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In Focus: Landscape Connectivity

VAISHALI VASUDEVA | UNIVERSITY OF BRITISH COLUMBIA
MEERA MAKWANA | WILDLIFE INSTITUTE OF INDIA

One of the main reasons for species loss and population decline is the loss of habitat or decline in the quality of habitat available to the species. Vast areas of undisturbed habitat are no longer available and therefore it has a direct impact on animal migration and population viability. Restoring habitats and their connectivity through corridors is one of the main priorities in wildlife conservation and very much needed to restore the population viability. In India, attempts have been made to study movement and corridors more commonly for species like elephants and tigers and in few instances for iconic species like red panda (Fig. 1). Many of these studies have tried to quantify structural connectivity i.e., physical connectedness of the patches based on shape, size and location for a specific species or potential connectivity that involves very limited movement data and functional connectivity that relies on actual movement data or genetic evidence of animal movement between two patches.

Further, approaches used to quantify the connectivity are many but dominated by least cost path approaches or circuit theory (Fig. 2). In this approach, corridors are often envisioned as linear paths in a matrix which an individual can easily traverse and links are established between patches which are most often protected areas. An alternative perspective to see corridors as non-continuous and non-linear paths or in fact 'areas', is still new in India. Although, to some extent, individual-based spatially explicit movement models can overcome some of the limitations of connectivity indices and cost-path models. In the absence of fine-scale movement data which is provided by satellite telemetry, most studies remain unvalidated. While we continue to face conservation challenges and there will always be data gaps, there is a need to come up with innovative ways to deal with these challenges.

Parameterisation of resistance surface, which is one of the crucial steps in connectivity modelling, has been achieved mainly through (1) expert opinions / literature review (2) inverse of occupancy or habitat suitability and less often through resource selection function models (Fig 2.). Multi-scale models to build resistance surface and selecting appropriate scale for predicting corridors are also comparatively less explored.

While intra-national collaborations are one way to share existing data and make best use of it, and international collaborations can help transfer models to Indian local contexts but coming up with smart and ecologically sound approaches to make best of little data is also needed. Sometimes, a simple model is more accurate than a very complex black-box model.

This issue

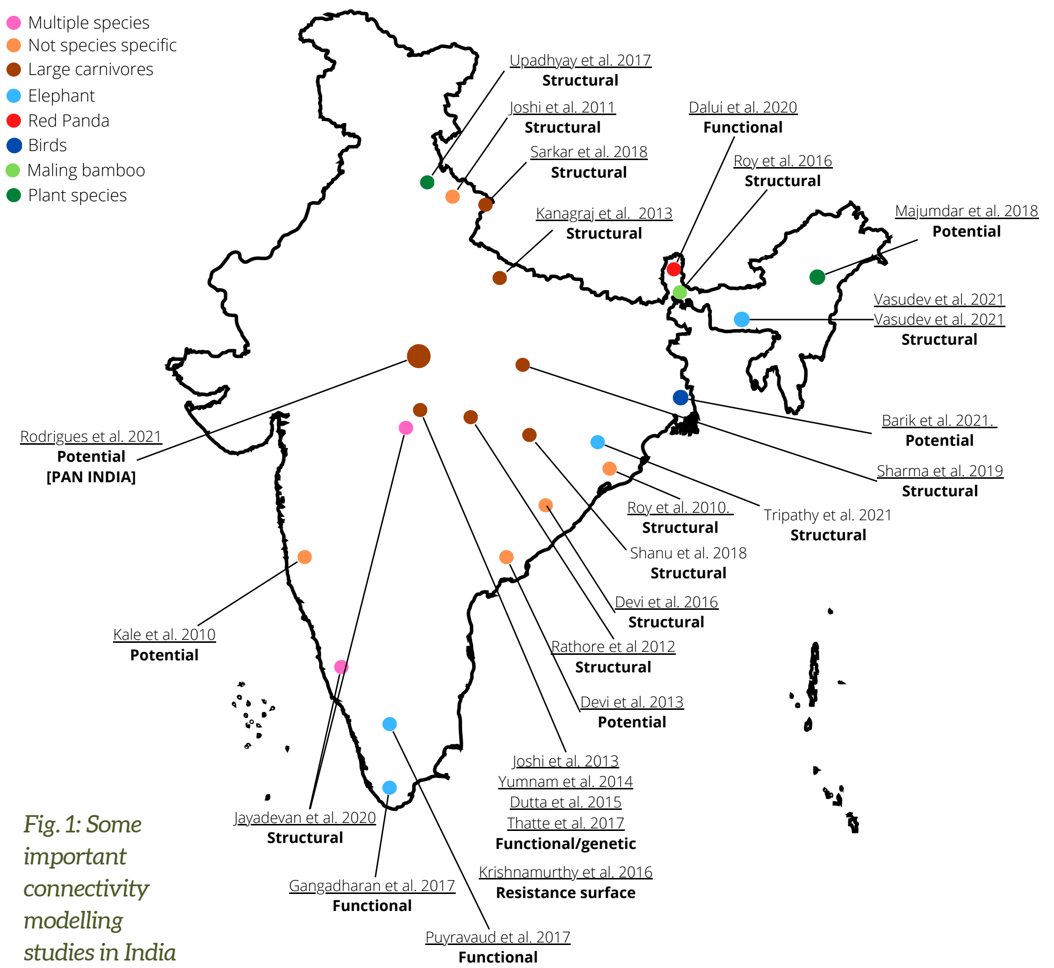

Fig. 1: Some important connectivity modelling studies in India

Methods for resistance surface

Expert opinion/Literature review

Kale et al. 2010
Rathore et al. 2012
Joshi et al. 2013
Dutta et al. 2015
Dutta et al. 2016

Habitat suitability/ Occupancy

Sarkar et al. 2018
Majumdar et al. 2018
Sharma et al. 2019
Vasudev et al. 2021
Tripathi et al. 2021
Barik et al. 2021

Multi-scale path selection function

Krishnamurthy et al. 2016

Methods/tools to quantify connectivity

Linkage Mapper

Dutta et al. 2015
Dutta et al. 2016

Circuitscape

Joshi et al. 2013
Yumnam et al. 2014
Sharma et al. 2019
Dalui et al. 2020
Barik et al. 2021
Rodrigues et al. 2021

UNICOR

Sarkar et al. 2018

Individually-based spatially explicit model

Kanagraj et al. 2013

Fig. 2: Commonly used approaches for resistance surface parameterisation and connectivity quantification

Free flowing stretch of Nayar River

Restoring freshwater connectivity: Lessons for India

DR. VIDYADHAR ATKORE

SALIM ALI CENTRE FOR ORNITHOLOGY AND NATURAL HISTORY | TAMIL NADU

Freshwater ecosystems and associated life is imperilled largely due to hydrological modifications due to dams, water diversion and overexploitation. Since the 1970's we have lost more than 83% of the freshwater species population and one-third of wetland habitat. Freshwater fishes- a vital component of freshwater ecosystems, have witnessed a sharp decline all over the world. Especially the large mega fishes (body size >30 cm) have drastically declined by more than 98 % on earth (Hughes 2021). This huge loss of freshwater biodiversity is not only affecting vital ecological balance but also an important means of livelihood for marginalized communities.

Globally, there is a significant interest among the citizens to make our rivers flow freely throughout their course. As a result, more than 4984 dams have been removed in many countries in Europe. One of the visions of the EU's 2030 Biodiversity Strategy is to restore 25000 km of rivers and stop their degradation. On similar lines, WWF is also working on maintaining healthy freshwater ecosystems, especially for rivers all over the world. In 2019, a paper published in Nature suggests that less than one-third of rivers remain free-flowing on the earth's surface (Grill et al 2019). This was one of the first attempts to map free-flowing river stretches on the earth enabling us to initiate more concrete steps.

Worldwide these days, dams whether big or small are being removed to restore freshwater connectivity. For instance, the dam removal progress report revealed that 4984 dams or barriers have been removed from many European countries. The EU's 2030 Biodiversity Strategy aims at restoring 25000 km of rivers across Europe to restore the degradation of freshwater ecosystems. Similarly, WWF aims at maintaining healthy freshwater ecosystems on earth. Recently freshwater scientists have suggested an Emergency Recovery Plan for Freshwater Biodiversity (Tickner et al 2020) and it has already proven successful in certain locations. This includes, (1) Accelerating the implementation of environmental flows, (2) Improving water quality, (3) Protecting and restoring critical habitats, (4) Managing exploitation of species and riverine aggregates, (5) Preventing and controlling non-native species invasion and (6) Safeguarding and restoring freshwater connectivity (Tickner et al 2020).

Ensuring and maintaining a free-flowing state of rivers is the single most important restoration effort that can meet many of these conservation actions. Although there are examples and best practices to follow to map existing river barriers and initiate people's movement on dam removal. For instance, an extremely dynamic website (https://damremoval.eu) and a phone-based app called 'AMBER' or Adaptive Management of Barriers in European Rivers' (https://amber.international/about/) enable one to map river barriers in their location by simply signing up on the app. Although this app is started by a research group based in Europe which has mapped thousands of barriers across Europe, most other developed and developing countries like ours are yet to initiate this.

Fish migration

Photo credits: N. Lakshminarayanan

What do we learn from these global efforts here in India? A cursory look at India's number of dams perhaps makes us feel good for a moment. For instance, we are only the second largest dam-building nation in the world with close to 5000 dams and there is not a single instance where our policymakers have thought about decommissioning our age-old dams and barriers! Even today, more than hundreds of dams are in the operation stage and many more are proposed. How long we are going to lose fragile riverine biodiversity and the livelihoods of our people? I think, it is high time for all of us to come together to think and initiate action on the ground, maybe develop a similar app for the Indian region and map all the barriers on our rivers including free-flowing riverine stretches in the country.

Past research has demonstrated that a significant level of fish endemicity thrives only in the free-flowing riverine habitats (Atkore et al 2020) and undammed tributaries help restore fish species recovery downstream of dams (Atkore et al 2017). Elsewhere, empirical research has shown that big river fishes such as Golden mahseer (*Tor putitora*) and Chocolate mahseer (*Neolissochilus hexagonolepis*) are able to migrate up to a distance of 100 km in dam-free river stretches in Bhutan (Phillip and Clausen 2015; Lovegren 2019). They perform migration two to three times a year. Researchers have also demonstrated that tagged mahseer was waiting downstream trying to find other possible undammed tributaries to migrate. Such ecologically insightful results can only be possible with strong fish tagging data which is a costly affair but to restore fish and its habitat many stakeholders need to join hands to curb anthropogenic threats such as dam building, sand mining and illegal fishing practices. It is also high time that such empirical research on understanding the movement ecology of freshwater organisms guide our dam building policies and provide alternative solutions (fish passages, identify key indicator species and their linkages with hydrology or minimum ecological flow) to map and restore connectivity.

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Phillip D and J Claussen (2015). Using Radio Telemetry to study Mahseer movement in Bhutan. https://www.fishconserve.org/wordpress/wp-content/uploads/2015/08/Mahaseer-Post-Trip-Report-Final-MAY2015.compressed.pdf

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Fish tagging in Nayar River
Photo credits: Vidyadhar Atkore

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MEMBERS IN ACTION

Understanding the dynamics of landscape change in a pristine riverine system- The Bhagirathi basin

TANVI GAUR | WILDLIFE INSTITUTE OF INDIA

In the past, rivers have been the primary centre for the evolution of many civilizations. They are revered ecologically, socially and culturally throughout history. The human settlements and civilization of major cultures and tribes have derived their values from rivers. My research focuses on one such mountainous riverine landscape named the Bhagirathi basin. The river 'Bhagirathi' originates in the ice cave of Gaumukh, at the snout of the Gangotri glacier (4100 m above sea level) and is referred to as river Ganga at the point of confluence (Devprayag) with river Alaknanda. Being a city girl, I was always fascinated by the surreal beauty of the mountains and fortunately got a chance to work in the landscape ecology and visualization lab under the NMSHE (National Mission for sustaining Himalaya ecosystem) project that focused on the impacts of climate change in the Indian Himalaya.

Riverine landscapes are one of the most dynamic and vulnerable natural ecosystems that are influenced by historical and current land use practices. They are a repository for providing diverse ecosystem services and maintaining a network of dispersal corridors for many species. The Himalayan riverine landscapes have undergone major modifications over time through land use change, climate change and water resource development activities. For my PhD, I intended to understand the spatiotemporal dynamics in one such riverine landscape, the Bhagirathi basin. Another objective of my research work is to map the ecosystem services using geospatial tools and identify areas for spatial conservation prioritization. For the first objective, we estimated the landuse/land cover (LULC) change in the basin over a period of 22 years (from 1993 to 2015) using the Landsat satellite data at 30 m spatial resolution. We also addressed the concerning issue of forest fragmentation in the river basin using the tool FRAGSTATS. The results indicated that the area under the dense forest cover has declined over time while there was a significant increase in the open forest area. We also found a considerable conversion of dense forest into open forest characterized by the proliferation of much smaller, less connected forest patches. Apart from the vulnerability arising from natural disasters, the river Bhagirathi is heavily dammed due to enormous hydropower potential that alters the river's natural flow. Hence, landscape level assessment and planning are needed to protect such ever-dynamic and vulnerable landscapes, which are also not protected under law.

Our study is a pioneering attempt in filling the information gap in the Himalayan landscape, which are poorly researched due to inaccessibility. The overall trends that emerged from our study gave a synoptic view of spatiotemporal landscape change and forest fragmentation processes in the difficult mountain terrains with high elevational gradients. The findings from our study can be utilized for forest conservation and landscape management at a broader scale.

Paper citation: Gaur, T., Sinha, A., Adhikari, B. S., & Ramesh, K. (2019). Dynamics of landscape change in a mountainous river basin: a case study of the Bhagirathi river, western Himalaya. Applied Ecology and Environmental Research, 17(4), 8271-8289.DOI: http://dx.doi.org/10.15666/aeer/1704_82718289

Tanvi has worked as a Senior Project Fellow in the DST-NMSHE project from the year 2015 to 2020. Presently, she is pursuing her PhD under the guidance of Dr K. Ramesh, Scientist-E, Wildlife Institute of India. Apart from her PhD, her research also focuses on identifying the nexus between ecosystem services and Quality of life in the Bhagirathi basin using a landscape-level approach in collaboration with Dr Sarah E. Gergel, Professor of Landscape Ecology & Conservation and Dr Hisham Zerriffi, Associate Professor, the University of British Columbia as a part of Queen Elizabeth Scholarship (QES) programme.

Membership Renewal

Requesting members whose membership ended last year or before but was extended until 2021 to kindly visit the page to renew it at the earliest. Those who became member last year (2021) will have their membership until one year from the date of registration.

Members can now choose between annual and term membership based on their interest.

Membership type	Tenure	Membership Fee (INR)
Student	Annual	1000
	Term (3 Years)	2500
Regular	Annual	2000
	Term (3 Years)	5000
Institutional	Annual	10000
	Term (3 Years)	25000

Opportunities

Workshop on Earth Observation for Ecosystem Accounting | ESA

Deadline 12 September | Dates: 28 November - 1 December | Find more here

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Deadline 31 August| Find more here

Post Doc | Hyperspectral remote sensing for forest trait retrievals and biodiversity estimation | Italy

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