

Locating Fisheries and Livelihood Issues in River Biodiversity Conservation: Insights from Long-term Engagement with Fisheries in the Vikramshila Gangetic Dolphin Sanctuary Riverscape, Bihar, India

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ABSTRACT

River biodiversity conservation faces the complex challenge of reconciling diverse competing human interests. Floodplain rivers, such as in the Gangetic basin, are multiple-use socio-ecological systems supporting nearly 500 million people as well as endangered species such as the Ganges River Dolphin and gharial.

Fisheries are an important case where human livelihoods compete strongly with riverine species for resources and space. Although conservationists blame fisheries as the “big threat” to biodiversity, they seldom acknowledge and mainly ignore the difficult realities of the issue, resulting in ineffective protection and conflicts. Underlying this is over simplistic rhetoric: e.g. “including fisher communities” or “banning fishing”.

We challenge these ideas based on our 15-year long engagement with fisheries in a contested riverscape, the Vikramshila Gangetic Dolphin Sanctuary in Bihar, India. Based on insights derived, we provide a conceptual framework linking together ecology, political history, property rights and social equity towards a wider understanding of biodiversity-fisheries interactions.

FRESHWATER BIODIVERSITY AND THE CHALLENGE OF FISHERIES

Biodiversity conservation in open-access, multiple-use floodplain river systems involves inherent conflicts (Klug 2002; Allan and Flecker 2007). First, floodplain rivers are highly productive habitats on which many endangered species as well as millions of human users depend for diverse needs (Dudgeon 2000).

This leads to conflicting positions regarding the management aims for river resources. Further, ambiguous property rights and ownership due to their biophysical nature makes rivers open-access, unregulated systems. Also, river systems are dynamic, posing difficulties in defining their physical boundaries over space and time and hence, for meaningful conservation of riverine ecosystems and

biodiversity, which are globally the most threatened (Allan and Flecker 2007; Collen et al. 2008).

Despite the wide academic acknowledgement of this reality, on-ground conservation approaches targeted at protecting river biodiversity (ranging from terrestrial protected areas to community-based conservation) appear naïve and unbelievably over simplistic, and often merely instrumental and symbolic. There are many critiques of pitfalls of exclusivist paradigms of freshwater conservation, and yet we see limited engagements that churn the waters (literally) for alternatives.

Among the most difficult are issues related to reconciling human livelihoods such as river fisheries with biodiversity conservation (Kelkar et al. 2010). Fisheries are especially regarded as antagonistic to biodiversity, and multiple negative impacts (e.g. bycatch, overfishing, use of destructive gear) are cited as major problems (Smith and Smith 1998; Dudgeon 2000; Allan et al. 2005; Mansur et al. 2008; Raby et al. 2011).

Fisheries have historically interacted and competed strongly with species for resources and spaces, and are undeniably a major group to address. However, the instrumental approaches that conservation managers (as well as fisheries officers) take assume that these mechanisms are always treated as “a separate issue” to be tackled by “others” (authors, pers. obs.). We argue that such approaches often lie behind commonly seen ineffective conservation planning and strategies.

This creates serious resource conflicts between fisher groups and conservation managers. Therefore, there is an urgent need to understand and engage with the “fisheries problem” as a manifestation of deep-rooted historical, social, political, economic and cultural realities (Reeves 1995; Kelkar 2012; Kelkar and Krishnaswamy 2014).

Fisheries are not homogenous, but are in themselves layered systems with contested histories and

vulnerable futures for poor people. As such, they can neither be reduced to “threats to biodiversity” alone (Choudhary et al. 2006; Bashir et al. 2010) nor can they be simply assumed to “coexist” harmoniously with wildlife (Kelkar and Krishnaswamy 2014).

River conservation in the Gangetic floodplain riverscapes of the Indian subcontinent suffers from the lack of acknowledgement of all the above gaps in understanding processes critical for informing meaningful interventions and analyses. Based on the above background, we categorically discuss key lessons learnt by us from our efforts with a river biodiversity conservation programme targeted at river dolphins with the active involvement of local fishers over 15 years (Choudhary et al. 2006; Kelkar and Krishnaswamy 2014).

We neither claim success nor failure in this endeavour. Rather we aim to provide a conceptual framework for conservation biologists, fisheries managers and environmentalists to link multiple social-ecological processes together while dealing with issues of fisheries and biodiversity conservation.

We outline this conceptual framework with a detailed story of the contested case of the Vikramshila Gangetic Dolphin Sanctuary (VGDS) in Bhagalpur, Bihar, India.

FISHERIES AND BIODIVERSITY IN VGDS

The Vikramshila Gangetic Dolphin Sanctuary (VGDS) is a 60-68 kilometers stretch of the River Ganges between Sultanganj (25°15'15"N & 86°44'17"E) and Kahalgaon (25°16'54"N & 87°13'44"E) towns near Bhagalpur, Bihar, India (Choudhary et al. 2006).

VGDS, notified in 1991, remains the only protected area especially notified for Ganges River Dolphins. This region of eastern Bihar is located in the Ganga-Kosi interfluvium and is highly prone to extreme seasonal flooding, leading to annual movements of people to higher areas (Sharma 2006). Flood discharge is high over four-five months (July-

November) after which waters recede substantially until May-June. Thus, the landscape is constantly in a state of dynamic movement and flux.

The movement reconfigures the riverscape every year and that is critical for the maintenance of life histories of several species. VGDS has high densities of Ganges River Dolphins *Platanista gangetica gangetica* and Smooth-Coated Otters *Lutrogale perspicillata*, plus about six turtle species, c.200 bird species, 90 freshwater fish species and occasional sightings of Gharial *Gavialis gangeticus* and Mugger *Crocodylus palustris* crocodiles (Choudhary et al. 2006; Kelkar et al. 2010).

It must be mentioned here that since its declaration by the Bihar Forest Department in 1991, even today VGDS largely remains a “protected area” only on paper. Three large towns are situated along the intensively used river’s southern bank, and have high pollution impacts in terms of sewage and solid wastes. Inland waterways ships and local boat traffic are also frequent, and associated with considerable disturbance to the aquatic wildlife. The predominant land-use is agriculture, and villagers are engaged in farming, dairy, fisheries and pilgrimage-related activities. Socio-economic and law-and-order indicators of the region are poor, and organised crime is common.

Fishing is very common in the Sanctuary and it is easy to chafe at this state of affairs for conservationists.

Fishing within any protected area is illegal as per the Wildlife Protection Act (GoI 1972). In general, however, in all flowing waters of Bihar, fishing is free-for-all and open-access, thus allowable anywhere as per the State Fisheries Act (Government of Bihar 2006).

This contradiction is difficult to resolve given legal conflict and prioritisation problems. It needs dialogue on the field, between the state forest and fisheries departments (Kelkar and Krishnaswamy 2014). However, the lack of political will have consistently undermined such efforts (despite being initiated by members of fishing communities).

Departmental conflict is significant in that there is no action on the ground due to legal confusions about the state of tenure for fisheries on the one hand, and sanctuary space for conservation. In addition, the changing and shifting river channels cause incredible uncertainty in the boundaries of both the protected area and areas of fishery operations.

Given this state of multiple confusions, fishing has continued in the Sanctuary since its declaration. There is high spatial overlap between fishing activity and river dolphin distribution (75-85 per cent; Figure 1). Fishers and Ganges River Dolphins use similar river channel habitats with availability of small-sized fishes, and close contact with gill nets exposes dolphins to by catch-related mortality risk (Kelkar et al. 2010).

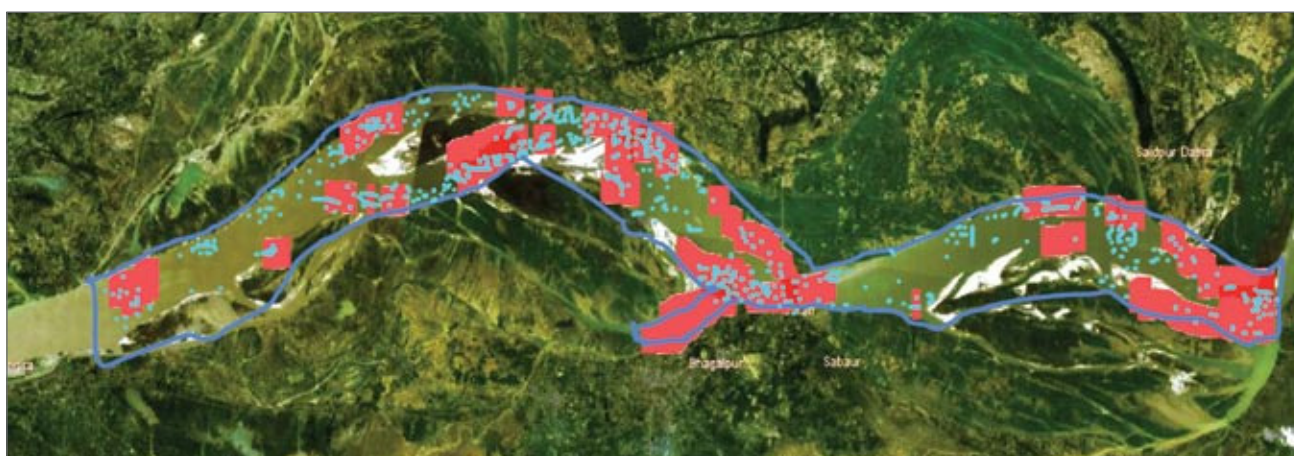


Figure 1: High overlap of fishing pressure with dolphin hotspots in the Vikramshila Sanctuary, Bhagalpur district, Bihar, India

In addition, turtle hunting has led to drastic declines in soft-shell turtle populations (fishers, pers. obs.). Bird populations (especially ducks and large waders) have shown an approx. decline of 50 per cent over the last 10-12 years, and an important factor seems to be hunting (authors, pers. obs.).

NEW LEARNINGS: LOOKING BEYOND BIODIVERSITY

The state-of-the-art discourse for the bona fide conservationist until the year 2000 was as follows: “Fishers fish ‘inside’ VGDS using ‘illegal’ nets, highly destructive fishing methods (e.g. mosquito nets, channel barricades and beach seines). They are overfishing and also hunting dolphins and other wildlife. This cannot be allowed inside a ‘protected area’. But since these people are poor, they need to be educated, and alternative livelihoods must be provided, by banning fishing in the area.”

When our team started working on dolphin conservation in the VGDS in 2000, this is where

we too began. However, it soon became clear that realities were far more complex as compared to this simplistic narrative. It was then that we came face-to-face with the poverty beneath the fisheries, the caste conflicts, and the destitution and vulnerability of fisher folk (Box 1). This complexity naturally forced us to look deeper into fisheries itself by keeping the proverbial “wildlife conservationist hat” aside. But are fishers alone really to blame? Who were these people who were, if at all, a “threat” to river dolphins?

Initially, we found during awareness and outreach programmes with fishers that they were “dead against” the idea of the Sanctuary itself, for the obvious reasons mentioned above. But despite entirely antagonistic turfs from which we were interacting, fishers pointed out that their real conflicts have been with decrees and laws regarding bans on fishing that criminalised and illegalised them, rather than with the protection of river dolphins and other riverine wildlife.

Socio-economic Profile of the Fishing Community Dependent on the Ganga in the VGDS

The fishing community (Mallah, Nishad castes and associated groups) belongs to one of the so-called low castes in the region, and also face severe socio-economic deprivation. Almost 500 families of traditional fisher community members (*Machuara*, including a few castes) depend almost entirely on fisheries in this stretch (mainly from the village-clusters of Bhagalpur, Barari, Kahalgaon, Navgachia, Tintanga, Lailakh, Sultanganj and Janghira). These fishers identify themselves as *pushtaini* (traditional fishers or fishing through ancestry) as opposed to others (*gair-pushtaini*, ancestral occupations other than fishing). However, a much larger agricultural population regularly cultivates food crops on the bank areas of the Ganga in VGDS. Most fishers are landless and have no alternative livelihoods to river fishing, and almost 75 per cent depend entirely on rivers. There has been a substantial exodus of fisher folk for menial jobs, such as in unskilled labour and construction work in cities (Singh et al. 2011). Many work as rickshaw pullers or as local labourers. Education levels are very low (about 29 per cent literacy) and average drop out age is by the end of primary schooling. Incomes are extremely meagre, ranging between 20000/- and 30000/- INR per year per household. Monthly incomes and savings are between INR 500/- and INR 2000/- on average. Nearly 80-90 per cent of the fishers are BPL (below poverty line), yet many have not been accounted for in public distribution systems. Rampant corruption has caused many fishers to remain in impoverishment despite the presence of rural welfare schemes and cooperatives in Bihar (based on authors, pers.obs.; Choudhary et al. 2006; Kelkar and Krishnaswamy 2014). Traditional fishing people in the Gangetic basin region remain socially and economically marginalized (Jassal 2001), lacking livelihood security and material dignity. Despite a semi-legal monsoon fishing ban, meant to allow for protection of breeding fishes, fishers are not in a position to afford not to fish for three months, due to extreme poverty.

We began to sympathise, even if somewhat doubtfully, with the fishers' concerns and over time have formed close interpersonal relationships with fisher groups across some villages. This relationship has helped us attempt to understand the many complexities of the problem. In the process, our team convinced many fishers to stop poaching and killing of dolphins for oil (used as bait for *Clupisoma garua*, a Catfish species). Regular monitoring has since shown that targeted hunting of dolphins reduced, with three village clusters complying with our "request",

not "ban" (Box 2), and becoming part of monitoring activities for fisheries and river wildlife.

POLITICAL HISTORY OF THE FISHERIES IN BHAGALPUR DISTRICT

The periods of Mughal and British rule proved to be major watersheds in terms of changing patterns of resource access and social stratification in fisheries. Pre-colonial fisheries (until 1793) worked on the basis of a relatively benign "Sayar" tax, which was revenue generated from charging fishers for rights

A Civil Society Effort: The Vikramshila Biodiversity Research and Education Centre (VBREC)

The Vikramshila Biodiversity Research and Education Centre (VBREC) is an informal research and conservation team working under the aegis of the Bhagalpur University. VBREC has been funded in the long run by WDCCS-UK and WCS. Conservation and awareness programmes by VBREC from 1999-2003 resulted in reduction of targeted illegal killing of river dolphins for blubber oil by fisher folk in this area. Along with this, VBREC has been pursuing high quality ecological research through multiple collaborations, and has published findings in several international peer-reviewed journals. A monitoring program has been running from 1999 till date and encompasses a wide range of variables, from socio-economic data on fishers, to river dolphin abundance, to hydrological profiles of river channels. Several fishers (n=c.200 households) of three major village clusters (at Barari, Kahalgaon and Sultanganj-Janghira) have shown positive responses to these efforts, and many have become strongly integrated with monitoring activities (authors, pers.obs.). Of these, 15-20 have consistently reported illegal hunting and destructive fishing practices in the Sanctuary through informer networks. In all, nearly 15-20 incidents of illegal fishing practices (mosquito-nets and beach-seines) are still consistently being reported per month. Long-term monitoring data have been crucial in identifying broad trends in animal distribution and fisheries status. The monitoring has also help identify conflicts between fishers and animals. Despite these data, identifying the impacts of hunting or by catch on animals is tantamount to some conjecture. For instance, there are frequent cases of net and gear damage of fishers by otters (around four-five times per month in monitored areas during otter breeding in the dry-season). The losses by themselves are minor (a few hundred rupees) and mostly repairable. For poor fishers who continue to use damaged nets (unable to afford even this cost), even these can sometimes be significant, running into a few thousands per net lost. Fortunately, this situation has not led to serious conflict perceptions against otters, owing to positive attitudes and favorable cultural perceptions (authors, pers.obs.). However, it has been a struggle to translate statistical inference from data to on-ground change. The big lesson we have learnt has been that our monitoring and research efforts, despite being thorough, robust and conducted in tough conditions, may have still been marginal given the root problem. The overall conditions of fishing communities in the landscape haven't changed much still, with poverty, threats from criminals, destructive fishing, corruption, social disparity and conflicts. Even if our work has benefited biodiversity to a small extent, direct tangible benefits accruing to fishers are still wanting. Until such benefits come about in a sustained fashion and provide socio-economic security, political identity to fishers, soliciting their long-term support for river wildlife conservation remains an uncertain issue.

of trespass and fishing for very short periods of time, and based on their expected income from the fish-working (Reeves 1995).

This idea was based on riparian law regarding ownership of water by the owner of the neighbouring land, but use rights were given free of much sanction (Puthucherril 2009). However, with the Permanent Settlement of Bengal (1793) and associated Tenancy Acts, the British formalised feudal systems with the Zamindars (landlords) for maximising revenue extraction (Reeves 1995; Robb 1997; Tsai and Youssof-Ali 1997; Sharma 2006).

The passing of these Acts involved assignment of complete, exclusive and rivalrous property rights to landlords owning riparian stretches (Reeves 1995, 2002). This system was the *Jal kar* (literally translated to “Water Tax”), which became a form of water lording (called *Panidari*, like *Zamindari*), and traditional fishers worked now as labourers to the *Panidars* (or the new Water lords).

River reaches within provincial boundaries were owned by the biggest Zamindari estates, and systems of sub-letting stretches for fisheries also prevailed. The Bhagalpur district *Panidari*, notified from Sultanganj to Pirpainti, was under the *Zamindars* Mahesh Ghosh and Musharaf Hussain, for over 300 years, until 1991 (Sharma 2006).

The *Jalkar*-based management was further maintained through multiple laws and acts, notably the Bengal Ferries Act (1885) (Government of Bihar 2011), whereby landlords could levy taxes even on users of ferry-ghats; especially Dalits and other “lowly” castes were charged heavy fares (Sharma 2006). Over the years, not surprisingly, the feudal system turned oppressive, and local power relations and caste inequalities deepened, at the cost of fisher livelihoods.

Despite *Zamindari* abolition in India (legally arrived in 1952), the feudal *Panidari* system of river fishing contracts prevalent in this region was abolished

only between 1987-1991 (Gupta 1993), following repeated efforts by the *Ganga Mukti Andolan* and *Jal Shramik Sangh*, a social-political movement springing from traditional fishers of Kahalgaon, against the shackles of oppression and for protecting the riverine fisheries.

Freeing all rivers or “flowing water” from contract systems, for everyone to fish in was a major political advantage to the socialist ruling party (Kelkar and Krishnaswamy 2014). In *Panidari*, the oppressive landlords who owned a segment of the river, would grab a large chunk of what fishers would fish there.

Needless to say, the *Panidars* would harass, beat up, or even kill fishermen and their families who refused to work on the contracts or pay up the “fish tax” (Choudhary et al. 2006; Sharma 2006; Kelkar and Krishnaswamy 2014).

But the abolition of *Panidari* also meant that fishing in the river became a “free-for-all” open-access, an unmanaged commons. The year 1991 was also when the Sanctuary was declared. The *Ganga Mukti Andolan* also became strongly opposed to the Sanctuary, identifying it as yet another form of state imposition on fishing rights (authors, pers.obs).

In fact, here the new symbolic boundary perceived by the fishers became: “the Sanctuary will ban fishing, and it is just a new form of *Panidari* in the form of state control”.

WATER TENURE, RIGHTS AND FISHERIES INSTITUTIONS

In dynamic river floodplains, land and water tenures are inherently conflicted, as, due to an impossibility of definition, the “default” situation is of ill-defined property rights (Begossi 1998; Neil Adger and Luttrell 2000; Sharma 2006). In such a situation, many questions arise: Who gets the right to fish? On what terms? Who gives these rights? How are fishing rights used and abused? (Begossi 1998; Neil Adger and Luttrell 2000; Lam and Pauly 2010).

Mismatches between biophysical, political and state processes create conflicts (Kelkar and Krishnaswamy 2014) as political history interacts with uncertain river boundaries. This is evidenced in VGDS: through the intermeshing of conflicting interests of state-led protected areas, private mafia control, state-led “cooperative management” and politico-legally prescribed unregulated open-access (Reeves 1995; Reeves 2002; Sharma 2006; Katiha et al. 2013).

In response, constant effort emerges, to create clearer boundaries over the existing haze. Fisher community groups have been arguing for exclusive “club-good” property rights based on traditional (caste) lines.

However, many people within the community still believe that “free” fishing (open-access) is needed. We believe that parcelling of water at scales manageable for fisher community groups will be inevitable for adaptive fisheries management. This would serve to curb illegal practices employed by non-fishing castes and improve conditions for biodiversity (fishers, pers. comm.). An instance of fishing conflicts over ambiguous tenure is as follows: Fishing is not allowed as per State Fisheries Department Guidelines on channels connected to the river main stem up to 100 metres (*kols*). But this is relaxed for oxbow lakes and overbank impoundments (*dhabs* – where fishing contracts are leased out even to non-fisher castes) (Government of Bihar 2006).

For officials who rarely visit the field, it is near impossible to even define *kols* and *dhabs*. Also, given alterations in flows, *kols* might change to *dhabs* and vice versa. Managing tenure claims in such a situation becomes virtually impossible. Further, lack of political organisation of fishers and of local institutions compounds the problem. Locally rooted, strong fisheries management institutions can significantly help mediate market pressures and social conflicts (Johnson 1998; Marshall 2001; Gerber et al. 2008).

Alternatives do not seem to be working. Between 1967 and 1970, fishery cooperatives were set up across several areas in Bihar. Cooperative extension schemes have either become defunct or corrupted by elite capture (Sharma 2006; Kelkar 2012). This has relegated them to pseudo-institutions with no meaningful function or structure, with no benefits transferred to intended communities. Landlords have enforced claimant fishers to become wage labourers on their own pond entitlements.

Conflicts over fisheries have turned violent over the last four decades in particular (Sharma 2006). This has led to continued disillusionment of fishers about prospective community-based management systems (Bennett et al. 2001; Ahmed et al. 2006). The change in institutional control, from the formal tender-based private contract system with inbuilt exploitation, to an open-access free-for-all situation of harassment and lawlessness, has now forced fishers to rethink alternatives (Kelkar 2012).

Recent surveys indicate that many fishers (almost 65 per cent, n=95), lacking knowledge of any other system, now perceive the days of contract as better than the present operation, and mention that the *Panidari* afforded some protection to them because of “bonded” labour.

Both private and open-access arrangements have failed to work, and what remains to be tested are participatory common-property management regimes (authors, unpubl., pers.obs.). However, fishers’ participation will be predicated on a systemic social and political change to improve trust and transparency between management interests (Marshall 2001; Zanetell and Knuth 2004; Campbell 2007). The fact is that the state of fisheries is downgraded everywhere, across Bihar, so the Sanctuary is not the only driver for conflicts. But also, we daresay that species protected under the declaration of the Sanctuary are found commonly even in unprotected areas (Figure 2), and interact with fisheries regularly even there.

This brings us back to the larger question of fisher livelihoods vis-a-vis biodiversity conservation, and suggests that we need to question the nature of conservation approaches we often take as granted.

SOCIAL CONFLICTS

Due to open-access fishing there has been no scope for the settlement of fishing rights (Kelkar and Krishnaswamy 2014). Criminal gangs operate regularly through a fishery mafia ring in the Sanctuary area (as well as outside) and illegally extort fish catch from these fishermen at gun point, killing anyone who refuses or defies them.

Our monitoring data suggest that nearly 75 per cent of fishers (n=300 approx.) in the area have personally been threatened. Further, their stated risk of fish grabbing and rent-seeking related harassment may be as high as once in every four days of fishing. The fishing mafia use destructive fishing practices to capture small fishes in the river to cater to a huge market at Siliguri in northern West Bengal (fishers, pers.comm.).

Destructive netting practices (e.g. barricading of confluences with mosquito nets), cause mass mortality of larval and juvenile fishes, reducing recruitment to the main river and suppressing viability of fish populations (Kelkar 2012; Dubey and Ahmad 1995). These threats have ousted both traditional fishermen and river dolphins from their preferred fishing/foraging locations.

Mosquito nets (*kapda jal*) and beach-seines (*kachaal jal*) are excessively operated, up to 20 times a month in side-channels at seven-eight locations by fishers and other villagers with the protection/ support of criminals. These nets are operated in the vicinity of productive confluence habitats and in floodplain wetlands marginally connected to the main river channel. New gears are also being increasingly used, such as shore-trap nets built over stakes using very fine mesh of 1 millimetres, which does not spare even fish larvae.

These nets are called *bahuwa jaals* and these are also creating similar problems, bringing in control of criminals over fish catch and its packaging and sale in markets in Siliguri. Establishing wholesale fish centres near river banks makes monitoring of catches from these nets very difficult. These easily-accessed centres have made the whole boom-and-bust business lucrative.

Sustaining traditional means of fishing is becoming increasingly uncertain and difficult for fishers. As conservationists, our limitations to negotiate with the fishery mafia inevitably make trust building uncertain among fishers (fishers, pers. comm).

Due to the open access, many “non-fishing” castes have plunged into fishing, including dominant landholder classes such as Bhumihars and Rajputs, to other marginalised floodplain castes. Recently, Mandals (Gangota castes), mainly floodplain



Figure 2: Distribution of Ganges River Dolphins within and outside the arbitrary boundaries of the Vikramshila Sanctuary

people involved in animal husbandry, have also been enlisted in Bihar as traditional fishers (fishers, pers. comm.).

In a state where caste plays an important role in determining almost any action, free fishing has also caused caste-based conflicts, and includes massacres of fishers and allied (lower) castes living on floodplains (Sharma 2006). Apart from large social conflicts, other monumental catastrophes of the past haunt the present fisheries.

ECOLOGICAL HISTORY: CHANGES AND CATASTROPHES

The Farakka Barrage built in 1972-73 (downstream on the Ganga in West Bengal) almost entirely destroyed the commercial Hilsa *Hilsa ilisha* fishery in the upstream reaches of Bihar and Uttar Pradesh (Banerjee 1999; Kelkar 2012). The Hilsa, highly valued across the region for its taste, and as a seasonal delicacy, had been a commercially invaluable resource for the fisher populations and a crucial seasonal prey-base for wildlife. Studies have estimated 99 per cent reductions in availability of Hilsa up river, since the Barrage was built (Payne and Temple 1996). This decline reflects to a large extent, the collapse of many important fishes in India's inland waters.

Barriers to movement imposed by dams, pollutant loads, spawning habitat degradation and overfishing have led to declines in native commercial carp species (Rohu/ Rui, Katla), and catches are gradually being replaced by "trash" species, mainly small catfish, barbs and gobies (Payne and Temple 1996; Tsai and Youssof-Ali 1997; Norman-Lopez and Innes 2005; Rahman and Rahman 2008; Vass et al. 2010; Kelkar 2012).

Pond-cultured carps and catfishes from Andhra Pradesh and West Bengal dominate the markets across Uttar Pradesh and Bihar (making up for 70-

95 per cent of the sold fish catch) (Kelkar 2012). For river fisheries as a whole, over 90 per cent fishers reported serious declines (>80-90 per cent) in natural population of prized major carps Rohu/ Rui (*Labeo rohita*), Katla (*Catla catla*) and Mrigal [*Cirrhina mrigala* (according to law of priority)] (*Cirrhina mrigala*) (Tsai and Youssof-Ali 1997; Rahman and Rahman 2008; Kelkar 2012).

The species composition of fishery landings at Bhagalpur in VGDS show a shift from major carps and large Catfishes to trash species (Choudhary et al. 2006; Montana et al. 2011). Average fish sizes available and caught in fishing in these reaches indicate mostly juveniles and small-sized adults, which is another indication of ecosystem-level fisheries collapse (Payne and Temple 1996).

The fisheries department rules specify that fishing with gill nets less than 40 millimetre in diameter is illegal anywhere in the Ganga's main channel, even if outside the sanctuary (Government of Bihar 2006). Thus, almost 80 per cent of the existing fishing in the sanctuary becomes therefore, illegal and destructive to river dolphins and fish populations.

Artisanal fisheries, being target-specific and inflexible in capture efficiency, have been predated by over-exploitative commercial fishing practices (Tsai and Youssof-Ali 1997; Kibria and Ahmed 2005). The diversity of fishing gears and practices is getting homogenised in the wake of mechanisation of fisheries. This has ushered in use of imported nylon monofilament gill nets instead of traditional cotton fiber nets, among other harmful, non-selective fishing techniques (Kibria and Ahmed 2005).

The mesh size of gill nets has since shrunk multifold: the average mesh-size used today is around 20 millimetres which is a decline of almost four-five times in 30-40 years. Due to fishers targeting small fishes, competition and conflict with dolphins have

¹ The Ganges Shad/ Padma Shad is *Hilsa ilisha* and not *Tenuulosa ilisha*. The Ganges Hilsa/ Ilish is smooth bodied and spotless whereas *Tenuulosa* is spotted (nomenclature based on Bhuiyan 2009).

likely intensified over the years (Kelkar et al. 2010). It is evident in the regular reporting of five-six cases/year of accidental entanglement and death of dolphins in gill nets.

Apart from the collapse of the once-resilient river fisheries, multiple contemporary problems of great seriousness continue to haunt fisheries production and sustenance. These include poor and altered river flows, erratic releases of water from upstream dams, extreme river pollution and climate change impacts (Sinha and Khan 2001; Vass et al. 2009; Orr et al. 2012).

Fish disease, juvenile mortality and toxicity of fishes are other grave problems, which need consideration in fisheries policy (Dubey and Ahmad 1995). There have to be large-scale attempts at river flow improvement, restoration, maintenance of water quality, productivity and hydrological connectivity, and overall ecosystem rehabilitation for fisheries (Dudgeon 2005).

When the resource base itself is so degraded, talking about last-ditch digs at biodiversity conservation by involving fisheries seems superfluous. As it is inadequate to talk about river biodiversity without considering the social side of fisheries, the reverse is also true. Social change without ecological river restoration may not achieve long-term fisheries improvement. Maintenance of ecological river flow regimes, protection of fish breeding sites and reduction of river pollution are also required along with strengthening local fisheries management.

MARKET PRESSURES AND SHIFTING BASELINES IN FISHING PRACTICES

The state of river fisheries directly indicates the biophysical, ecological and social integrity of the river basin (Welcomme 1995). Existing in-river fisheries contribute merely about five to 10 per cent of overall inland fish production, and fisheries in the Gangetic basin has been labeled a “failed economic sector”, with current production highly unsustainable (Gol (Planning Commission) Report 2010; Gol -

Department of Animal Husbandry, Dairying and Fisheries 2007; Datta et al. 2010; Gol 2011).

In Bihar, boom-and-bust fishing operations are entirely illegal (Government of Bihar 2006), but still go on because of zero monitoring of fisheries. The fisheries now represent trophic downgrading. The fish market is now like a market that scrapes these remains and continues generating even more pressure on rivers, and more “trash fish”.

It is obvious that unsustainable fisheries leads fishers to take even more desperate measures (Smith et al. 2005; Norman-Lopez and Innes 2005; Datta et al. 2005; Kasulo and Perrings 2006). Fisheries policy and statistics appear to misrepresent this condition. The recent boom in artificially managed pond aquaculture and wetland fishing especially in Andhra Pradesh and West Bengal has changed the nature of supply radically (Gol - Department of Animal Husbandry, Dairying and Fisheries 2007; Gol 2011). This has contributed to India becoming one of the largest producers of inland freshwater fishes in the world, but, one may note, of this river fisheries’ contribution is negligible (Kumar et al. 2003; Datta et al. 2005; Miao et al. 2010).

Although net aquaculture production shows increases, the collapse of in situ river fisheries that still support thousands of poor people who don’t get access to aquaculture, get totally ignored under such swamping. River fisheries thus need urgent attention not just in ecological but economic terms.

ALTERNATIVE LIVELIHOODS

For immediate concerns of livelihood sustainability, alternative livelihoods need to be made available to fishers through informed choice. Co-operative land leases for development of pond fisheries that are managed by family groups or settlements of fisher folk is an idea being proposed by many fishers in floodplain belts (Das 2006; Dey and Prein 2006).

It is necessary to create systems where better community control on well-defined water bodies

(e.g. tanks, wetlands, floodplain pools, oxbow lakes) is possible. If planned well, these systems could help in fostering socially equitable and profitable fisheries management alongside biodiversity conservation (Folke et al. 2005; Hoggarth et al. 1998). This can help link fisheries with floodplain agriculture, rather than antagonise them over water sharing.

River fisheries need adaptive management that utilises fishers' traditional local knowledge while securing livelihoods and conserving biodiversity (Folke et al. 2005; Berkes et al. 2008; Kingsford et al. 2011). Through gradual, active river restoration and fisher support, "biodiversity-friendly" fisheries could be developed through monitoring standards of zero-entanglement or setting of species or size-specific targets.

Fisher communities can help protected area authorities in monitoring neighbouring river stretches. The fishers' own use of resources also needs critical scrutiny. Monitoring of the following parameters both from within and from outside the community is essential: 1) Net mesh-sizes used 2) Fishing in ecologically sensitive areas or regulated zones, 3) Hunting of wildlife in rivers, especially turtles, gharials, Ganges River Dolphins, Smooth-Coated Otters, muggers, birds or any other species mentioned in the Wildlife Protection Act ((GoI (WLPA) 1972) with amendments in 1991, 2002, 2006, 2011), and 4) Density of people fishing in different areas and laying claims based on flowing or impounded water areas.

Rural labour programmes and food security acts in India could enhance both nutrition and wage rates of fishers, providing protection to livelihoods without adverse impacts on fisheries (Kelkar and Krishnaswamy 2014). Improved social security could also potentially create opportunity for involving fishermen in small-scale ecotourism around riverine protected areas such as the VGDS. Finally, the quest for sustaining fisheries in the Ganga River Basin will require integration on multiple fronts: ecological restoration of rivers, biodiversity conservation, and

socially just management of traditional fisheries systems.

SOCIAL, CULTURAL AND MATERIAL WELL-BEING OF FISHERS

We will conclude with one last point: that the social, cultural and material well-being of fishers is also an important goal unto itself that should not be overlooked by managers and conservationists. Community cohesiveness, identity, dignity and security can in themselves be empowering forces as they enable fishers to take decisions in a self-reliant manner (Stewart et al. 2004; Smith et al. 2005; Ahmed et al. 2006; Deacon 2012).

Creating such an environment in itself can take practitioners beyond the rhetorical confines of "inclusive conservation". We stress that it is now much needed on the part of conservationists to clarify what exactly they mean by saying "we must involve fishing communities in conservation".

There is a need to identify meaningful, realistic, objective and tangible objectives and practices that are beyond rhetoric. First, there is a need to communicate on-ground fisheries problems through sustained dialogue between local government departments, fishers and conservationists. There has to be appreciation of the livelihood values of fisheries at higher levels of policy and government authority.

In our case, the Bihar Forest and Fisheries Departments need to actively engage with fishing communities together to understand the complexities than blindly following their standard managerial mandates. At present, due to pettiness and power abuse on the side of the departments there is mistrust, fear and suspicion on the fishers' side. The existing tension appears to be beyond immediate resolution.

There are constant breaches of decided actions, as forest officials often take the wrong action against non-errant bonafide fishers using small nets (while

leaving the bigger mafia scot-free), and this can potentially erode support for conservation built by our long-term efforts considerably (authors, pers. obs.). The acknowledgement that livelihood security of fisheries and biodiversity conservation are inextricably intertwined issues, by itself equalises the otherwise polar debate.

Fishers are certainly worthy of receiving conservation benefits in the form of legally recognised rights but one need not ignore that by the nature of their livelihood itself, they will also always be exploiters of biodiversity (Kelkar and Krishnaswamy 2014). Hence, though we need not essentialise traditional fishers either as “noble savages” or “destroyers of nature”, we will have to be cautious in promoting systems of dignity and equity by ensuring compliance to biodiversity conservation.

We have still been struggling to ensure complete compliance from the fishers’ side towards biodiversity conservation – the reason for this being that they don’t perceive any benefit of doing so. After the Ganges River Dolphin was declared India’s national aquatic animal (Gol 2010), Bihar has taken some measures, such as the appointment of “dolphin *mitras* (friends)” from local fishermen who will monitor illegal fishing and intentional killing of dolphins (Kelkar and Krishnaswamy 2014). However, this has the danger of getting reduced to symbolic cash incentives and may not be enough, particularly in the absence of sustained funding and governmental interest. Nevertheless the scheme can, if well supported, be developed as a means for conservation, through economic gains to complying fishers, and mobilise their support in surer ways (van der Ploeg et al. 2011).

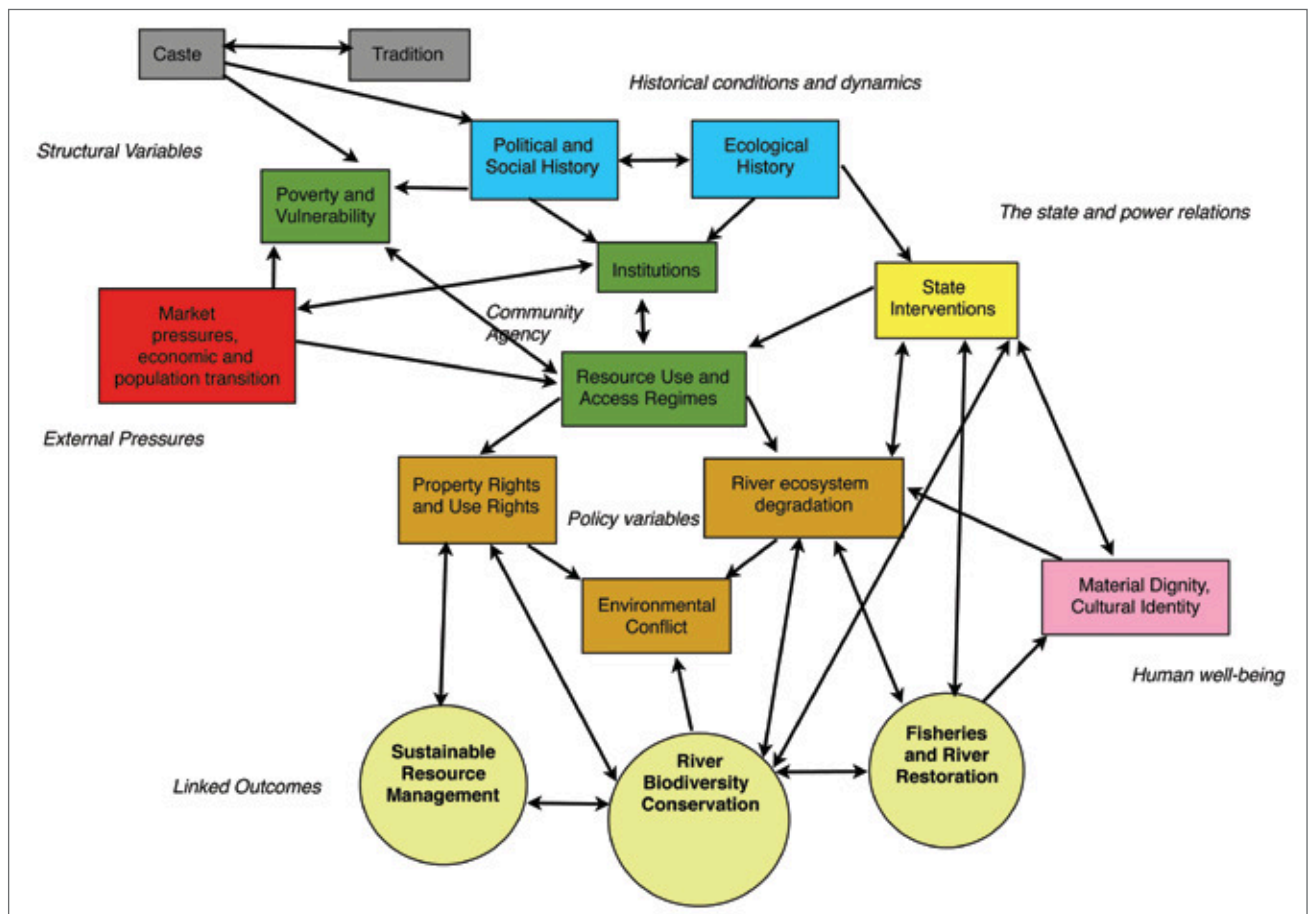


Figure 3: Conceptual framework to link variables and outcomes of interactions between social, political, historical and economic drivers of fisheries with ecological conservation

Fisher compliance to ecologically conducive practices for biodiversity conservation can be incentivised through recognition and positive reinforcement via “entitlements” provided to fisher community groups (Leach et al. 1999). It is equally important to recognise the whole issue in terms of identity of fisher communities (“fisher folk”).

Fisheries need attention as an independent socio-cultural system, on an equal plane as with an agrarian system. Fisher identity has remained a poorly acknowledged issue, but we stress that the political space for river fisheries can spring only from rightful assertion of local identity and organisation (Stewart et al. 2004).

From the above synthesis, we provide a conceptual framework for linking variables and issues in fisheries and biodiversity conservation together in a coherent manner for the consideration of conservationists (Figure 3). We regard empowering community agency, rights and local institutions as central to conservation planning, supported by state interventions and river ecosystem restoration programmes.

With this, the goals of sustainable resource management, fisheries restoration and river biodiversity conservation appear complementary rather than antithetical. This means that secure fisheries might naturally lead to conservation of river biodiversity because of overall improvements in their human condition.

In a nutshell, conservation and fisheries management have to be mutually reinforcing. We hope to realise this aim for the complex and curious riverscape of Vikramshila, by developing understanding useful to integrating such thinking across resource conservation and management in dynamic systems (Bengtsson et al. 2003).

REFERENCES

- Ahmed, M., Salayo, N.D., Viswanathan, K.K., Garces, L.R. and Pido, M.D. 2006. *Management of Fishing Capacity and Resource Use Conflicts in Southeast Asia: A Policy Brief*. WorldFish Center, Penang, Malaysia. 13 p.
- Allan, J.D. and Flecker, A.S. 2007. Biodiversity Conservation in Running Waters. *BioScience* 43: 32–43 pp.
- Allan, J.D., Abell, R., Hogan, Z.E.B., Revenga, C., Taylor, B.W. and Welcomme, R.L. 2005. Overfishing of Inland Waters. *BioScience* 55: 1041–1052 pp.
- Banerjee, M. 1999. *A Report on the Impact of Farakka Barrage on the Human Fabric. A Submission to World Commission on Dams. Thematic Review: Flood Control Options in the Gangetic Basin*. New Delhi, India.
- Bashir, T., Khan, A., Behera, S.K., and Gautam, P., P. 2010. Socio-economic factors threatening the survival of Ganges River Dolphin *Platanista gangetica gangetica* in the upper Ganges River, India. *Journal of Threatened Taxa* 2: 1087–1091 pp.
- Begossi, A. 1998. Property rights for fisheries at different scales: Applications for conservation in Brazil. *Fisheries Research* 34: 269–278 pp.
- Bengtsson, J., Angelstam, P., Elmqvist, T., Emanuelsson, U., Folke, C., Ihse, M., Moberg, F., and Nystrom, M.. 2003. Reserves, resilience and dynamic landscapes. *AMBIO* 32: 389-396 pp.
- Bennett, E., Neiland, A., Anang, E., Bannermann, P., Rahman, A.A., Huq, S., Bhuiya, S., Day, M., and Clerveaux, W. 2001. *Towards a Better Understanding of Conflict Management in Tropical Fisheries: Evidence from Ghana, Bangladesh and the Caribbean*. CEMARE Research Paper 159, Portsmouth, UK. 22 p.
- Berkes, F., Coldingand, J., Folke, C. 2008. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10: 1251–1262 pp.
- Bhuiyan, A.S. 2009. Nomenclature of our national fish Hilsa, *Bangladesh Journal of Zoology* 39: 329-331.
- Campbell, I.C. 2007. Perceptions, data and river management: Lessons from the Mekong River. *Water Resources* 43: 1–13 pp.
- Choudhary, S.K., Smith, B.D., Dey, S., and Prakash, S. 2006. Conservation and biomonitoring in the Vikramshila Gangetic Dolphin Sanctuary, Bihar, India. *Oryx* 40: 189–197 pp.
- Collen, B., McRae, L., Kothari, G., Mellor, R., Daniel, O., Greenwood, A., Amin, R., Holbrookand, S., Baillie, J. 2008. *Living Planet Index 2010 and Beyond: Rising to the Biodiversity Challenge*, WWF, Gland, Switzerland.
- Das, S.K. 2006. Small-scale rural aquaculture in Assam, India – A case study. *NAGA-World Fish Center Quarterly* 29: 42-47 pp.

- Datta, S.K., Singh, S.P., Chakrabarti, M., Biswas, S., and Bittu, S. 2010. A Perspective on fisheries sector interventions for livelihood Promotion. *Working Paper No. 2010-02-03*, 32 p.
- Deacon, R.T. 2012. Fishery management by harvester co-operatives. *Review of Environmental Economics and Policy* 6: 258–277 pp.
- Dey, M.M. and Prein, M. 2006. Community-based fish culture in seasonal floodplains. *NAGA World Fish Center Quarterly* 29: 21–27 pp.
- Dubey, G.P. and Ahmad, A. 1995. Problems for the conservation of freshwater fish genetic resources in India, and some possible solutions. *NAGA, the ICLARM Quarterly*, July 21–25.
- Dudgeon, D. 2000. Large-scale hydrological changes in tropical Asia: Prospects for riverine biodiversity. *BioScience* 50:793–806 pp.
- Dudgeon, D. 2005. River rehabilitation for conservation of fish biodiversity in monsoonal Asia. *Ecology and Society* 10: 15 p.
- Folke, C., Hahn, T., Olssonand, P., and Norberg, J. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30: 441–473 pp.
- Gerber, J., Knoepfel, P., Nahrath, S., and Varone, F. 2008. Institutional resource regimes: Towards sustainability through the combination of property-rights theory and policy analysis. *Ecological Economics* 68: 798–809 pp.
- Government of Bihar. 2011. Model Rules(2011) under Bengal Ferries Act-1885. Patna, India.
- Government of Bihar. 2006. Bihar Fish Jalkar Management Bill - 2006 (Bihar Act 13). Govt. of Bihar, Patna, India, [Amended in 2007, 2008 and 2010] 11 p.
- Government of India. 2010. Dolphin declared national aquatic animal. Press Note of the Ministry of Environment and Forests, New Delhi, India. URL: envfor.nic.in accessed on July 6, 2012.
- Government of India (GoI). Ministry of Environment and Forests (MoEF). 1972. The Wildlife (Protection) Act (Schedule I). Government of India, No. 53 of 1972, New Delhi, India.
- Government of India (Planning Commission). 2010. Report of the Working Group on Fisheries for the Tenth Five Year Plan. New Delhi, India. 185 p.
- Government of India. 2011. Manual on fishery statistics. Section B - Inland Fishery. Ministry of Statistics and Program Implementation, Central Statistics Office, New Delhi, India. 90 p.
- Govt. of India (GoI). Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture. 2007. *Handbook on Fisheries Statistics*, Table 4.29: Fishermen population-2003. New Delhi, India.
- Gupta, C. 1993. Unshackling the Ganga. *Down to Earth* 2: 22-24 pp.
- Hoggarth, D.D. and Aeron-thomas, M. 1998. Adaptive co-management of harvest reserves in Indonesian rivers. *The 51st Gulf and Caribbean Fisheries Institute Annual Meeting, November 9-13, 1998, St Croix, U.S. Virgin Islands, West Indies*. 9–13 pp.
- Jassal, S.T. 2001. Caste and the colonial state: Mallahs in the census. *Contributions to Indian Sociology* 35: 319–356 pp.
- Johnson, C. 1998. Beyond community rights: Small-scale fisheries and community-based management in southern Thailand. *TDR/ Quarterly Review* 13: 25–31pp.
- Kasulo, V. and Perrings, C. Fishing down the value chain: Biodiversity and access regimes in freshwater fisheries — the case of Malawi. *Ecological Economics*, 59: 106–114 pp.
- Katiha, P.K., Sharma, A.P., and Chandra, G. 2013. Institutional arrangements in fisheries of Ganga River System. Paper Presented in Conference on Health and Fisheries of the Major River Ecosystem of India with Emphasis on River Ganga, jointly organised by AEHMS, Canada, IFSI and CIFRI, Kolkata, India. URL: <http://ssrn.com/abstract=2219347>. Accessed on July 21, 2013.
- Kelkar, N. 2012. *Fishing for Scrap: Sustaining River Fisheries in the Face of Ecosystem Degradation, Socio-political Dynamics and Poverty in the Gangetic Basin. A Brief Report on the Status of River Fisheries: Causes of Decline, Conflicts and Potential Alternatives. Report submitted to the Parliamentary Committee on Fisheries, Government of India*. New Delhi, India. 41 p.
- Kelkar, N. and Krishnaswamy, J. 2014. *Restoring the Ganga for its Fauna and Fisheries*. Book chapter, in: Madhusudan, M.D., Rangarajan, M., and Shahabuddin, G. (eds.) *Nature Without Borders*. Orient BlackSwan, India.
- Kelkar, N., Krishnaswamy, J., Choudhary, S., and Sutaria, D. 2010. Coexistence of fisheries with river dolphin conservation. *Conservation Biology* 24: 1130–1140 pp.
- Kibria, G. and Ahmed, K.K.U. 2005. *Diversity of Selective and Non-Selective Fishing Gear and their Impact on Inland Fisheries in Bangladesh*. NAGA World Fish Center Newsletter, Vol. 28, No. 1&2.
- Kingsford, R.T., Biggs, H.C., and Pollard, S.R. 2011. Strategic adaptive management in freshwater protected areas and their rivers. *Biological Conservation* 144: 1194–1203 pp.
- Klug, H. 2002. Straining the law: Conflicting legal premises and the governance of aquatic resources. *Society and Natural Resources* 15: 693–707 pp.
- Kumar, A., Katihaand, P.K.. and Joshi, P.K. (eds.) 2003. A profile of people, technologies and policies in fisheries sector in India. *Proceedings Series 10* p. 170. National Centre for Agricultural Economics and Policy Research, New Delhi, India.
- Lam, M.E. and Pauly, D. 2010. Who is right to fish? Evolving a social contract for ethical fisheries. *Ecology and Society* 15: 16–34 pp.

- Leach, M., Mearns, R., and Scoones, I.A.N. 1999. Environmental entitlements: Dynamics and institutions in community-based natural resource management. *World Development* 27: 225–247 pp.
- Mansur, E.F., Smith, B.D., Mowgli, R.M., and Diyan, M.A.A. 2008. Two incidents of fishing gear entanglement of Ganges River Dolphins (*Platanista gangetica gangetica*) in waterways Sundarbans Mangrove Forest. *Aquatic Mammals* 34: 362–366 pp.
- Marshall, J. 2001. Landlords, leaseholders and sweat equity: Changing property regimes in aquaculture. *Marine Policy* 25: 335–352 pp.
- Miao, W., Silva, S.D., and Davy, B. (eds.) 2010. *Inland Fisheries Resource Enhancement and Conservation in Asia*. FAO, Bangkok, Thailand. RAP Publication 22.
- Mokhlesur Rahman, M. and Rahman, M.M. 2008. Capture-based aquaculture of wild-caught Indian major carps in the Ganges Region of Bangladesh. In: Lovatelli, A., Holthus, P.F. (eds.) *FAO Fisheries Technical Paper No. 508, Rome, Italy*. 127–140 pp.
- Montana, C.G., Choudhary, S.K., Dey, S., and Winemiller, K.O. 2011. Compositional trends of fisheries in the River Ganga. *Fisheries Management and Ecology* 18: 282–296 pp.
- Neil Adger, W. and Luttrell, C. 2000. Property rights and the utilisation of wetlands. *Ecological Economics Special Issue: The Values of Wetlands: Landscape and Institutional Perspectives* 35: 75–89 pp.
- Norman-Lopez, A. and Innes, J.P. 2005. Review of river fisheries valuation in tropical Asia. *Tropical River Fisheries Valuation: Background Papers to a Global Synthesis* 147–226 pp. Centre for the Economics and Management of Aquatic Resources, University of Portsmouth, Hampshire, UK.
- Orr, S., Pittock, J., Chapagain, A., and Dumaresq, D. 2012. Dams on the Mekong River: Lost fish protein and the implications for land and water resources. *Global Environmental Change* 22: 925–932 pp.
- Payne, A.I. and Temple, S.A. 1996. River and floodplain fisheries in the Ganges Basin. Final report R.5485. Marine Resources Assessment Group Limited, Overseas Development Administration, London, 1996.
- Ploeg, J. Van Der, Cauilan-cureg, Weerdan, M., M., and Van de Groot, W.T. 2011. Assessing the effectiveness of environmental education: Mobilizing public support for Philippine crocodile conservation. *Conservation Letters* 4: 313–323 pp.
- Puthucherril, T.G. 2009. Riparianism in Indian water jurisprudence. In Iyer, R. (Ed.) *Water and the Laws in India*. Sage Publications, New Delhi, India. 97–137 pp.
- Raby, G.D., Colotelo, A.H., Blouin-demer, G., and Cooke, S.J. 2011. Freshwater commercial bycatch: An understated conservation problem. *BioScience* 61: 271–280 pp.
- Reeves, P. 1995. Inland waters and freshwater fisheries: Issues of control, access and conservation in colonial India. In: Arnold, D. and Guha, R. (eds.) *Nature, Culture and Imperialism*. OUP, New Delhi, India. 260–292 pp.
- Reeves, P. 2002. Regional diversity in south Asian inland fisheries: Colonial Bengal and Uttar Pradesh compared. *Journal of South Asian Studies* 25: 121–135 pp.
- Robb, P.G. 1997. Ancient rights and future comfort. Bihar, the Bengal Tenancy Act of 1885, and British rule in India: London Studies on South Asia No.13. School of Oriental and African Studies, London, UK.
- Sarker, M.H., Huque, I., and Alam, M. 2003. Rivers, chars and char dwellers of Bangladesh. *International Journal of River Basin Management* 1: 61–80 pp.
- Sharma, M. 2006. 'Diara Diary', 'Snatching food from a tiger's mouth', 'A Private Ganga' and 'The Fickle River Basin'. In: Sharma, M. (2006) *Landscapes and Lives*. OUP, New Delhi. 12–41 pp.
- Singh, N.P., Singh, R.P., Kumar, R., Padaria, R.N., Singh, A., and Varghese, N. 2011. Labour Migration in Indo-Gangetic Plains: Determinants and Impacts on Socio-economic Welfare. *Agricultural Economics Research*, 24: 449–458 pp.
- Sinha, M. and Khan, M.A. 2001. Impact of environmental aberrations on fisheries of the Ganga (Ganges) River. *Aquatic Ecosystem Health & Management* 4: 493–504 pp.
- Smith, A.M. and Smith, B.D. 1998. Review of status and threats to river cetaceans and recommendations for their conservation. *Environmental Reviews* 6: 189–206 pp.
- Smith, L.E.D., Kho, S.N., and Lorenzen, K. 2005. Livelihood functions of inland fisheries: Policy implications in developing countries. *Water Policy* 7: 359–383 pp.
- Stewart, W.P., Lieber, D., and Larkin, K.W. 2004. Community identities as visions for landscape change. *Landscape and Urban Planning* 69: 315–334 pp.
- Tsai, C.F. and Youssof-Ali, M. (eds.) 1997. *Openwater fisheries of Bangladesh*. University Press Ltd., Dhaka, Bangladesh. 208 p.
- Vass, K.K., Das, M.K., Srivastava, P.K. and Dey, S. 2009. Assessing the impact of climate change on inland fisheries in River Ganga and its plains in India. *Aquatic Ecosystem Health & Management* 12: 138–151 pp.
- Vass, K.K., Mondal, S. K., Samanta, S., Suresh, V.R., and Katiha, P.K. 2010. The environment and fishery status of River Ganges. *Aquatic Ecosystem Health & Management* 13: 385–394 pp.
- Welcomme, R.L. 1995. Relationships between fisheries and the integrity of river systems. *Regulated Rivers: Research & Management* 11: 121–136. doi: 10.1002/rrr.3450110110.
- Zanetell, B., and Knuth, B. A. 2004. Participation rhetoric or community-based management reality? Influences on willingness to participate in a Venezuelan freshwater fishery. *World Development* 32: 793–807 pp.