
5. Creating a web-based platform to collect information on community-based fish sanctuaries in collaboration with Ms. Neethi Mahesh				In collaboration with Ms. Neethi Mahesh and Jackfruit Solutions, we have developed a web-application module on the Our Rivers Our Life website (https://www.ourriverourlife.com/home) to collect information on Community-based Fish Sanctuaries in India (https://www.ourriverourlife.com/fish-sanctuaries).

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

Delay in obtaining forest research permits: Due to my affiliation with a non-Indian University, I had to await central-level clearance from the National Biodiversity Authority before receiving my research permit. Furthermore, the government had revised the permit application procedure without putting up any public notice. Hence, there was a 4-month waiting period before my project was even considered. This delayed my field work by 3 months, and I was able to begin only by January 2021.

The COVID-19 pandemic: The Indian Government announced a nationwide lockdown on 25th March 2020, by which time I was only able to sample 33 sites. Thereafter, I was forced to abandon fieldwork and return to the city. This prevented me from sampling streams in the Yettinahole and Bisle regions of the Netravathi river

basin. I worked around this by incorporating the data I collected from my previous work in 2014 into my current dataset.

The onset of the monsoons: Although travel restrictions were lifted by the end of May 2020, I was unable to resume fieldwork since the monsoon rains had begun. Since my study aims at assessing impacts in the water-scarce dry season, sampling the rivers in the monsoon was not ideal. Further, given that the rivers were in torrential flow, it was dangerous to resume sampling at that time.

Missing data in the JRC Monthly Water History v1.2 (Pekel et al. 2016) dataset: The large proportion of missing data across spatial and temporal scales precluded its application in quantifying flow alteration. We worked around this constraint by working with a subset of the data to create seasonal composites of surface water for dry (February to April) and wet (October to December) seasons. These seasonal composites were used to evaluate temporal trends in surface water area in: (1) transects laid across rivers throughout India; and (2) sub-basins and basins in east and west flowing rivers of peninsular India.

3. Briefly describe the three most important outcomes of your project.

Creation and validation of a new index to measure river fragmentation: The CAFI and CARFI are effective metrics that can assess the impact of individual and cumulative barriers on river network fragmentation across spatio-temporal scales. The index can be computed even in data-deficit landscapes, can be weighted by ecological data of interest, and can be used to assess a range of scenarios due to its computational efficiency. We were further able to validate the ecological relevance of this metric based on primary field data collection. At the scale of 1st to 4th order streams, the CAFI and CARFI were able to significantly predict fish functional connectivity in the Netravathi River basin. These results are expected to be published soon in a peer-reviewed scientific journal.

Conservation and development plans for river basins in the Western Ghats: Our index of river fragmentation has been used along with information on freshwater fish biodiversity and flow regulation to identify how past, present, and future dam development has affected river systems in the Western Ghats. In examining these variables across spatial and temporal scales, we can now develop river basin conservation and development plans for each basin of interest in the Western Ghats. This work enables us to identify key sites for conservation to be declared as 'no-go' zones, priority dam sites for river restoration or dam removal, and identify 'good' and 'bad' dams among the list of proposed projects. This is one of our most important outputs, having direct potential for on-ground conservation application.

Creation of a website to visualise and download information on surface water trends across India: In collaboration with Mr. Pradeep Koulgi, we used the JRC Monthly Water History dataset to create a time series (1991-2018) of surface water trends for rivers and river basins across India. These trends of seasonal and permanent surface water change can be visualised and downloaded for rivers and basins across India from a Google Earth Engine website

(https://pradeepkoulgi.users.earthengine.app/view/india-changing-rivers-and-basins)

4. What do you consider to be the most significant achievement of this work?

Given all the constraints we faced the past year, I believe our most significant achievement has been to adapt and achieve most of our objectives. Our work on river fragmentation indices and their application in conservation planning has been an important achievement. This will help us create basin-wide conservation plans that can have direct application in conservation and development planning. This work is the first step towards building effective science-based decision-making tools.

5. Briefly describe the involvement of local communities and how they have benefitted from the project.

This project had minimal direct involvement with local communities. However, our work on community-based fish sanctuaries examined them as complex socio-ecological systems (paper in review with the journal *Oryx*) and highlights the crucial role of local communities in participatory decision-making and management of freshwater resources. We plan to expand this work in our next steps and have a deeper collaboration with local communities.

6. Are there any plans to continue this work?

Yes. So far, we have used case studies to illustrate the application of an index-based approach in aiding science-based decision-making pertaining to basin-wide conservation planning. In next steps, we will aim to expand this approach across larger spatial scales, as well as incorporate additional variables of interest to further develop more holistic spatial river conservation plans for the Western Ghats. This is crucial since ongoing and future dam developments that are concentrated in this region overlap with areas of high freshwater diversity and endemism. We will also endeavour to develop an interactive portal that allows for these indices to be computed and displayed with maps and graphs, so that citizens, stakeholders and policy makers can use it as a tool to assess potential impacts of specific dams. Additionally, basin-level analyses to determine trends in surface water area will also be pursues using the JRC derived seasonal surface water composites.

7. How do you plan to share the results of your work with others?

- All major findings and associated code will be published in peer-reviewed scientific journals.

- Findings pertaining to river-basin conservation plans will be shared through popular scientific writings. Additionally, regional basin-specific reports will be created and shared with relevant decision-makers (such as various State Boards for Wildlife and State Forest Departments), NGOs and conservationists for maximum impact.

- Transect-level and basin-level surface water time-series data has been published as an interactive Google Earth Engine application (https://pradeepkoulgi.users.earthengine.app/view/india-changing-rivers-and-basins). This will allow any user to access processed data for a region of interest to be used for academic, conservation action, or planning efforts.

- The citizen-science initiative on community-based fish sanctuaries hosted on the Our River Our Life website will be actively shared across social media platforms to maximise engagement. All data will be publicly available to users as well.

8. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

The grant was used over a period of 23 months instead of the anticipated 12 months due to delays and constraints outlined above. The specific components of the study and their timeline is mentioned below:

- Off-field data collection and development of the theoretical framework: A large part of this was completed before the grant, though work on the conceptual development progressed during the granting phase as well.

- On-field data collection: January 2020 to March 2020 (as opposed to the anticipated October 2019 to April 2020).

- Data analysis and validation of index-based approach: May 2020 to November 2020 (as opposed to the anticipated February 2020 to June 2020).

- Assessing trade-offs of river infrastructure development under various scenarios of dam development: January 2021 to August 2021 (as opposed to the anticipated July 2020 to September 2020).

- JRC surface water time series analysis: February 2021 to August 2021.

- Web-based platform on community-based fish sanctuaries: August 2021.

9. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Administrative overhead & office support	545	560	+15	
Contingency costs	35	35		
Equipment & stationery	340	625	+285	A new GPS unit was needed since the previous one used on field broke
Vehicle hiring charges	180	178	-2	
Fuel costs for vehicle	200	181	-19	
Field food costs	350	239	-111	
Field lodging	550	410	-140	
Field assistant wage	550	520	-30	
Per diem for research associate	2700	2702	+2	
Printing and postage costs	50	50		
Website development	500	500		
TOTAL	**6000**	**6000**		

10. Looking ahead, what do you feel are the important next steps?

- Incorporating additional variables in river-basin conservation and development optimisation studies.

- Creating interactive maps and web-based applications to help users visualise key river conservation zones, changes in river fragmentation and flow regulation with varying scenarios of dam development, and priority sites for river restoration. This can help guide basin-wide conservation and development plans.

- Improving the inventory of existing and proposed river infrastructure projects to better inform the above steps.

- Active and effective collaborations with decision-makers and stakeholders to translate our scientific findings towards on-ground action.

- Highlighting the role of community-based fish sanctuaries as tools for freshwater fish conservation in India. Also, working with local communities to facilitate the creation of additional community-based fish sanctuaries and studying their impact on fish population dynamics, water quality, and other ecosystem services.

11. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

The logo was used in an oral presentation and a poster presentation made at the Society for Freshwater Science conference, 2021. Additionally, the Rufford Foundation has been acknowledged in my manuscript (to be submitted to *Ecological Indicators*), and in all presentations of this work, including at the University of Florida, USA and in India. The Google Earth Engine application (https://pradeepkoulgi.users.earthengine.app/view/india-changing-rivers-and-basins) also acknowledges the Rufford Foundation for financial support. Through these platforms, the RF has received some publicity during our work.

12. Please provide a full list of all the members of your team and briefly what was their role in the project.

Dr. Matthew Deitch – My doctoral advisor

Dr. Jagdish Krishnaswamy and Ashoka Trust for Research in Ecology and the Environment (ATREE) – Advice and institutional support
Foundation for Ecological Research, Advocacy and Learning – Institutional support

Mr. Joel Correa – Research associate for field-based validation of the AFI

Mr. Babu and Mr. Daya – Local field assistants and fishermen for field data collection

Mr. Pradeep Koulgi - Research associate for geospatial data analysis for the surface water data analyses

Ms. Neethi Mahesh – Collaborator to develop a citizen science section on community-based fish sanctuaries in India on their website https://www.ourriverourlife.com.

13. Any other comments?