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Declining native fish, diminishing livelihood security: the predicament of Indian Himalayan communities

Nishikant Gupta^{1*}

¹International Centre for Integrated Mountain Development (ICIMOD), Post Box # 3226, Kathmandu, Nepal.

*Corresponding Author (nishikantgupta@live.in; +9779808022156)

Mark Everard²

²University of the West of England (UWE), Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY, UK. (Mark.Everard@uwe.ac.uk; +44-7747-120019)

Chhaya Vani Namchu³

³Integrated Mountain Initiative, 315/274, 2nd Floor, Westend Marg, M.B. Road, Saidul Ajaib, New Delhi 110030, India. (chhayavani@gmail.com; +919667911770)

Abstract

Native fish species provide significant ecosystem services, including as food (provisioning services), as organisms with specific cultural and spiritual importance (cultural services), and contributions to supporting and regulatory services across the Indian Himalayan biodiversity hotspot. Fisheries in the Himalayan midhills and foothills, including in the Shivalik Hills and parts of the Terai (between the lower Himalayan foothills and the plains), provide livelihood security and cultural values for millions of people. Multiple anthropogenic stressors compounded by climate change have significantly depleted native fish populations over recent decades. Literature survey, focus group discussions and semi-structured interviews reveal that the decrease in native fish species undermines freshwater-dependent livelihood security in the region with 'knock-on' impacts on downstream ecosystem functions and services. Better understanding of the current distribution, habitat requirement and dispersal of native fish species important from a local perspective is essential to manage the growing threats to livelihoods in the Indian Himalayan region.

Keywords

anthropogenic stressors; climate change; ecosystem services; freshwater; India

Introduction

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Flows in the rivers of the Indian Himalayas (IH henceforth) are dominated by rainfall runoff, inputs from glacial and snow melt (Shrestha et al. 2015). They support the livelihoods of millions of people within their catchments, and make substantial contributions to millions more in downstream reaches through supporting irrigation, domestic use, fisheries, tourism, transportation and hydropower (Alfthan et al. 2018). Soil and nutrients transported over considerable distances by these rivers to downstream floodplains contribute significantly to productive uses such as agriculture and fisheries. Over 2.5 million fishermen in India relying on the waters of the Brahmaputra River for their income and nutrition (Alfthan et al. 2018).

The IH region is also host to a high diversity of human settlement patterns, occupations and ways of life. Over 36 million people reside in the IH region and is also home to great cultural diversity (Table 1). This rich ethnic and cultural diversity is further linked to a multiplicity of ecosystem services and agrobiodiversity, which provides an important key to livelihood enhancement.

Table 1: Examples of cultural diversity in the Indian Himalayas

Indian Himalayan region	Cultural influences
Western Indian Himalayas	Influence of Afghan-Iranian culture
Central Indian Himalayas	Kumaon and Garhwal people known as ‘paharis’ (or ‘mountain people’)
Eastern Indian Himalayas	This region comprises the greatest cultural diversity, including ethnic and indigenous minorities such as: <ul style="list-style-type: none">• Bhutias, Gorkhas, native Lepchas in Sikkim and Arunachal Pradesh states; and• Akas, Daflas, Apa Tanis, Galongs, Abors and Mishmis, among others.

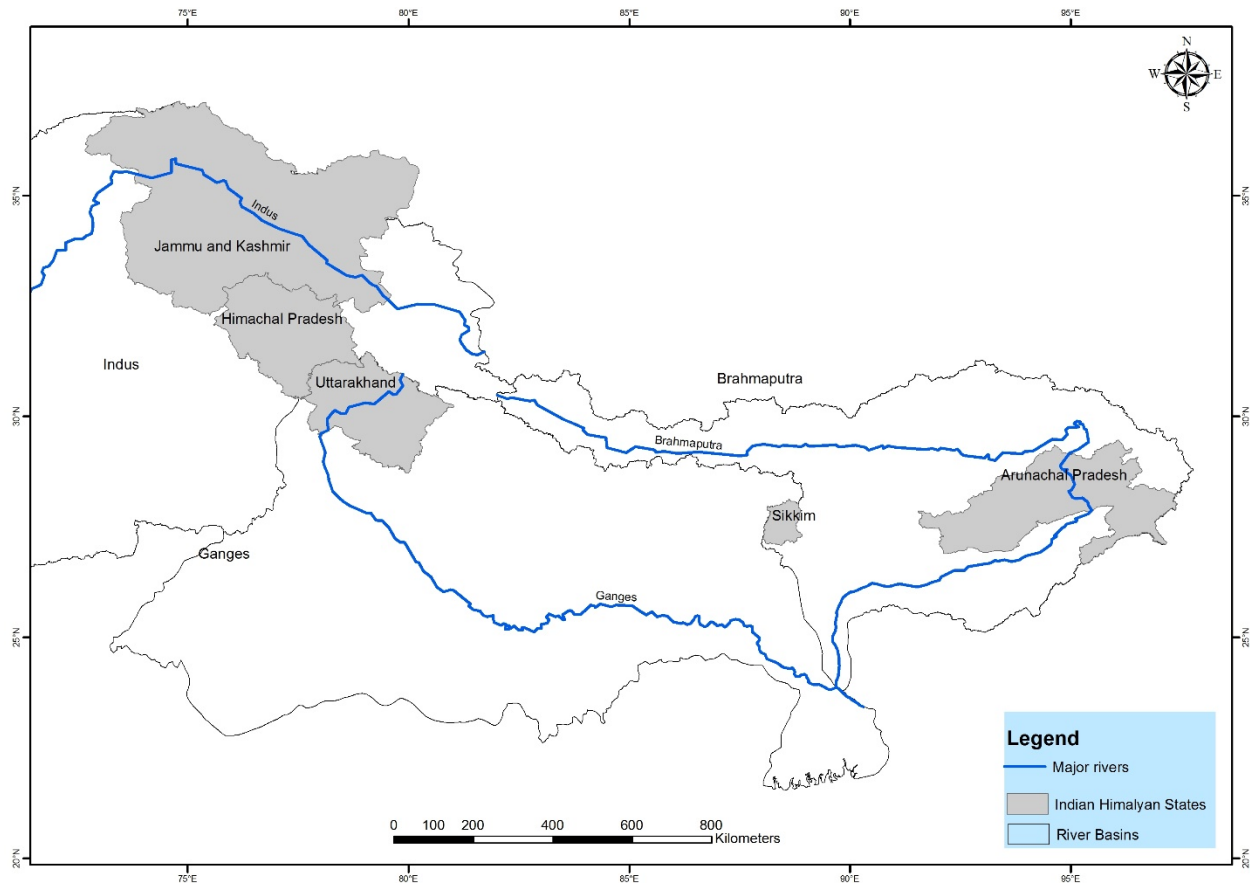
Despite the broad range and significance of the ecosystem service benefits that they provide, fish species native to the region continue to face increasing anthropogenic stressors leading to a diverse set of adverse impacts (Raut et al., 2019). These stressors are likely to increase in severity and diversity as human populations and resource demands rise, driving significant degradation and depletion of land and other natural resources, compounded by climate change. As one example of an emerging concern, the spread of non-native fish species and the apparently rapidly declining distribution of native fishes (Gupta and Everard, 2017) pose additional risks for the region’s livelihood security.

Methods

Literature review

An in-depth literature survey was carried out using Google Scholar to determine the human communities reliant on fish as a vital provisioning ecosystem service in five of the twelve Indian Himalayan States (from a geological viewpoint), i.e. Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh (Figure 1). A pilot survey of all IH states identified these five states as the most appropriate for focused study due to ease of access to sites, openness of communities, and local support. (Further research is currently being planned within the remaining IH states). The key literature search terms used were: ‘Indian Himalayan fish’; ‘Indian Himalayan ecosystem services’; ‘Himalayan communities’; ‘Provisioning services’; ‘Communities of Jammu and Kashmir’; ‘Communities of Himachal Pradesh’; ‘Communities of Uttarakhand’; ‘Communities of Sikkim’; and ‘Communities of Arunachal Pradesh’ using Google Scholar. Literature searches identified a total of 537 articles, of which 123 topic-relevant peer-reviewed, non-peer reviewed and ‘grey literature’ articles were read in full and included in the analysis. In this literature survey and considerations behind interviews and focus group discussions in this research, we used the Millennium Ecosystem Assessment (2005) classification of ecosystem services. We explicitly included supporting ecosystem services as, despite their redefinition as functions in some subsequent reclassifications (for example TEEB, 2010; Braat and de Groot, 2012) to avoid ‘double-counting’ of benefits to people, supporting services are nevertheless vital for the functioning, resilience and capacities of ecosystems to continue to provide a wide range of benefits to dependent communities, and are therefore central to informing management plans and decision-making.

Figure 1: A map showing the Indian Himalayan region, its basins and the examined state, (i.e. Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh)



Semi-structured interviews

Semi-structured interviews were also conducted with communities residing along the banks of the IH rivers (n=89; 79 males, 10 females; 16-72 years) to ascertain the amount of native species featuring in daily fish landings, and the potential impacts of trends in fish landings on the livelihood security of surveyed communities. The structure against which these interviews were held addressed the following questions:

- a) Which fish species do you commonly catch every day?
- b) How has the number, size and quantity of fish caught different than the last 10 years?
- c) Are fish species being caught now different from this earlier time?
- d) How is the selling price of the fish caught now different than in the last 10 years?

A total of 60 households were selected for interview during field surveys from the five IH states, with a significant response rate of 58 households offering feedback. It is appropriate to conclude for IH on the basis of 60 households from a small part of IH. A majority of the respondents to there were males, despite the presence of female members, as within local cultures men preferred to answer the questions in their roles as heads of surveyed households. Whilst female household members were present during the surveys, their representation was not made available due to the social structure of societies in this region as fishing grounds located outside the private space of

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the home are inaccessible to women. The community selection for the study was based on the voluntary willingness and the availability of community members in the study area during the field survey. Consent was requested and obtained from all participants to make notes of the conversations. All responses were anonymized so that respondents felt free to express their views.

Discussions took place primarily in local languages and dialects. Conversation flowed freely with no evidence of it being dominated by any individuals. Researchers fluent in local languages translated the responses, taking written notes in English and collating them following the meeting. Additional input was derived from literature searches (as seen in the citations used in this paper). Ecosystem services were introduced by conversation in locally relevant terms and in a semi-structured way rather than through a rigid questionnaire, reflecting the cultural differences between researchers and local people and the diversity of views of the interviewee group (following Everard et al. 2019). Discussion revolved around people's livelihoods and their relationships with the natural resources. Responses were stratified by the interviewers, enabling interviewees to respond freely rather than asking them rigorously to stick to precise questions limited just to specific services. Interviews terminated with thanks and confirmation of the consent to use anonymized input once interviewers had introduced and exhausted discussion. The research team also made direct observations in the area. When transferring responses into spreadsheet format from field notes, researchers stratified all feedback according to the Millennium Ecosystem Assessment (2005) ecosystem service classification.

Focus group discussions in the mid-hills of West Bengal

Focus group discussions (FGDs) were conducted only in the mid-hills of West Bengal (a sixth Indian Himalayan state) among the Lepcha fishermen community dependent on native fish species for their subsistence (n=41; all males; 27-40 years), and among local fishermen communities in the Jalpaiguri (West Bengal) floodplains (n=58; all males; 20-60 years). The structure of FGDs followed that of the questions asked of village communities in the other five IH states. It is accepted that there is gender bias in this survey of fishermen, though in practice the survey was representative of the fact that only men undertake fishing activities in this region.

Results

Results from literature review

The in-depth literature survey revealed the strong dependence of communities (N=13) on fish as a provisioning service (i.e. fisheries, aquaculture, and fish as a nutrient source or tradable commodity) within the five IH States (Table 2).

Table 2: Communities of five IH States (Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh) dependent on fish as a vital ecosystem (provisioning) service
(SOURCE: review of published/grey literature; N=123)

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State	Community/tribe	Fish (as a provisioning service)
Jammu and Kashmir	Balti, Arghons	Fisheries
Himachal Pradesh	Kinnaure, Lahules, Pangwal	Fish culture
Uttarakhand	Tharu, Bhotia, Jaunsari, Raji	Fisheries; fish as a nutrient source
Sikkim	Bhutiya, Lepcha	Fish as a nutrient source
Arunachal Pradesh	Apatani	Fish culture
	Nyishi	Fisheries; fish as a nutrient source

Results from semi-structured interviews

Interview respondents noted that a number of fish species (of local economic value) had disappeared from downstream reaches of the surveyed rivers including (using their local/indigenous names as reported): aar, bagar, papda, bhodor, uperchokha, chanda, kajori, and chingri. (Seeking definitive species identification on the basis of local names is challenging, the Fishbase website offering only *Ompok pabda*, the Pabdah catfish, as a plausible suggestion for ‘papda’, and *Parambassis ranga*, the Indian glassy fish, as a plausible suggestion for ‘chanda’.) The fish species which had disappeared were: bam (eels), jal kapur, khop, mahseer (golden mahseer, *Tor putitora*), and other catfish species. As a result, the male members of these fisher communities were also now being pushed towards outmigration to nearby towns and cities in search for improved livelihood security in comparison to the earnings from fishing activities earlier.

Results from focus group discussion in the mid-hills of West Bengal

FGDs revealed that the warming up of rivers, coupled with the decrease/uncertainty in the water level (dependent on monsoons), played a significant role in damaging fishing activities in the basin in the preceding 7-10 years, causing losses to local livelihoods (perception of respondents and supported by science, see Alftan et al. 2018). Fish landings were reported as being lower in quantity (total mass) of native fish landed (total landed mean body weight), also resulting in the unnecessary capture of juvenile life stages (both in wet and dry seasons) further hampering the long-term sustainability of the native fish populations.

Respondents from Jalpaiguri (West Bengal) reported that the area was formerly a breeding ground for numerous fish species from the Brahmaputra River in Bangladesh, but unpredictable river flows and water levels had drastically disturbed breeding leading to a decline in the variety, number, and individual mass (g) of fish caught in the past two decades (Table 3).

Table 3: Reduction in weight (g) of locally important fish species in downstream Teesta River in Jalpaiguri, West Bengal (based on the observations of local fishermen)

Local name	Mean weight (g)	
	20 years ago	Present (2017 – 2018)
Mohasol (mahseer spp.)	Up to 19000	2000
Boal (<i>Wallago attu</i>)	Up to 17000	700 – 1500
Soal (<i>Schizothorax richardsonii</i>)	3500	500 – 700
Magur (<i>Clarias batrachus</i>)	400 – 500	100
Chingri (Catfish spp.)	250	25

In the midstream of West Bengal, fishing is also practiced as a sport, often jointly for subsistence needs. This form of livelihood also revealed a different perspective of fishing, wherein fishermen reported changes in the energy and strength of the fish, hence making it easier to catch fish as they were now found to be considerably weaker and slower (based on perception of local fishermen). This loss of strength in fish was also mentioned by the downstream Jalpaiguri fishermen, and is a topic of further research as it may confer a potentially significant selective advantage.

Discussion

Ecological trends in IH Rivers

In summary, the findings of the community surveys and FGDs concluded that fish captured through fishing activities are possibly declining in numbers and sizes, and that fish populations could be changing in structure. The spread of non-native fish species may assert synergistic pressures on the capacities of aquatic ecosystems to produce provisioning and cultural services vital for human wellbeing (Millennium Ecosystem Assessment, 2005), compounded by other pressures such as barriers to fish passage (Raut et al., 2019) and changes in land use and climate (Krishnan et al., 2019).

Fish populations reflect environmental conditions but, as corroboration for these observed trends, top aquatic predators also serve as ecological indicators of overall river health. Three species of otter are susceptible in the Indian Himalayan region according to their IUCN ‘Red List’ categorizations: the Eurasian otter (*Lutra lutra*, Near Threatened), the smooth-coated otter (*Lutra perspicillata*, Vulnerable) and the small-clawed otter (*Aonyx cinereus*, Vulnerable) (Roos et al.

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2015; de Silva et al. 2015; Wright et al. 2015). All three otter species are high-order carnivores at the top of their niche ecosystem, renowned as the ‘ambassadors of wetlands’, relying on fish species as their primary food item. Additionally, the Critically Endangered gharial (*Gavialis gangeticus*) feeds solely on fish species available in its habitat (Choudhury et al. 2007). The Vulnerable fishing cat (*Prionailurus viverrinus*), although a dietary generalist, also consumes a variety of native fish species (Mukherjee et al. 2016), as does the Vulnerable broad-snouted crocodile (*Crocodylus palustris*) (Choudhury and de Silva 2013). The diets of the Endangered Pallas's fish-eagle (*Haliaeetus leucoryphus*) and the Near Threatened lesser fish-eagle (*Ichthyophaga humilis*) also consist primarily of large freshwater fish species (BirdLife International, 2016, 2017). Focus group discussions held in the Teesta river basin further revealed that the last 7-10 years had seen the absence/disappearance of the Endangered South Asian river dolphin (*Platanista gangetica*) (Braulik and Smith, 2017), which were earlier observed migrating to downstream reaches of the Teesta in Jalpaiguri during monsoons.

Implications for ecosystem service provision

Ecosystem services generated by rivers of the Indian Himalayas provide a diversity of benefits for dependent local communities. Fish have direct subsistence and market values for local communities, as well as playing significant roles in local culture and spirituality (Gupta et al., 2016). In this study, people were found to be substantially dependent on fish for their provisioning needs. Any increasing stressors may therefore have detrimental, potentially devastating impacts on the livelihoods of local communities dependent on this natural resource.

Conclusions and recommendations

Perturbation of ecosystem service flows have far wider implications for human wellbeing, as the IH region's predominantly rural population depends on the ecosystem services of mountainous landscapes that are degrading under changing climate and cultural pressures. It is therefore important that the implications of degrading ecosystem services are substantially researched and fed into policy-making, including implications for the quantity, quality and hence security of water resources with linked risks for food and other ecosystem resources, biodiversity protection, employment and economic progress, and the livelihoods of indigenous communities.

Monitoring of fish populations in IH rivers, both for their direct contributions to local livelihoods but also indicative of overall river health and its potential to contribution to a wide range of direct and indirect benefits both locally and overall considerable downstream distances, should therefore be regarded a priority to safeguard the wellbeing of multiple constituencies of society. It is also a basis for identification of the many pressures impinging on IH river systems, from which to develop mitigation measures.

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