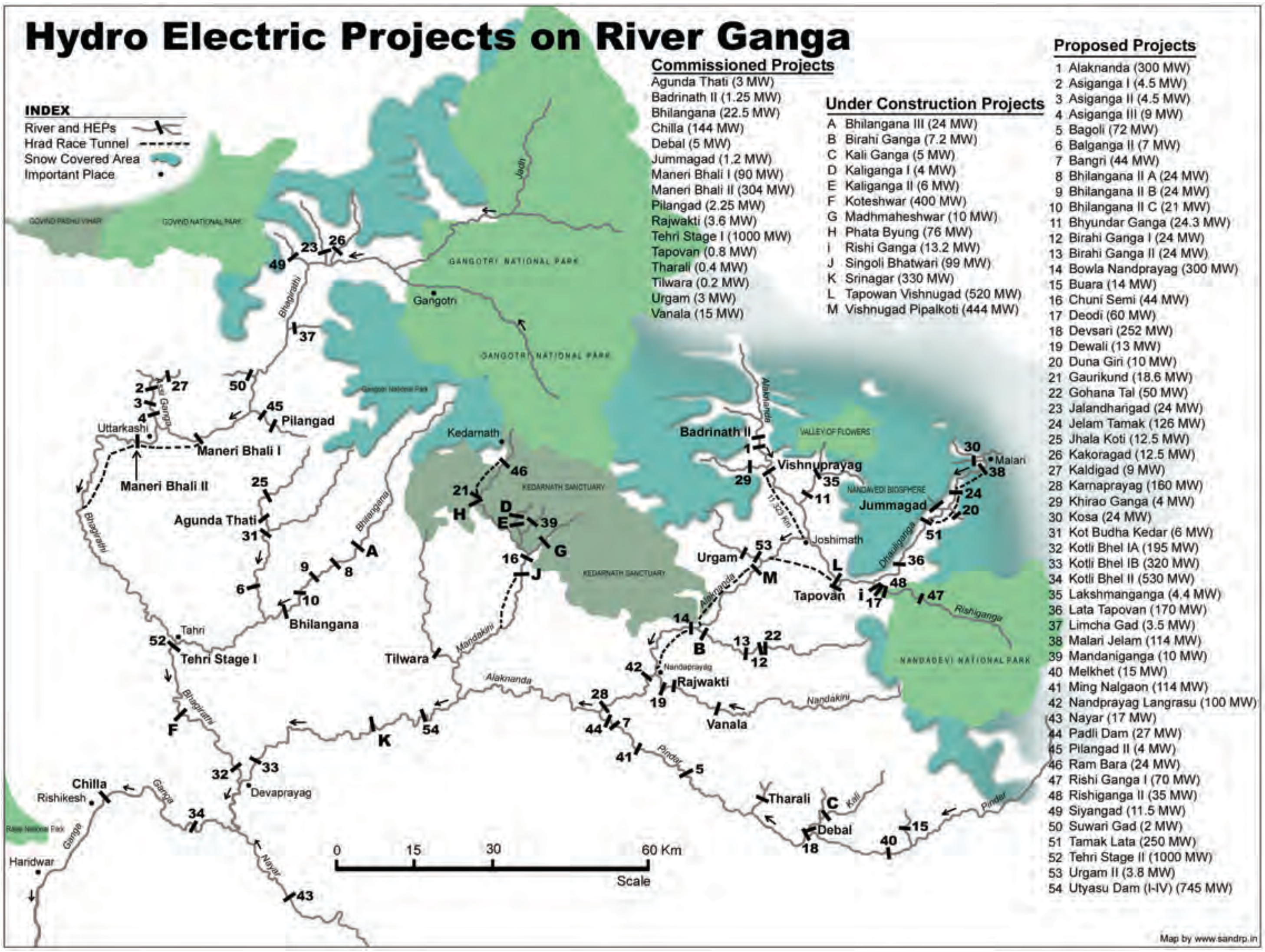
Headwater Extinctions

Hydropower projects in the Himalayan reaches of the Ganga and the Beas: A closer look at impacts on fish and river ecosystems

Emmanuel Theophilus

November 2014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Map by www.sandrp.in

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SOUTH ASIA NETWORK ON DAMS, RIVERS AND PEOPLE
S A N D R P

November 2014

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Maps: SANDRP
Cover design: Systems Vision
All photos: By Author

November 2014

Published By: South Asia Network on Dams, Rivers & People – SANDRP (a YUVA project),
c/o 86-D, AD Block, Shalimar Bagh, Delhi 110088
ht.sandrp@gmail.com, http://sandrp.wordpress.com/,
http://sandrp.in/, https://www.facebook.com/sandrp.in

Suggested Contribution: Rs 200/-

Designed and Printed by:
Systems Vision
A-199, Okhla Ph-I, New Delhi 110020
systemvision@gmail.com

Cover Photo: *Submerged villages and fields, upstream of the Tehri dam, during draw-down. Photo by author.*

Back Cover Photo: *Pansul Mehta*

This document has been produced by South Asia Network on Dams, Rivers and People (a YUVA Project) with financial contribution by Swedish public development co-operation aid through the Swedish Society for Nature Conservation, SSNC. Their support is gratefully acknowledged. The views herein shall not necessarily be taken to reflect the official opinion of SSNC or its donors.

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Acknowledgements

We are delighted that Emmanuel Theophilus of Himal Prakriti, Uttarakhand agreed to take up this study for SANDRP and that this is finally seeing the light of the day.

The author is very grateful for the support extended by Malika Virdi and K. Ramnarayan from *Himal Prakriti*, Manshi Asher, Prakash Bhandari and Sumit Mahar of *Himdhara*, and Himanshu Thakkar and Parineeta Dandekar of SANDRP during the study. Thank you, all of you.

SANDRP (a YUVA Project) is thankful to Swedish Society for Nature Conservation for their continued support for our work for so many years right from inception. We are also thankful to Shri Vinay Aditya for promptly agreeing to doing the layout and printing in time for publication during India Rivers Week, 2014.

We are also thankful to Pansul Mehta for allowing us use of his photo for back cover.

Hope this helps the fish in the rivers, which was the main purpose of this work!

SANDRP

November 2014

Headwater Extinctions

SANDRP initiated a study to bring together information that could be of use in understanding the nature and scale of disruption and set-back to fish populations and fisheries caused by hydropower projects, dams and diversions in India. *Himal Prakriti* was requested to join in the effort, and to undertake a study to reflect the impact of the build-up of hydro-power projects in some Himalayan sections.

Exercises that look closely at such impacts, and at fisheries plans, their effectiveness and their implementation would require to be conducted at a stream or sub-sub-basin level (often Stream Orders 2-3)[1] onwards to a sub-basin level (often Stream Orders 4-5). This is in view of the uniqueness of every stream or river in terms of the contributing factors such as climate and geology, that yield the rhythms, substance and proportions of flows, and consequently the habitats and niches, and the fish-species assemblages and fish populations that inhabit them. In mountain rivers, where diverse habitats are found in relative proximity, each occupied by specialist species, suggests that any small or medium-scale disruption could also reflect impacts at a population scale.

Almost dry Bhagirathi River at Uttarkashi, downstream of Maneri Bhali Project

1 I refer here to the Strahler Stream Orders, that can help us understand the build-up of network complexity of a stream or river. To understand, among other things, the increase in the potential magnitude of a river, by knowing how many confluences of which magnitude there are upstream at any given point on a river. Not very different from the way network complexity builds up on say, Facebook, with every additional Friend, who may already come with their many friends, who are similarly linked with many other friends. Some of these 'confluence' nodes are larger than others, and this kind of ordering reflects that complexity.

In view of the time and resources available at hand however, it was decided to start with two significant river sub-basins in the Western Himalaya, the Ganga (Bhagirathi and Alaknanda) in Uttarakhand, and the Beas in Himachal Pradesh. These were shortlisted as suitable for this initial study, since both have numerous Hydroelectric-power projects (HEPs) on them, and many more are planned and underway. It was decided, despite time constraints, not to look only at a few specific Hydro-power projects as cases in point, but to try and look at the entire fish zones in two sub-basins, to get a hang of the cumulative impact of existing as well as underway hydro-power projects on the river ecologies.

The time planned for this study was determined by a number of constraints, including the availability of funds. This meant a challenging 3 months of work; one month of which was travel up the two rivers to see and sniff closely (February 2014), and two months (March-April 2014) to read and write-up. Another month was required to finalise the report based on comments received. Unfortunately, due to various reasons, the finalisation has taken longer than envisaged.

What we set out to do:

1. Undertake a preliminary assessment of cumulative impact of HEPs on fish populations, and species assemblages along the entire sub-basin.
2. Assess the appropriateness of fisheries plans proposed and implemented by HEPs on the two select sub-basins.
3. Assess the effectiveness of these plans and their implementation.
4. Assess impacts on livelihoods (both negative and positive) of related communities with regard to impacts on fish.

Schedule of visits: While accessing and reading published and online material began in January 2014, visiting all the hydropower projects within the fish-zones of the two sub-basins were undertaken in the month of February 2014. Despite heavy winter snows in winter of 2014, most of the fish-zones in all the sub-basins were visited, with minor difficulty in places. The upper reaches of the Ganga near Harsil were inaccessible by road in early February due to heavy snowfall. The time-frame of the study did not permit the additional days it would have taken to walk there and back. In Himachal however, it was possible to visit the entire fish zone affected by hydropower projects along the tributary streams of the Beas, a little later in the month.

Defining the area of study; the fish zones: For the purpose of our study, the upper limit of the fish-inhabited zone for the Ganga was assumed as 2,400 meters altitude based on reports from the Cumulative Environmental Impact Assessment (CEIA) report by Wildlife Institute of India (WII) 2012, and reports from scientists engaged in species surveys[2]. Indigenous fish, of which the Snow Trout (*Schizothorax richardsonii* which is not a true trout) among them inhabit the relatively higher niches, are not found above 2,000 m asl in Uttarakhand. However, the higher

[2] Assessment of Cumulative Impacts of Hydro-electric Projects on Aquatic and Terrestrial Biodiversity in Alaknanda and Bhagirathi Basins, Uttarakhand. WII. 2012 and pers comm. Dr. P Nautiyal HNB Garhwal Univ.

limit of 2,400 meters altitude is in view of the fact that a few streams such as the Asi Ganga and portions of the Bhagirathi upto Harsil harbour populations of the exotic Brown Trout (*Salmo trutta fario*) introduced here over 60 years ago, and which are known to inhabit the colder waters upto 2,400 meters altitude. In the Beas basin in Himachal Pradesh, Rainbow trout were introduced in 1909, over a hundred years ago, and the Brown trout decades later. Here too, they are known to inhabit various tributaries upto about 2,500 meters altitude. The indigenous Snow trout is not reported to be found above 2,000 m asl in Himachal Pradesh either[3].

We see that many fish species in mountain rivers are specialists and inhabit specific niches within the distinct stream habitats created by variations in volumes of flow, depth, speed, temperature, dissolved oxygen and substrate. Some of these variations form a gradual, wide and passable physio-chemical transition, limiting the movement of only those species who are not evolved to survive much variation. There are, however, some species in mountain rivers, who can tolerate, indeed adapt to seasonal changes in these factors, and are medium or long-distance migrants, for breeding, coping with temperature and flow variations, and for dispersal. In both the Ganga and the Beas, there are at least 17 species of short and long-distance migratory fish species which include three species of Mahseer, which are long distance migrants[4]. Dams and barrages form a sudden physical barrier, that may be passable (if at all that is the right word here) only one-way, that too either through long tunnels under pressure and then through the 'mixer-grinder' of the turbines, or falling over high spillways.

We also see that once rivers reach the plains the aquatic habitats in them are relatively less varied, and therefore harbour fewer specialists. Within a few years of construction of such barrages, there is often a marked difference in the species of fish found above and below the barrage that divides the mountain sections from the plains section[5]. Since our present discussion is focused on fish inhabiting the mountain sections of the river and much on this follows, suffice it to say here that what befalls the fish populations and species assemblages in the plains sections of rivers would largely be determined by upstream changes. These would include changes in water and sediment flows, changes in the food-web upstream due to these alterations, and also the scale and timing of water being taken out for various uses in the plains sections, such as irrigation, power generation. What goes into the river, in terms of sewage, chemical pollution and so on, would also have a profound effect.

For the mountain sections, which is the area of focus for this study, hydropower projects radically alter and affect river ecosystems. There is much scientific literature on this aspect to hand. The Cumulative Environmental Impact Assessment (CEIA) report by WII summarizes this aspect well. "Available worldwide literature on consequences of dam development reveals that the impacts of dams on ecosystems are profound, complex, varied, multiple and mostly negative.

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3 Seemingly strangely, the Diptycus snow-trout of Ladakh can be found in ice-cold waters commonly at altitudes above 3,000 meters asl.

4 CEIA by WII for the Ganga basin.

5 Pers comm with fishermen at the Tanakpur barrage on the Kali river.

By storing or diverting water, dams alter the natural distribution and timing of stream flows. This in turn, changes sediment and nutrient regimes and alters water temperature and chemistry resulting in impacts on ecosystems and biodiversity elements that these streams support, and on their attendant socio-economic aspects."

The socio-economic impacts of dams are known to be numerous, long-term and deeply political too, but while this is not the main focus of this study we cannot but keep them in peripheral vision during our analysis. It is also somewhat unrealistic to try and separate the impacts of hydropower projects on terrestrial ecosystems from those on aquatic ecosystems, because we know that rivers and their ecosystems flows interact intimately with the terrestrial realm, and are often even a function of each other. While recognizing this, the attempt will be to keep the focus of our analysis on the aquatic realm.

The Ganga near Kodiala, where the 530 MW Kotlibhel II Project is proposed

Foreword

Along the entire fish zones on the Bhagirathi and the Alaknanda, there are now very numerous hydro-electric projects in operation, and many being built and planned, with initial work underway[6]. Roads being a primary pre-requisite for hydro-projects, it was possible to drive up to almost every hydropower project (except in the uppermost reaches where the road had not been repaired after the June 2013 floods) on these two rivers as well as their major tributary streams. This was not so three decades ago. Over this time, I have been fortunate to walk to the glaciers of origin and/ or climb the high ridges dividing the watersheds of each and every major tributary of the Ganga on successive expeditions[7]. On the Bhagirathi, up the entire length to and above the source glaciers, as well as the Bhilangana, Balganga, Assiganga, Dingadh and Jadhganga. On the Alaknanda, up the entire length and beyond, to the source-glaciers, and on the Mandakini, Pindar, Kailganga, Nandakini, Birahiganga, Dhauliganga and Bhyundargadh. The present study provided an opportunity to revisit the lower sections of some of these streams, as well as see some lower sections for the first time.

Powerhouse transformers stacked by the roadside

The first part of this report, is written as a travel narrative, as reportage, to take you the reader along on the journey, but also to bear witness to the very radical changes that I have seen brought about in these landscapes, and in the rivers that run through

6 Please see the list in Annexure A.

7 Other than the source of the Rishiganga in the Nandadevi Sanctuary where access has been prohibited for almost 30 years. The ostensible reason for closing the area to civilians is nature conservation, but it is also well known that the primary reason is the missing nuclear-powered device after the spying misadventure by the Intelligence Agencies of India and the USA. (*Spies in the Himalayas* by MS Kohli and Kennth Conboy 2002)

them. The second part, the discussion and analysis, is written journalistically or in research mode too, while also being referenced and footnoted.

Travelling now, in the early Spring of 2014, along the lower reaches of the Bhagirathi upto Uttarkashi, and up the Bhilangana upto Ghansyali after three decades, I was completely disoriented by the great transformation of the land and waterscape. Towns and villages I had visited were drowned deep by massive dam impoundments stretching to the horizon. There were kilometres of deep sediment in reservoir bottoms like just-exposed tidal mud-flats, or completely dry riverbeds between hydropower projects. In many sections, the once-mighty Bhagirathi, the main-stem of the Ganga, could be hopped over on exposed boulders without even wetting shoes, because of the entire river having been diverted into kilometres of tunnels. The *curriculum vitae* of the river, the very course of its life, had been radically altered. Could there be any doubt, that the effect of such large-scale transformations of the river would impact all life in and dependent on it? But more on that shortly, with the lens of science in hand.

There was also another, almost undefinable, but growing feeling of discomfort all through my travels along the Ganga and the Beas this time. I could only put a finger on it at the end of the month, when I exited Himachal Pradesh into Punjab. Right then, I got the strong feeling that I had just left occupied territory. And suddenly, all the reasons for this feeling fell into place.

Both, the Beas valley of Himachal Pradesh and the Bhagirathi and Alaknanda valleys, which I first visited decades ago, not only look very different, but feel different to a visitor. Even as you drive up from the plains up the first rise of the mountain roads, you are greeted by large signboards put up by Hydro-power Companies. They 'welcome' you into the state (only residents or 'owners' of a place do that, right?), and they tell you how many hydro-power projects you will encounter, the mileage to each one of them, and all the major towns *enroute*. Not the Highways Authority, but private hydropower companies, Government hydropower companies, cement companies, and companies that conveniently do both cement and hydropower.

These Companies and their visual fallout alone, are now the most dominant presence all along the highways. The huge dams, drowned valleys and dry riverbeds apart. Roads ripped wide, giant transport vehicles crawling up with either fly-ash for cement, or building material and

One of very many wrecked earth-movers dumped on roadsides towering machinery for hydropower plants hogging the highway. Wreckages of trashed earth-movers with rusted tank-treads, and twisted trucks abandoned by the side of roads as if in a battlefield. Many sections of the roads, tunnels, and in places, entire roads up distant valleys, have been built by the hydro-power companies for transporting their heavy equipment[8]. There are billboards that tell you that entry is restricted to the entire road even though there are many villages upstream, and this is the only public access to entire valleys. And photography too, so keep that camera down or you will receive the hostility due to a probable subversive. I did. Near every hydropower installation, your vehicle will be stopped and you will be questioned by armed men in uniform. And you are being constantly watched. On a mountain highway, of all places. There are numerous signboards, those for example put up by the Mandi District Police. They invite you to follow them on Facebook, while also telling you that you are "under CCTV surveillance". The signage for distances are often coupled with rhyming slogans about the Company's concern for the environment. Right in front of a half-submerged village upstream of the Koteshwar dam, at a bend in the road, is a Tehri Hydroelectric Development Corporation sponsored signboard bearing a cheesy sexual quip about hugging her curves. But wait, let me conclude on sense of being in occupied territory.

Whether it is a government or a private hydropower company, for all practical purposes, they now own long stretches of the river where they have a complete run of the river[9], under agreements with the state for 40 years. Local communities cannot fish in these waters, let alone sell their produce, unless they have been licenced or auctioned leases. The bidders, unsurprisingly, are not fisher-folk, but industrial-scale contractors. Residents of the valley cannot even use their own boats to cross the river or impounded lake to go to school or to visit relatives on the opposite bank. They must catch ferries run by the Company. And the main reason for these dams and diversions? To generate, export and sell electricity, and in some cases water as well, to distant towns and industries. It is hard to miss the similarities with Colonial occupation. Complete with local sub-contractors for 'law' or compliance enforcement.

The all-present corporate highway signage

[8] The road along the lower Bhagirathi from Koteshwar dam to Tehri dam, and from Tehri dam up the Bhilangana in Uttarakhand, and the road up the Sainj valley in Himachal Pradesh for example.

[9] This is the only context in which these words 'run of the river' hold true. The complete deceit in calling diversion dams 'run-of-the-river (ROR) projects' is evident as most of these projects allow no water to flow between the dam and the tailrace during the lean season, and the exceptions allow at most 15% of the lean season flows. Most 'ROR' projects also have fairly massive dam impoundments, e.g. the Srinagar HEP by GVK, where you can drive for 18 km along the impounded water.

The Travel Report:

The Ganga
(Bhagirathi, Alaknanda and major tributaries)

For this study, we looked at the Ganga from Haridwar upwards, to the source glaciers and water-divides of the Bhagirathi and Alaknanda, and all their major tributaries. Apart from the barrages at Haridwar and Rishikesh which are in the plains of the Terai, there are 70 commissioned, under-construction and proposed hydropower projects in the mountainous reaches. Please see the list in Annexure A[10] . The Bhagirathi and Alaknanda sub-basins drain the north-western mountains of Uttarakhand, and the catchment above their confluence at Devprayag is about 19,600 km^2. Altitudinal gradients in the sub-basins vary from >7, 400 meters to <200 meters above sea level (asl), yielding an astounding seven climate types, that range from Polar to Tropical in a very small geographical area.

The Bhagirathi river originates from the Gangotri glacier complex at about 3,900 m asl, and after 217 km meets the Alaknanda at Devprayag (472 meters asl). Or what is left of it after all the impoundment and diversions. The catchment area of the Bhagirathi is 8,846 km2 which includes the catchments of the Bhagirathi, the Bhilangana and Assi Ganga rivers, each with their numerous glacier-fed, snow-fed and spring-fed tributaries. There are 9 commissioned projects here, 4 projects are under-construction and 19 are proposed projects.

The Alaknanda mainstream originates from Satopanth glacier complex and runs a distance of 224 km till its confluence with the Bhagirathi at Devprayag. The basin drains the eastern part of Garhwal, and covers a total catchment area of about 12,587 Km2. The Alaknanda catchment comprises of the Alaknanda, Mandakini, Nandakini, Pindar, Dhauliganga and Birahiganga sub-catchments. A total of 38 Hydropower Projects are underway in this basin. There are eight commissioned projects, 10 projects under-construction and 20 are proposed projects. (source CEIA, WII. 2012)

[10] This list is taken from WII's CEIA. However, for a complete list please see http://sandrp.wordpress.com/2013/07/10/uttarakhand-existing-under-construction-and-proposed-hydropower-projects-how-do-they-add-to-the-disaster-potential-in-uttarakhand/

The travel up the Ganga:

During the river-travel for this study, I first went up the Ganga from Haridwar, to get an understanding of the sequence of the build-up of dams and diversions along the Ganga, in space and time. Though the build-up of hydropower projects upstream along the river is not all in time sequence, it begins with, at Haridwar. An interesting aspect of traveling up a river in the Himalaya, is that you encounter ecological transitions as if you were going back in geological time. You can travel up through four distinct geological units, each born out of different tectonic events and periods, starting with the most recent at the Shiwalik range, through the mid-Himalaya, the Greater Himalaya, and onwards to the oldest in the Trans-Himalaya, and each separated by a geological fault. Even more interestingly, in doing so, you also travel back in Climate-time, towards and into regions that are still tangibly in the current Ice-Age that we live in, to areas that are still deeply glaciated.

At Haridwar you encounter the Bhimaghoda barrage, as well as the three associated barrages that stop and divert the waters of the Ganga towards the temple complex and pilgrim bathing *ghats*, and then on to the head-works of the Upper Ganga Canal network. Right here is an instance of a radical break in the connectivity of the Ganga as it comes down from the mountains to the plain. And this hiatus, of headwaters beheaded, is common to every large river in Uttarakhand and Himachal Pradesh.

The Upper Ganga Canal was constructed between 1842 and 1854, and was perhaps the first such radical disconnection of Himalayan rivers in the country. This large network of canals was built from Haridwar to Kanpur after a debilitating drought, with the stated objectives of drought-proofing, as well as inland navigation. While the main-canal length was 435 km, the irrigation network was 5,794 km long, capable of carrying water at 368 cumecs, irrigating 1.4 million hectares[11], and essentially diverting most of the Ganga, for many months of the year.

The Bhimagoda barrage at Haridwar

[11] Ref for figures. http://www.newyorkcanals.org/_pdfs/Kumar.pdf

Built at a time and by an openly utilitarian political system that was unmindful of environmental consequences, but riding on seemingly noble intentions[12], this massive project was a bit of a marvel, complete with watermills at various places. Canal Navigation ended around 1930 due to excessive siltation of the canals, and mills fell defunct only in the 1970s. And the fish? While we have not come across any quantitative documentation or baseline data on what happened to fish populations and diversity soon after the impoundment, it is not hard to gauge what would be the downstream impacts of a riverbed running like a river only during the monsoon, and at a virtual trickle thereafter for many months of the year. Most of the water, along with any fish that survived beyond the diversion, would go down a one-way street to agriculture fields. Those left in the impoundments would be intensively fished through the year by contract fishermen, and those migratory fish stranded downstream of the barrage would congregate and attempt to get over the high barrage during the migration season in futile desperation, making an easy catch for fishermen as well[13].

Further upstream at Rishkesh is the Rishikesh-Chilla barrage. Here the 312 meter wide barrage diverts a portion of the flow (565 cumecs) into a wide, lined canal that flows down 14 kilometers to the 144 MW Chilla HEP, and back into the impoundment at Bhimaghoda at Haridwar. Apart from the usual concerns about large-scale diversion and its impact on fish populations, it bears mention also that the canal cuts right through a portion of the Rajaji National Park, and its steep lined sides are clearly impassable or hazardous to elephants, tigers and other terrestrial animals who may attempt to cross it.

The Rishikesh-Chilla canal cutting off movement of animals even within the Rajaji National park

Soon after Rishikesh you enter the Shiwalik hill tract, where the Ganga flows in a deep steep-sided valley. The river is big and deep here, with riffle and deep pool ratios[14] seeming almost 1:1, most ideal for fish habitats. This reach of the Ganga

[12] The canal building project by the military engineers of the East India Company ran into financial trouble when the Board withdrew funding after commencement of work. It was only when this project was posed as essentially for navigation that they agreed to finance it and work commenced again. http://dsal.uchicago.edu/reference/gazetteer/pager.html?objectid=DS405.1.I34_V12_144.gif

[13] I have personally seen this, and have also spoken to fishermen at the barrages at Ropar on the Sutlej and at Tanakpur on the Mahakali.

[14] A riffle is a section of a river that is relatively shallow and sloping, and runs evenly but turbulently. Because of differing depths and velocities of flow in riffles and pools, they variously provide preferred habitats for different fish species, as well as refugia at low flows.

contains the highest diversity of fish species along the entire Upper Ganga[15]. At every meander there are beaches of silver sand snuggled in the inner curve of the bend, and rounded boulders and cobbles centrifuged at high-flows onto the outer crook of the meander. Between Kodiala and Rishkesh, a river length of 35 km, there are presently 140 licensed river-rafting operators. There are 42 rafting camps on lease on these beaches which are on Forest land, and another 30 odd on Civil land. These rafting companies are owned both by local and non-local people, and one interest that they do have in common is that the river continues to run wild and free, and that the aquatic and riparian environment be conserved so as to continue to attract their clientele. In addition to rafting, trekking, village walks and sport-fishing are part of the fare on offer. An informal estimate made of the revenue generated by these companies directly amounts to around Rs. 20 Crore annually[16]. Ancillary business which includes transport, hotels, shops and so on would make this substantially higher.

However, right at Kodiala, 35 km upstream of Rishikesh, at a heartbreakingly beautiful curve on the river, an 82 meter high storage-dam has been proposed to operate a 530 MW power-station (the Kotlibhel II project). Not only will this entire non-extractive enterprise of river-related tourism literally dry up, but the Ganga will also lose its most species-rich and beautiful stretch of the river. The CEIA by WII had recommended that this stretch be left free of hydropower projects, and while the project is on hold now, the proponents are waiting for the political trade-winds to blow, and to fill their sails again[17].

Then on to Devprayag, the confluence of the Bhagirathi and the Alaknanda, after which the river is called the Ganga. Driving up from there along the Bhagirathi, I come across masked billboards of the THDC, and enquire from local residents about the status of the Kotlibhel 1A project that was also recommended to be 'reappraised', cancelled, and work ordered by the Supreme Court to be halted[18]. A gentleman took me to peer over the edge of the road from where a tunnel of the project was visible. There was a hum of heavy machinery coming up from below, and I was told that work on the tunnel was underway anyway.

Driving further up, you come to the Koteshwar dam. This dam is located 22 km downstream of the Tehri dam and is part of the Tehri Hydropower complex that serves to regulate the Tehri Dam's tailrace for irrigation and to create the lower reservoir of the Tehri pumped storage Power

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[15] CEIA WII 2012.

[16] Pers Comm. Yousuf Zaheer, pioneer river rafter, Himalayan River Runners.

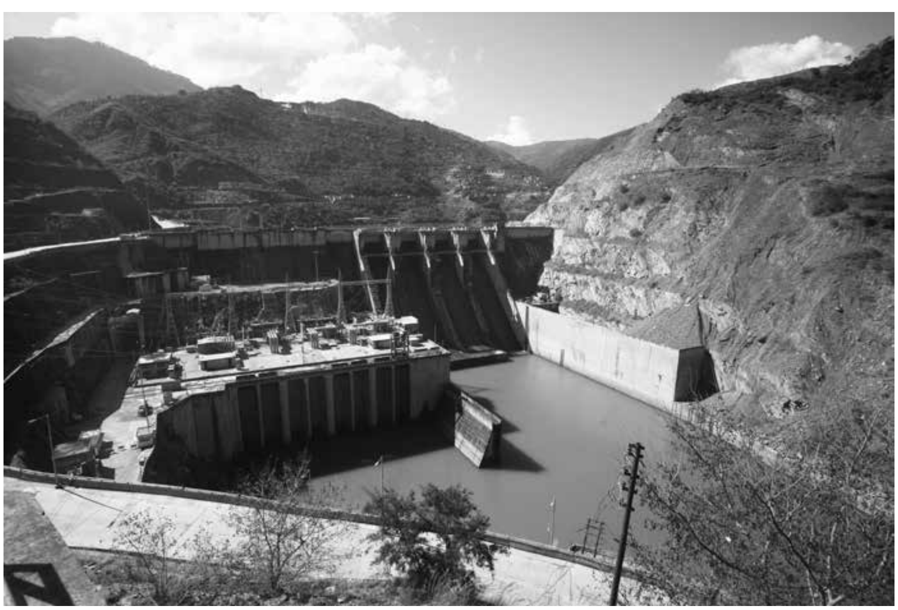
[17] As we finalise this in Nov 2014, the Expert Body report, commissioned following Supreme Court order of Aug 13, 2013 has been submited, it recommended cancellation of the 23 projects and significant modification of the 24th (Kotli Bhel 1A). These 24 projects were recommended to be cancelled by the earlier WII report and includes Kotli Bhel II. But in the SC proceedings, the MoEF, with support from IIT Consortium seems to be working in the interest of hydropower lobby to push all hydro projects, including the Kotli Bhel II, see: http://sandrp.wordpress.com/2014/04/29/report-of-expert-committee-on-uttarakhand-flood-disaster-role-of-heps-welcome-recommendations/ and http://sandrp.wordpress.com/2014/11/01/why-is-the-iit-consortium-acting-like-a-hydropower-lobby/.

[18] Please see http://sandrp.wordpress.com/2013/08/14/uttarakhand-flood-disaster-supreme-courts-directions-on-uttarakhand-hydropower-projects/ and http://sandrp.wordpress.com/2013/10/20/expert-committee-following-sc-order-of-13-aug-13-on-uttarakhand-needs-full-mandate-and-trimming-down/

Station. The dam has a 400 MW diversion or 'ROR' power station. Commissioned in March 2011, the dam is 97.5 m tall and 300 m long. When the reservoir is at flood level, the spillway has a discharge capacity of 13,240 cumecs. Receiving water from the Tehri dam, from a catchment area of 7,691 km2 the dam creates a reservoir holding 88,900,000 m3 of water, of which only 35,000,000 m3 is active, ("live" or "useful"). So almost two thirds, or over 50,000,000 m³ worth of valley inundation is just dead storage? The dam's power-station uses the active storage in the reservoir which can draw the lake down 30 m from full-pool.

While acknowledging that flow regulation would have far-reaching impacts all the way downstream, the WII, during their CEIA, assessed only the relatively proximate impacts of each hydropower project separately, and calculated what they called the Zone of Influence (ZoI). The Zone of Influence for each of these projects was defined as an area which will be influenced by all activities by the Project. This took into consideration the location and scale of the dam, barrage, the area under submergence, Head-race and Tailrace tunnels, the diversion zone, muck deposits, as well as built-up areas for establishing related infrastructure, including road networks. They also assessed each project for river length affected. These calculations only included the area above the dam that would be inundated by impoundment, and that below the dam till the tailrace, where flows would be reduced drastically, and the area used for generation and other project uses. Their assessment covered Devprayag upwards, and their estimates show that the Kotlibhel II project at Kodiala would either drown or dry-up a river-length of 59.2 km, and the Kotlibhel 1A a river-length of 18.4 km.

The huge impoundment of the Koteshwar dam drowns the valley right upto the foot of the giant 260 meter high Tehri dam. Built strategically at a very narrow part of the Bhagirathi valley soon after the confluence with the Bhilangana, Tehri, the highest dam in India looks quite unremarkable, till you crest the ridge overlooking the unbelievable sight of two wide valleys drowned as far as the eye can see.


Koteshwar dam

If you drive along this huge reservoir up to a town on the ridge called Chamba, the view of the impoundment still stretches on to the horizon, and on a further 77 km on to Chiliani Saur. The huge terraces of agriculture land are now drowned in meters of sediment-ooze at the drained portion of the reservoir. This is the silt deposited at the bottom and exposed during seasons of low-flow due to the draw-down of waters for generating 1,000 MW of power (2,400 MW for the whole complex which includes pump-storage as well as the Koteshwar dam), for irrigating 870,000 hectares of land, and when industrial areas in Delhi and U.P. take a deep suck of more than 1,215 million litres of drinking water a day[19]. While the length of the Tehri reservoir is said to be 44 km along the main valley, the waters go far past the confluences and into all the side valleys and streams that flow into the Bhagirathi. By road, you must drive for around 90 km to get from one end of the reservoir to the other.

Tehri dam

The waters of this dam, that began filling the valley in 2002, completely drowned the ancient town of Tehri, that had been since 1803, the capital town of the Tehri Kingdom. 40 other villages were completely submerged, and 72 others partially so, officially displacing over 100,000 people. Having seen the valley before it was submerged, I can also say that one of the widest and among the most agriculturally productive valleys of Uttrakhand has been lost. This has far-reaching implications in the medium and long-run, in terms of self-sufficiency and food security of the region.

The impoundment of the Tehri dam

Any fisherman will tell you that river confluences, big or small, are known

[19] http://thdc.gov.in/Projects/English/Scripts/Prj_Introduction.aspx?vid=132

Wrecked confluences, inaccessible river-bed cremation ghats due to deep, wet sediment in the Tehri reservoir

to be important habitats for fish. They are also important areas for people living in the area, since all their cremation *ghats* are located at confluences. If you look at and below the drawdown level of the water all along the reservoir, you will see that it is very steep-sided, and inaccessible either to humans or their cattle. Not only are cremation *ghats* drowned in meters of wet sediment mire, but the river rendered inaccessible in most places even higher along confluences. Moreover, the still waters of the reservoir have gradually got increasingly polluted, and since quite often cremation is incomplete (during the rainy season or at pyres of the uncared-for), it is not uncommon to see half-burned bodies floating in the waters of the reservoir. Children, unmarried women, sub-adult males (for whom the thread ceremony has not been performed) and even pregnant women who die, are normally accorded a water-burial as their last rites. Along flowing rivers, such mortal remains would drift out of sight and be assimilated in the trophic build-up soon enough. River currents 'picking their bones in whispers', to paraphrase Eliot[20]. Decomposing bodies along banks of a reservoir, however large, are not just unsightly, but also insanitary; and increasingly, people here no longer perform the full rites that include a ritual gulp of water from the river, and a cathartic bath at the *ghat*[21].

And what about the fish here? For one, average flows in this section of the Bhagirathi have since reduced from 28 cumecs to just 5.7 cumecs. At the time of my visit, 8th February 2014, the was no flow from the Tehri dam into the Bhagirathi. We will talk more about what this and other changes have meant for fish, together with what is happening in the Alaknanda, the other largest tributary of the Ganga.

Upstream of Chiliani Saur and towards Uttarkashi, the Bhagirathi, now a small and greatly reduced stream, flows for 22 km and into a furrow past the massive zone of deep sediment deposits into the reservoir. The recently built Maneri Bhali II dam just before Uttarkashi diverts the entire waters of the Bhagirathi (other than what escapes from under the sluice gates) into a 22 km long tunnel to feed the 304 MW Maneri-Bhali II powerhouse at Dharansu. Upstream of this dam,

[20] T.S. Eliot. The Wasteland. IV. Death by Water. The Gutenberg Project.
[21] Pers comm. Shekhar Pathak, Historian. Nainital.

the Bhagirathi flows for less than a kilometre after being released at Tiloth from an 18 km long tunnel from the Maneri-Bhali I dam upstream. Yes, the diverted 18 km section runs practically dry, except for some basal flows and a small escape from under the sluice gates of the Maneri dam.

Maneri dam on the left of the U-curve. Whatever water is flowing is from leaking sluice-gates

Above Uttarkashi and between the two Maneri-Bhali projects is the confluence of one of Bhagirathi's larger tributaries, the Asi Ganga, at Gangori. On a previous visit I had seen the start-up of the first of three small HEPs (Asi Ganga I - 4.5 MW, Asi Ganga II - 4.5 MW, and Asi Ganga III - 9 MW) that were being constructed along this tributary. I now had news that all three had been buried or washed away during the flood even of June 2013. I drove up to have a look. All three projects had either been completely washed away, or severely damaged, not just by flood waters, but by massive bed-load movement in much of the valley. I was informed of a trout breeding farm up this valley near Kuflon village, but on enquiring while in the valley, I was told that the farm had also been washed away in the floods the previous year, 2012[22].

The main source of the Asi Ganga is the Dodital lake at 3,077 meters altitude, nestled in a hollow amidst a cold-temperate oak forest, still beautiful despite loud and jostling hordes of corporate tourists being herded up like sheep. There is no glacier at its head, and it is entirely snow and spring-fed. The British had introduced Brown Trout in this river, and it has thrived here, with periodic set-backs during recurring flood-cycles, and in stretches of the Bhagirathi as far up as Harsil at 2,620 m altitude.

I drive up the Bhagirathi past the Maneri I dam that is the oldest dam on the Bhagirathi. I had seen it soon after it had been commissioned in 1984. Its diversion reservoir is not large, but it is now almost completely silted up with sediment. In 30 years. To my eye, it seemed as most of the reservoir was silted up, and I could not help wonder what the utility and efficiency of this structure must be today. Due to vast sections of the road having been torn away during the floods

[22] The Asi Ganga had also experienced a devastating flood event during the previous monsoon of 2012. I later learned that all three hydropower projects on the Asi ganga had also been damaged during these floods. Please see http://dmmc.uk.gov.in/files/pdf/Uttarkashi_Report_Final.pdf

Upstream of Maneri dam. Completely silted over

last year, many sections to and beyond the Maneri dam were past active landslides, and barely passable.

I stop for lunch at Barkot, a small village market-place near Bhatwari. Most of the village had already been severely damaged in landslides over successive years since 2010, and many residents have left for safer places. Some had stayed back for work on the now-scrapped 600 MW Lohari Nagpala Hydropower Project by NTPC, just a few kilometres ahead of the village. I struck up a conversation with a few men sitting at the eat-shop, asking what they felt about the scrapping of the Project by the Government of India, due to protests. The most urban-looking among them spoke up quickly. Prefacing his piece with gallis, he went on to say; "these god-men and environmentalists between them have managed to have the project scrapped. When, and god forbid, I become a politician, I will see to it that the power supply is cut off for these Ashrams and 'hotels', where these god-men are raking in the money, sitting in air conditioned rooms, and getting massaged by girls god-knows-where-all". He quoted the case of Asaram Bapu and his son, who were currently in the news, and in jail. He said all this while wolfing down handfuls of rice and dal. He stopped for a moment to glare at me and say "I say this even while I am eating… but I hope their bodies are eaten by worms…" I asked why he was so angry about the scrapping of this project, and he said that it had snatched away their livelihoods. I enquired what these livelihoods might be? He replied that he and others in the village had dumper-trucks and contracts for transportation with the National Thermal Power Corporation (NTPC) whose project it was[23].

I drive on towards Harsil hoping to get to the Brown trout zone, even though I am warned that there is too much snow *enroute*. Sure enough, even my four-wheel-drive is unable to get beyond the hot-springs of Gangnani, and I return to Uttarkashi. There were no existing HEPs further up anyway, other than the small 2.2 MW Pilangadh project which I could see at the confluence of the Pilangadh with the Bhagirathi across the river.

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[23] Rozi-roti, was the term he had used for livelihoods. Rozi-roti in Hindi would literally translate to plain bread earned from a daily wage, and implies a subsistence level of earning. Owning transport vehicles and getting large contracts sounds more like rosy-roti.

I then head down again, and up the other major tributary of the Bhagirathi, the Bhilangana. I have to use the heavily guarded road across the Tehri dam to get to the Bhilangana valley. It is difficult for me to remember any more what the valley looked like when I first visited it in 1980. The valley is drowned so deep that there are no landmark clues to anchor memory on. The difference between the full reservoir level and the draw-down levels[24] were even more stark here, especially when greeted by the 'ghosts' of drowned villages. Ruins of homes and silted-over fields forlorn, now exposed at low reservoir levels. There are some partially drowned villages along the way too, and there is something about them that evoked a deep sense of discomfort. I stopped to speak to Bhaveshwari devi of the half-drowned Basaun village, she said that for those of them who still lived in and near their half-drowned villages, it seemed like death, but without closure.

Submerged villages and fields, upstream of the Tehri dam, during draw-down

The Bhilangana valley is under water, past the confluence with the Balganga, almost up to the town of Ghansiali. I am able to see the small Bhilangana HEP, but not go further to see Bhilangana III, since the road is still in disrepair. At the place I sit down for lunch, I am asked if I will have fish. I decline, but ask whether it is the local snow-trout that is being served? I am told that it is carp from the reservoir that is more easily available, and snow-trout is all but gone from the Bhilangana. They wouldn't take the tasteless carp home, they said, but do serve it up to travellers at eat-place near the taxi-stand.

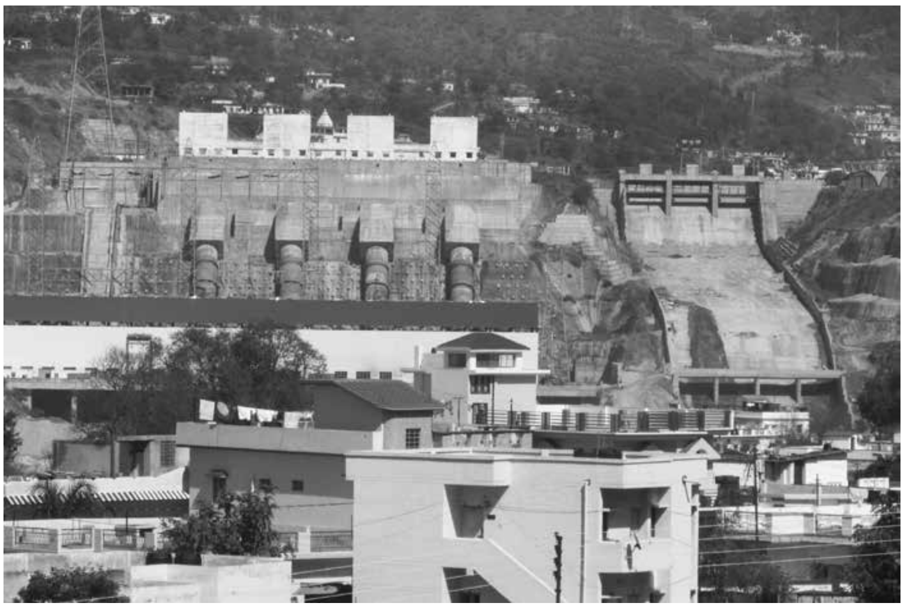
There are no existing projects presently on the Balganga other than the 3 MW Agunda-Thati, the Balganga river has been assessed by WII to be one of the most valuable in terms of fish diversity and fish habitats in the two basins. This tributary too is only snow and spring-fed, and so is relatively warm and meso-trophic.

From here I head for the Alaknanda, by a short-cut over a ridge between the two basins, and reach Srinagar, where the lowest elevation hydropower project on the river is, just above the proposed Kotli Bhel 1B on Alaknanda. I get to meet Professor Prakash Nautiyal, fish biologist

[24] The lowered water levels after release from the dam.

at the HNB Garhwal University, for a very educative conversation, especially on fish hatcheries. More about our discussions when we discuss fish soon.

Despite many months of reclamation and earth-moving with heavy machinery, many parts of Srinagar town and the University on the opposite bank are still partially drowned in the debris that had been stacked by the Srinagar HEP by the river-side during construction, and that struck Srinagar during the flood episode of June 2013. Located where it is, Srinagar has been the site of previous numerous devastating floods, even in living memory. Even so, the administration had turned a blind eye to the dumping of excavated debris along the banks of the river. While a great mass of debris was washed into Srinagar town in the recent flood episode, huge dumps still lie accumulated on the banks below the Srinagar dam, to be 'worked' down again in ensuing floods.



Srinagar dam

The 330 MW Srinagar HEP looks complete and functional at the dam-site. While the GVK website says that it is nearing completion, their news update says that the plant has been inaugurated by Akhilesh Yadav, CM Uttar Pradesh in March 2014[25]. It is a travesty that you can drive almost the entire length between Srinagar and Rudrprayag along the Alaknanda valley drowned by the dam impoundment, and still get away by calling this technically a 'run-of-the-river' project[26].

From Rudraprayag I head up the Mandakini valley. Mandakini was much in the news after the floods last year (June 2013) because of the very high number of people killed at the Kedarnath shrine and downstream at Rambara and beyond. All subsequent analyses point to torrential rain

[25] Srinagar Project, however, as per Central Electricity Authority website, has generated no power at least till end of October 2014 for which information is available, see: http://cea.nic.in/reports/monthly/generation_rep/tentative/oct14/opm_16.pdf. the project was in news for the damages in 2014 too.

[26] The official definition of a 'run-of-the-river' (ROR) project seems interminably stretchable. While it implies that only a portion of the river is diverted while the rest continues to run free, there is another generous definition that says that those dams that impound water enough for upto 12 hours of generation can be called ROR dams. However, what we see is that any dam that has its powerhouse located at a distance from the toe of the dam, and to which water is diverted, is being called an ROR dam, irrespective of the river being completely impounded, or the size of the impoundment. There are exceptions to this description though, with even big dams with big reservoirs and dam toe power houses also claimed to be called ROR projects.

coupled with the collapse of the moraine-dammed proglacial lake at the head of the valley, (as well as the untimely concentration of pilgrim-tourists) as the cause for the flood being more devastating here than in other valleys during the same period.

The drive up the valley, (barring a nocturnal misadventure with a flat tyre, coupled with a flat stepney and further compounded by a malfunctioning jack), was along a now serene river, but still-evident devastation to roads, bridges and newly built hotels and shops along the highway. There are nine HEPs of various sizes proposed and underway in the valley. Each and every one of them that was under active construction or functional was damaged or completely destroyed in the 2013 floods. This is not surprising at all, not just because of the intensity of last year's flood, but also because this valley has a history of frequent and devastating tectonic and weather events. Look at just the past 20 years[27].

1997: The Ukhimath landslide that dammed the river and then took away a village above it.

1999: The Chamoli Earthquake.

2000-2001: The Phata landslide.

2012: The Mangoli village landslide.

2013: The Chorabari glacial lake collapse and ensuing floods[28].

At Rudraprayag, the confluence of the Mandakini with the Alaknanda, monsoon related disasters have been recorded seven times in the last 34 years[29] and these include 1979, 1986, 1998, 2001, 2005, 2006 and 2012.

After Ukhimath, along this frequently flooding Mandakini, first up the road comes the 99 MW Singoli-Bhatwari HEP by L&T. The Mandakini had torn away the side of the valley to bye-pass

The Singoli-Bhatwari HEP that is now stranded at one side of the riverbed

27 Source: Madhur Darmora, local resident.

28 For a film on Uttarakhand floods and how hydropower projects fared, see: http://sandrp.wordpress.com/2013/12/16/uttarakhand-flood-ravage-and-the-dams-short-film-english/

29 http://sandrp.wordpress.com/2013/06/21/uttarakhand-deluge-how-human-actions-and-neglect-converted-a-natural-phenomenon-into-a-massive-disaster/

The remnants of the Phata-Byung dam that was blown away during the 2013 floods

the under-construction dam, also damaging it substantially.

Enroute to the damsite, you pass the site of the headrace tunnel where it exits the mountain for the powerhouse. The exit is almost fully blocked by bedload, and early construction of the powerhouse damaged. Many of the muck dumping sites right next to the river have either been partially or completely washed away. Such dumping is entirely illegal. Hydropower companies are required to locate their muck dumping sites at least 30 meters away from the High flood levels of the river[30].

The 76 MW Phata-Byung HEP a little before Sonprayag and that was under construction by LANCO was also completely destroyed. Just before the confluence of the Mandakini with the Son river, there is an enormous landslide of a giant tallus-slope torn away by flood waters from upstream, and the amount of material that has come downriver is visible as bed-load, already cut over 10 meters deep by the river by the end of one monsoon. Nothing in its way stood a chance. There was only a little bit of concrete left with some twisted reinforcing steel left where the barrage was.

I had been enquiring about fish all along the way up the Mandakini, especially among the Nepali migrant labour who are the only ones who catch fish here, and was told that fish (snow trout) are to be found as far up as Sonprayag. I go up to Sonprayag (the road is not passable beyond) and have a look. It was the Son, even at 1,716 meters altitude that looked more hospitable for fish. I have been right up to the source of the Son on a previous occasion and know that it emanates from a large and beautiful tarn called Basukital, in a deep hollow left behind by a retreating glacier, high up at 4,231 meters altitude. It is largely snow-fed. The Mandakini is predominantly glacier-fed and is much colder. I pull out a thermometer to confirm, and even in early February, when glacier melt is at minimum, the Mandakini was 6.5° C and the Son was 8°C.

I head back to Rudraprayag, Karnprayag, and up the main Alaknanda valley to Nandprayag, the confluence of the Nandakini with the Alaknanda. The Nandakini also has its beginnings at a small pro-glacial tarn called Humkund, at 5,617 meters altitude, bounded by a moraine-ridge

[30] Pers Comm. Himanshu Thakkar.

at the head of the valley. It cascades very steeply down a valley we found impassable while in spate on the descent during the monsoon a couple of years ago.

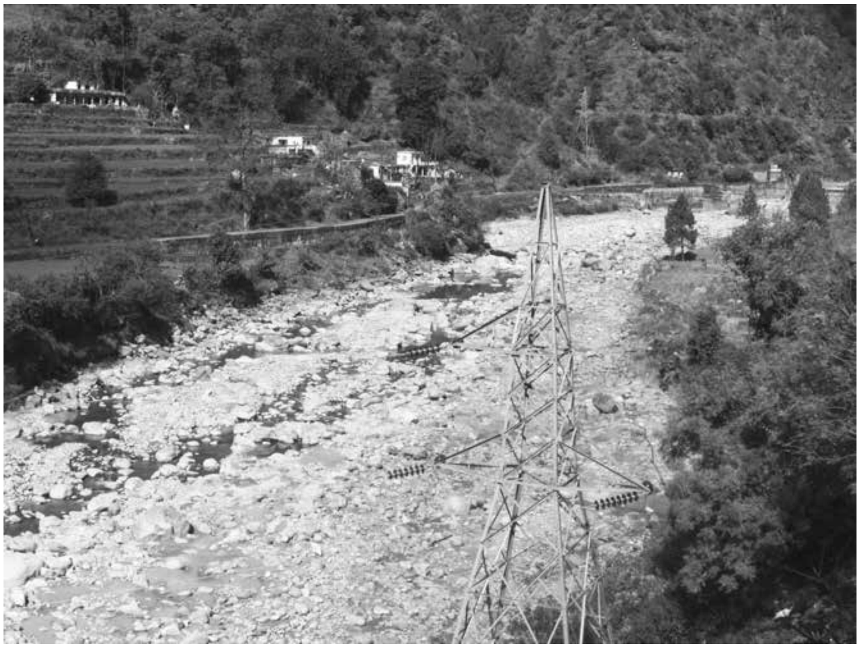
There are two HEPs up this catchment; the 3.6 MW Rajwakti HEP owned and run by Himurja Pvt Ltd, and the 15 MW Jakhni Vanala HEP also by Himurja but presently run by Ramoj Construction Company. Both these HEPs have been damaged during the floods of June 2013. The first one, the Rajwakti suffered exposed-channel and pipe damage, which has been repaired already and is functional again, though barely so. Its dam a few kilometres upstream is completely filled up with sediment, and all the present low-flow is diverted directly into the intake channel. The river in between is almost completely dry.

The small Rajwakti reservoir completely silted over

The larger 15 MW Jakhni Vanala HEP upstream is severely damaged by the flash movement of bed-load from a smaller side stream immediately downstream of the dam. Even though this is in hindsight, it is amazing that the planners did not notice the hazardous nature of the location. The channel to the siltation tank has been deluged and damaged by boulders and earth-movers were working to clear the massive heap before any repairs can be undertaken.

The damaged Jakhni-Vanala HEP damaged by bed-load movement

Because of the damage and the repair underway, the Nandakini was running free between the two HEPs. It is a very beautiful river where it runs, but now, entirely bereft of any fish anywhere above the first dam, the Rajwakti.


What is left of the Nandakini below the Rajwakti HEP

I spoke to 80 year old Sher Singh from Jakhni village enquiring about fish in the river. He said that fish were plentiful in the rivers all through his life, right until the time the Rajwakti HEP was built in the year 2002. Both snow trout and barils. All the villages along the river who depended on fish for food now must do without it. This entire stretch is below 1,000 meters altitude, and the river being largely snow and spring-fed, is ideal for fish. I also stopped and asked a group of young men about this, and about whether they were benefited in any other way by the HEP. They were very unhappy at not just their river being robbed of fish, but also that they got absolutely no electricity from either of the two HEPs on their river.

Enroute to Joshimath then, on the true-left bank is the confluence of the Birahiganga with the Alaknanda. Right near the confluence itself it the 7.2 MW Birahiganga HEP power-station. Two and a half km upstream, in a narrow gorge, accessible only through a gated private road, is the dam for this project. Here too, well within the fish-zone, the river runs practically dry between the dam and the powerhouse. Upstream of this, there are three HEPs planned and underway. Birahiganga I and II, both for 24 MW, and the Gaunatal HEP for 50 MW. Is collective memory so short, or is it plain deafness that the name Gaunatal fails to ring a bell with the planners and approving authorities?

Among the most catastrophic floods in recorded history for the region was triggered by what happened in the Birahi catchment. In October 1893, a landslide in the Birahi catchment near Gauna village formed a 350 meter high dam that blocked the river forming a huge lake that came to be known as Gaunatal. Following very heavy rainfall and debris flow the following year in August 1894 the lake breached. The surge of water that rushed down the valley raised the level of the Alaknanda by 50 meters even at the wide floodplain of Srinagar 110 km downstream, destroying the entire town[31].

[31] Varun Joshi and Kireet Kumar. 2006. Extreme rainfall events and associated natural hazards in the Alaknanda valley, Indian Himalayan Region. J. Mount. Sci.3 (3), 228-236. Also described in The State of India's Environment 3. A Citizen's Report. Floods, Floodplains and Environmental Myths. CSE

That is not where the story ends either. Over the years landslides in the unstable valley blocked the Birahi river yet again to form a lake 5 miles long, 1 km wide and about 300 feet deep. As recently as 1970, this massive lake breached catastrophically again after three days of heavy rain in the catchment, the impacts of which are said to have been felt all the way down to Haridwar[32]. It is in the same unstable valley, and the same location as the breached lake that the Gaunatal HEP is planned and underway. With regard to fish in the Birahi, let it be said here that WII's assessment less than two years ago classified this river as one of 'high' fish biodiversity value. With four successive projects coming up in this valley, it would no doubt mean oblivion for fish. Just like in the Nandakini.

The Birahi, rated by WII as one of the most valuable for fish diversity, bone dry below the diversion for the Birahiganga HEP

Further up towards Joshimath, and just before the Urgam stream joins the Alaknanda on the true-right (with the 3 MW Urgam HEP on it also damaged), is the damsite of the 444 MW Vishnugadh-Pipalkoti HEP by THDC at 1117 meters altitude at Helang, where work is underway. The project, to be funded by the World Bank is awaiting the report of the Inspection Panel to which a complaint of World Bank policy violations have been sent[33].

A few kilometres ahead below the town of Joshimath is the powerhouse site for the 520 MW Tapovan Vishnugadh HEP by NTPC where there is a hum of activity. Conversations with people at Helang village had confirmed that this powerhouse site, at 1,394 meters altitude, was the upper limit of fish (snow trout) on the mainstem of the Alaknanda. On my way up to the last major HEP on the Alaknanda mainstem, the 400 MW Vishnuprayag HEP, I took on board a hitchhiker who was currently working there. He had previously worked at the 520 MW Tapovan Vishnugadh HEP, and informed me that there, the Tapovan Vishnugadh project had been using a drilling machine (instead of using explosive, as all the other projects have done)

32 For a very interesting narrative on this, please see Anupam Misra's piece. http://mansampark.in/2013/06/22/uk/

33 The Inspection Panel report is pretty disappointing, see for details: http://ewebapps.worldbank.org/apps/ip/Documents/Press%20Release%20Board%20Discussion%20India%20and%20Kenya%20Investigations%2010.2.14.pdf

to create the 15.5 km long tunnel from Tapovan to Helang. He said that a portion of the tunnel had collapsed onto this very expensive machine, and that all tunnelling work had to be halted. A team of overseas experts he said, had been called in to handle this situation, and that they were on the job.

Though the Vishnuprayag HEP is well above the fish-zone, I went up to visit it because I had last seen it prior to it being damaged, and was curious to see what state it was in currently. The way led past the devastation at Govindghat, opposite the Bhyundarganga. It was disconcerting to see that the Gurudwara complex was being repaired and rebuilt exactly where it previously was, right at the riverbank, in the line of future floods. But also on the opposite bank one could see the tunnelling work of the 24.3 MW Bhyundarganga HEP carry on apace right next to the devastated river-bed.

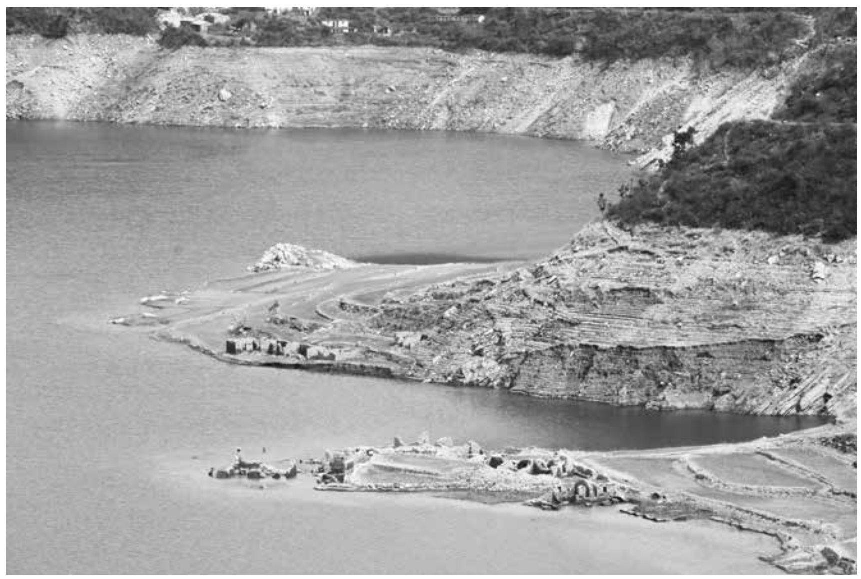
The road to the Vishnuprayag HEP was currently being repaired by the Jaypee Group who built and runs the HEP, and coupled with recent snowfall, melting slush, falling boulders and active landslides, was in a state that was somewhat extreme. I drove to where the road fell away to the river, and judging from the pictures of the barrage almost completely buried in bed-load during the floods, it was surprising to see that over the past 6 months or so, the company had worked to clear all the bed-load from the barrage. I had also been told by our hitch-hiker friend that while much work had been done on the barrage site, that the clearing of boulders and debris that had filled the head-race tunnel was underway.

The Vishnuprayag HEP under repair

The last HEP visited on the upper reaches of the Alaknanda was the site of the 520 MW Tapovan-Vishnugadh damsite on the Dhauliganga. Again, while this was also well above the fish-zone, I went up to see what I could on the progress of the project onsite. While there was only some initial work on the damsite visible above-ground, most of the work was being done underground on the tunnelling. There are however eleven projects proposed and underway upstream of this on both the Dhauliganga and the Rishiganga.

Finally, I travelled along the Pindar river, one of the longest, though by no means the largest tributary of the Alaknanda. Apart from the existing 5 MW HEP at Dewal and a 0.4 MW one at Tharali, there are 8 other HEPs planned and underway along the Pindar. The road along the Pindar is up to Deval, and thereon up the Kailganga. The Pindar is predominantly a glacier-fed river, but the lower sections, especially after Deval down to the confluence at Karnprayag, is at low altitude, is gently sloping, sparsely inhabited, and fairly well forested. Most certainly good habitat for fish. From conversations with people along the river, it was clear that riverside villages depend quite heavily on fish for food.

The most visible HEP building activity along this river is the 252 MW Devsari HEP by the Sutlej Jal Vidyut Nigam Ltd (SJVNL). Signboards marking the damsite, quarry site, dumping site and office sites are already up. While the dam site will be at Nandkesari, just before Deval, the powerhouse will be 21 km downstream. As in the case of all the other so-called run-of-the-river projects, here too one can expect the river to run dry for these 21 km. Right at the proposed site for the powerhouse, one can already see a disquietingly large movement of bed-load from a smaller tributary stream joining the Pindar. It is clearly a steep and flashy sub-catchment that is very likely to yield a catastrophe in the event of a serious storm event. The proposed quarry site also promises to be eventful. It is at a narrow part of the valley, which is especially steep sided, and is visibly a boulder-field from previous landslides. While this may be a convenient site for the SJVNL in terms of easily accessible exposed rock close at hand, it is most likely to leave behind an unstable slope leading down to the river's edge.



Stagnant waters of Bhilangana river and scarred river banks

The Travel Report:

The Beas

While the Bhagirathi and the Alaknanda are among the many headwaters of the Ganga and drain into the Bay of Bengal, the Beas is one of the headwaters tributaries of the Indus, which drains into the Arabian Sea. While these tributary rivers (Bhagirathi, Alaknanda and the Beas) have their origins on the southern divide of the Himalaya, it is interesting to remember that both these great main-stem rivers were antecedent to the rise of the Himalaya, and even today, have major tributary contributions from across the Himalaya, on the Tibetan plateau. You have perhaps seen the fascinating hypothesis by fish taxonomist S.L. Hora, who deduced from the similarities in fish species-assemblages in the Ganga and the Indus, that once these two great rivers flowed into each other and into the Arabian Sea, and parted ways subsequently with the east-ward tilt of the Indian plate[34].

The river Beas, this tributary of the Indus, is said to originate from a pro-glacial lake called Beas kund at 4,062 meters altitude, in the Solang nallah on the southern slopes of the Rohtang pass. Its major tributaries are the Solang, Manalsu, Sujjain, Fojjal, and Sarvari on the true-right bank,you have the Alleo, Duhangan, Chhaki, Haripur nallah, Parbati, Tirthan and the Sainj on the left bank. The course of the Beas runs through the Greater Himalaya, the Lesser Himalaya and the Shiwalik, before it meets the plain.

The travel up the Beas:

At this time of year, late winter, most of the waters of the Beas flow down to the plain not on its normal course down a river-bed of its choosing, but through the Beas-Sutlej Link Canal, and down to the Bhakra dam reservoir, then on to the reservoir at the barrage at Ropar, and thereon, to the agriculture fields of Punjab. I chose to follow the waters of the Beas through this route rather than the other this time, because travel time would not permit both approaches.

I drive up past the Ropar barrage, where over 30 years earlier, I had first seen the sight of a stranded shoal of Mahseer downstream of the barrage, using the astounding strategy of heaping

[34] Hora's hypothesis is cited in Menon, A.G.K. 1954. Fish geography of the Himalayas. Proc. Nat. Sci. India 20(4): 467-93.

The barrage at Ropar

themselves on top of each other in a pyramid on the spillway, in a futile attempt to make it over and up to their dispersal and breeding streams. Looking at those at the bottom of the pile, I had imagined then, that it was collective breeding strategy, to enable even a few to get over, and run with the genetic baton. But not one was anywhere close to getting over the 10 meter high obstacle, and some fishermen were collecting them by the sack-full in shin-deep water at the bottom of the barrage.

The sight of the barrage was entirely different this time. No longer a quiet place by the ice-blue waters of the Sutlej and the Beas, the barrage was now a constant noisy stream of vehicular traffic. The thing with old barrage impoundments in the plains is that, for one, they are not very deep and after many years they silt up with sediments, and even if they don't do their job very well, they begin to sport margin vegetation, and resemble marshy wetlands. During the month of March there were some water-birds, mostly migratory ducks and some cormorants, at a safe distance from the din. I should say here however, that this is not a common sight among dam reservoirs in the mountains, where the impoundments are deep, and the drawdown frequent, leading to radical and quick exposure of the banks, and no place for waders to feed.

In all my travels to the many dam impoundments in the mountain areas of Uttarakhand and Himachal for this study, barring an odd cormorant, I never saw any waterbirds in the upstream of a dam in its impounded water. The only place where I did see any waterbirds, was in the downstream natural flow (whatever little was flowing from the impoundment), of the Srinagar dam. A covey of about 30 red-crested pochards (who were so yellow-crested) perhaps on their migratory flyway along the river. This is the first year of impoundment at this dam, so also the first time these pochards would have encountered such an altered flow.

As I drive uphill towards Bilaspur, I encounter the welcome boards of hydro-power companies, both private and government-corporate. The Bhakra-Beas Management Board (BBMB) of course, but also the NHPC and the Bhilwara Group at Allain-Duhangan. I drive past the detour to the Bhakra-Nangal dam complex, which is in the Sutlej catchment, but today receives much of the waters of the Beas river as well. I had visited the famed Bhakra dam one foggy winter morning with a bus-load of lefty MPs and MLAs from Kerala, one of whom was my uncle. Clad in too-thin muslin mundus for a north-Indian winter, they were on an official visit to witness first-hand the 'development' of Punjab, and I was tagging along. This was almost 45 years ago, and as a little boy, looking down the spillway of that giant concrete structure, it was like looking down from three Qutub Minars stacked on top of each other. The Bhakra dam is 225 meters high, and the Qutub Minar at 73 meters high, was the only 'skyscraper' in Delhi at that time, and the highest structure I had been on till then. I was impressed, to say the least. Driving up now, all these years later, to look at the impacts that the flurry of dam-building has had in this corner of the Himalaya, was a curious and interesting journey.

I drive up to and past the huge reservoir of the Pong dam, at a place called Dholra, near Bilaspur. (The Bhakra dam holds the waters of both the Sutlej and the Beas, which is channelled there by means of the Beas-Sutlej link canals.) This is the month of March, so the draw-down in the reservoir is drastic enough to reveal a huge area drained of water, leaving behind a deep accumulation of fine silt sediment. Parts of it were still gleaming wet, and looked like freshly drained tidal mud-ooze. I had no idea as to how deep this was, till I saw the tops of some ancient stone temples drowned and barely sticking out of the mud in places. As you drive on, you see more temple roofs sticking out of the mud, and you get an idea of how magnificent they were, when you see one of them only partially submerged in sediment.

The drowned valley of Dolra. The temple-tops visible at draw-down

I sat down for lunch at a restaurant that over looked the reservoir. I guess this must be a spectacular view when the reservoir is full, but right then, all I got was the ugly sight of the huge expanse of mire, that had not yet been able to obliterate the memory of the beautiful labour of art. Speaking to a man who served me lunch there, I learned that these were the ancient temples of Dholra, and that at high water levels, during the monsoon and after, these temples are completely submerged. They emerge every year, when the water is low he said. I thought he too muttered something about dead people and memories. I asked how the people of this place could allow this to happen. He said that it happened during the times of his father, who himself was from the times of British occupation, and they were used to the 'Sarkar' having their way; even if this Sarkar was in Independent India.


Partially submerged temples

Here it was then. More clarity on why this seemed so like colonial occupation, even in its present manifestation. You see, both the Bhakra dam on the Sutlej and the Pong dam on the Beas were colonial projects in the first place. Work on the Bhakra dam was conceived of in 1908 and preliminary work started during British occupation, by the Governor of Punjab in 1946[35]. The dam construction proper however was undertaken in 1948 at a faster pace, after Independence from the British.

The idea for a dam on the Beas at the Pong site was first proposed as early as 1926, again under British colonial rule. The subsequent survey of the Indus and its tributaries deemed the project risky because the flood-prone nature of the Beas[36]. After Independence however, a final design was issued and construction on the dam began in 1961. It was completed in 1974 and the power station commissioned between 1978-1983.

The colonial nature of this enterprise is embedded in the rapacity of its conception[37], and in the laws and legitimation under which private lands were appropriated and people displaced. What is colonial about it, is the forcible and large-scale appropriation of land and resource by and for a distant set of people, and only because they have the power to do so. The colour of skin is incidental. The reservoir created by the Pong dam can store 8.5 billion m^3 of water from the Beas, and covering an area of 260 km^2 upstream of the dam [38]. During a public meeting in the submergence zone of the Pong dam in 1961, the then Finance Minister Morarji Desai had declared "we will request you to move from your houses after the dam comes up, it will be good, otherwise we shall release the waters and drown you all."[39] The man went on to become the Prime Minister of India.

[35] For great detail on this, please see Shripad Dharmadhikari's Unravelling Bhakra; Assessing the temple of resurgent India. Manthan Adhyan Kendra 2005, see: http://www.manthan-india.org/spip.php?rubrique1.

[36] Development History of Beas Project. Bhakra Beas Management Board. 2011.

[37] You can see similarities in the rough-shod and exploitative nature of the prevailing utilitarian view and capitalist economy of the Empire then, that was playing itself out in exactly the same way in the large-scale felling of forests, and the export of wood to distant places, irrespective of consequences to local human populations and to ecosystems.

[38] India: National Register of Large Dams 2009. Central Water Commission.

[39] see: http://www.narmada.org/sardar-sarovar/sc.ruling/ashwinee.bhatt.letter.html

On my return, I read up on the Bhakra-Nangal, the Pong and other Projects on the Beas, and here is what I learned. The Beas Project is a part of a grand Master Plan at a regional scale, for the utilization of the waters of the three tributaries of the Indus; the Sutlej, the Beas and the Ravi, for both irrigation and for power generation. The Bhakra-Nangal project uses the entire average flow 16,652 million m^3 of the Sutlej. The Madhopur-Beas link transfers 2,344 million m^3 of water from the Ravi to the Beas. The Bhakra dam, the Beas dam (including the waters of the Ravi) and the Beas-Sutlej link together 'harness' 97% of the average flows of these three rivers. The project was conceived as part of a larger project known as the Rajasthan Canal Project, where the waters of these rivers were to be taken to the distant deserts of Rajasthan, to enable agriculture there at an industrial scale.

The process of land acquisition for the Pong dam started in the early 1960s, for a total of 75,000 acres spread over 94 villages constituting 339 hamlets. When the dam waters filled the valley, 223 of these hamlets were fully drowned and 116 partly submerged. The area that was submerged was known as the 'Heart of Kangra', named the Haldoon valley, and meaning the granary of Kangra. An unusually wide, green and gently sloping valley-floor for the Himalaya, with fertile soil and with a river weaving through it. The farmers here produced enough food not only to feed the entire district, but a substantial surplus for other areas as well. Because of this surplus, this valley also cradled one of the oldest stratified civilizations in this part of the Himalaya, and was also what drew the Gorkha invaders farthest west, in their brief invasion across the western Himalaya.

This reservoir displaced 30,000 families of around 150,000 people, who were told that they had to move from their cool, verdant mountain valley to the hot desert-lands of Rajasthan, where they would be allotted land along the canals that carried water from their valley. For all practical purposes, it was like being asked to move to a different continent. Even so, right until when the waters started filling up the reservoir and drowning their villages, the relocation had not been undertaken. In democratic India, were people asked whether they would be willing to move? No. They only knew of the project being underway, when acquisition began. Did they protest? They did, but all that succeeded in doing was getting some of the families getting cash compensation with which it would be impossible to buy similar land, and some relocated to the driest parts of Rajasthan[40]. Rajasthan, which is not even a lower-riparian state of the Beas. It was an inter-basin transfer. Of the kind that Prime-Minister Narendra Modi promised during the 2014 Parliamentary elections he will wreak at a sub-continental scale, all over the river basins of India.

While people were protesting, they had been given false promises by co-opted local politicians, and this, combined with poor information, led them to flee in panic when the waters began to drown villages low in the valley. Hari Mohan's report[41] that describes all this in detail, says that not only did this lead to the loss of much property and crops, but 'several unfortunate people

[40] This was done in 'independent' India under an old colonial legislation, the Land Acquisition Act 1894, where all that is required to be done by the government is to issue a notification to the effect in a government gazette, and in two local vernacular newspapers. You can imagine what this would have meant to what was then a largely illiterate, entirely rural population, with little access to newspapers.

[41] Hari Mohan Mathur. Struggling to regain lost livelihoods. The case of people displaced by the Pong dam in India.

who had not been quick enough had been drowned'[42]. The promise of another Prime Minsiter, Morarji Desai.

But people apart, when I drove past Nadaun, after which similarly vast expanse of deep sediment was exposed along the drained sections of the Pong reservoir, it was clear that life had changed drastically for all aquatic life in and near the river here as well. We will look more closely at the impact of this and other impoundments and diversions on the Beas together soon. However, I had read some rapturous reports on the Pong reservoir becoming a birders' haven. There were no birds other than a few crows flying low across the drained sections of the reservoir near Nadaun where I was. The lower sections, near the dam were said to be where the concentration of birds were. I read that the Pong reservoir was declared a Bird Sanctuary in 1983, and as one of India's 25 International Ramsar sites[43] in 2002. One famous Hugh Whistler reported some 39 bird species from this area in a list published in 1926. Jan Den Besten though, in his book Birds of Kangra, suggests that over 400 species of birds can be seen in and around the Pong reservoir now, and the annual bird-count in 2010, recorded an influx of 144,000 migratory birds[44]. 150,000 people moved out and we got 144,000 migratory birds instead. It is when this is written or spoken about in the context of nature conservation, or in the 'benefits' of dams that I cannot help wonder how thrilling the numbers would be, if someone created a large reservoir right where Delhi is today[45].

I want to make a brief mention here of another aspect about this huge body of water, because it occurred to me right then. The reservoir stores about 8.57 billion cubic meters of water covering an area of 260 km². This is a huge impoundment by any standard. It is well researched that such an additional weight on the Earth's crust can have severe seismic implications. The Pong dam is in Kangra district, and we know that Kangra witnessed a devastating earthquake of 7.8 magnitude[46] in 1905. It is reported that even with the relatively sparse population then, around 19,800 people were killed and very many injured. This is clearly an area of very high seismic potential and it does not require a geologist to tell you that this dam and reservoir are located in an extremely seismic area. There is a temple very close to the reservoir called the Jawalaji, at a place called Jwalamukhi[47] that is situated right on a rock-fissure where natural gas streams out from a deep fissure in the crust. At the alter-piece in the temple, the priests light a clear blue flame from the gas emissions, and close-by, are deep pits with welling hot springs. We know that such phenomena occur only in places where there are crustal faults or plate boundaries, where serious seismic movements can occur. This is just one of many instances of criminally cavalier

[42] This is somewhat difficult to comprehend, as I imagine that waters filling such a huge reservoir would take time to rise. It is more credible that some people may have just chosen not to flee, at whatever cost. Also, under the above-mentioned Act, the government was not obliged to compensate for anything but 'immovable' property, and neither ofcourse, for the village forests, grazing lands, water sources and other commons that people depended on for their survival.

[43] A Ramsar site is a wetlands site that has been designated as Internationally important to conserve for biodiversity values.

[44] Sanjeeva Pandey. The Pong dam lake: A birding paradise. Sanctuary Asia. Vol XXXIII, No.1. 2013.

[45] In any case, these southward winter bird migrations would be at least as old as the Holocene, and become suitably attractive for these birds to change their route only in preference to other wetland locations along their flyway. Using the reservoir as a stopover at this reservoir would only be feasible after it became silted over and shallow.

[46] The Gujarat earthquake of 2001 was of 7.6 magnitude on this exponential scale, and even though I was a few hundred kilometres away from the epicentre in Gujarat right then, the ground rocked enough to drop standing people in my sight.

[47] Which in Hindi, literally means volcano.

planning and construction of hydro-power and river-regulation projects in the face of evidence of the location being extremely hazardous.

I then move on from here towards the next part of the Beas Project, and that is the Pandoh dam, 140 km upstream of the Pong. I am joined in my further travels along the Beas by the good company of Sumit Mahar from *Himdhara* in Palampur, a group working on river related issues in Himachal Pradesh.

On our drive up towards Pandoh, along the amazingly wide valleys of the Shiwalik below the Kangra valley, we stop to have a look at what seems to be unusually coloured rock and soil, in an area that seemed to severely eroded. It looked like crumbly rock with hues of green and pink in clear strata. We speak to a passer-by and he informs us that this is one of various sites in this area that are commercially mined for rock-salt. When he comes to know that we are traveling along the Beas looking at hydro-power projects, he volunteers that there is a small hydro-power project somewhere between two rock-salt mines here, and that their metal machinery and metal lined-tunnels have corroded rapidly due to the extreme salinity of the water that passes through the area and into them. The conversation is concluded abruptly and the gentleman walks on because of approaching policemen on the road, who wish to know who we are, peer into our vehicle, and squint at the outlandish name on my driver's licence.

But still, on the matter of salts in the water. I find it hard to comprehend how a hydro-power project would be taken by surprise on this aspect. But it turns out that such 'surprises' are not so uncommon. Soon after I returned home from this trip, a friend phoned to say that he had just returned from Assam, and he told me a story of a chemically inverse surprise. He said that he had just seen the Khandong hydropower project on the Kopili river in Dima Hsau, where the water in the reservoir had turned into sulphuric acid, from run-off from a coal mining area upstream, where coal-seams are interlaid with organic sulphur seams. It had an unbelievable pH of 3.5 at the reservoir, and a few of its tributaries had a pH close to 2, which is about as acidic as vinegar. The turbines and other machinery had to be repeatedly replaced because of this[48]. I also looked this up, and see that the same scientists[49] who call hydro-power 'clean energy' in the preface to their piece, say that this is caused by local artisanal mining, which they term derogatorily 'rat-hole' mining[50].

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48 Pers Comm. Abhijit Menon Sen. This is also the case with the Kopili HEP on the same river. Please see http://sandrp.wordpress.com/2013/09/21/eac-must-address-issues-first-before-clearing-lower-kopili-hep/

49 Sharma, P et al. Acid Mine Discharge- Challenges met in a hydro-power project. Inl. J. of Env Sciences. Vol.1. no 6. 2011.

50 While that may be so, there are three thoughts here. One, it is surprising that the technical planners of this project did not have information that this was a likely development, seeing how close to the surface coal is almost all over Meghalaya and adjoining parts of Assam, where the headwaters of some of these tributaries originate. Two, there is quite obviously, a conflict of interests here between the local (coal often mined for artisanal limestone production) and the non-local benefits (hydropower and the money thereof that gets exported to distant locations), that is bound to play itself out in the longer run with all such projects that straddle local resources for the benefit of distant interests. As far as the environmental outcomes are concerned, at the local scale both coal-mining and dams would result in dead tributaries with no fish. The hydro-power companies are clearly concerned about the rapid corrosion of even their stainless-steel machinery, not the lack of aquatic life in the river. The first 'problem' can in fact, be fixed at a local level by covering unused mines that no longer permit the interface of pyrite with water and oxygen to form the acid and its run-off to the tributaries. With hydro-power projects, the problem will not only persist, the cumulative impacts of flow-regulation and barriers, will have an exponentially negative impact all along the continuum, from the local, the regional to the global. Three, speaking of 'rat-holes' and the obvious bigotry underlying such terminology, I saw no mention in the scientists' report on acidification, of the much larger-scale commercial mining in this coal-rich area.

We reach the Pandoh dam near Mandi, and take photos in the fading light, but even so, from a safe distance. The Pandoh dam is the first phase of the diversion of the waters of the Beas into the Sutlej. The diversion dam was completed in 1977 and it powers the 990 MW HEP being run by the Bhakra Beas Management Board (BBMB). This dam diverts the waters of the Beas through a 38 km long system of tunnels and channels to eventually join the Sutlej. The first 13 km is the Pandoh-Baggi tunnel, then an 11.8 km long channel sends water to be stored at the Sundarnagar balancing reservoir that has a capacity of 3.7 million m³.

The Pandoh dam reservoir

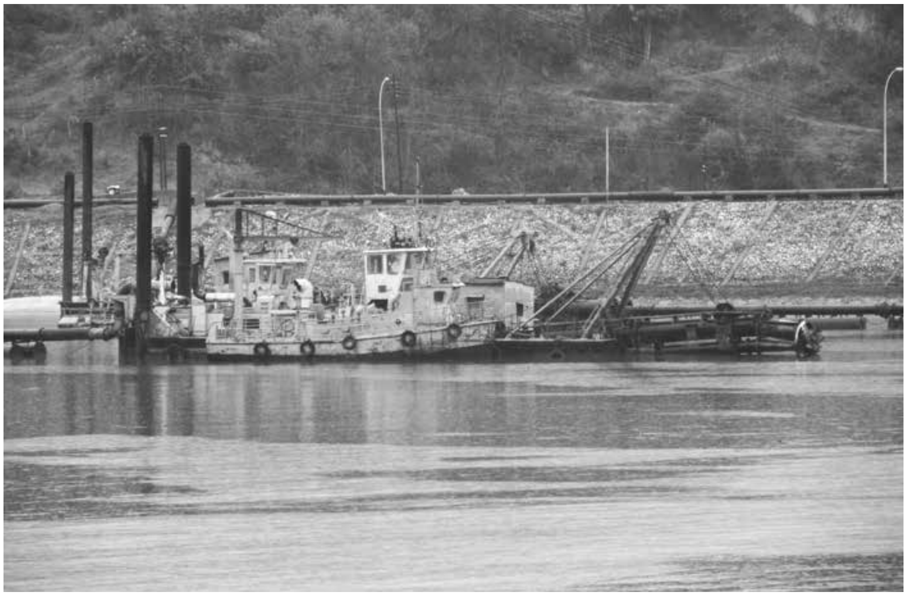
Here you can see two dredging machines constantly at work. The massive silt load that comes into just the balancing reservoir is estimated at 8,00,000 m³ annually. This too is blamed on the supposed deforestation being caused by mindless villagers upstream, no matter that the rivers of the Himalaya are known to carry the highest silt-load compared to any others world-wide, and that the entire Gangetic plain, which was earlier the Himalayan fore-deep, is filled with debris from the erosion of the Himalaya, as much as 5 km deep. Be that as it may, the BBMB has been operating dredgers with a capacity to remove upto 800 m³ of solids an hour. Since 1994 the dredger has been put to work three shifts a day, round the year and flushing thick silt-laden slurry onto the agriculture fields of the adjoining Suketi valley, where thousands of farmers fields were destroyed[51]. Peoples' protests notwithstanding, this continued till the State Pollution Control Board registered a criminal case against the BBMB who were ordered to stop[52].

There is now a plan proposed by an institution that calls itself the National Environmental Engineering Research Institute (NEERI), to blast another set of tunnels for silt removal alongside those that take water to the Dehar power-plant, and to flush the silt back into the released waters thereafter. On the question of what would be the impact on downstream fish and aquatic life of this sudden release of concentrated silt back into the water, they are pleased to declare that their investigations reveal that "all the parameters are within the permissible limits of BIS

[51] Panday,S and Kelkar P. Silt Management in Run-of-the-river hydroelectric project- A case study. Journal of Indian Waterworks Association. June 2008.

[52] http://www.tribuneindia.com/2002/20020609/main7.htm

[53] http://www.neeri.res.in/project_details.php?PID=88&DIV=7



Dredgers at work on the Sundarnagar balancing reservoir

10500."[53] This is typically disingenuous of them, because the BIS 10500, it turns out, specifies only the permissible limits of *inorganic* chemical and radioactive pollutants and so on in drinking water by humans, set by the Bureau of Indian Standards for that purpose. It has nothing to do with the most essential properties of water that determine its suitability as habitat for fish, such as water temperature, dissolved oxygen, seasonally variable turbidity, and the organic energy-nutrient interface determining food availability. All of this would be radically altered downstream by water flowing under pressure for 12 km in a tunnel and then meeting the concentrated flush of sediment.

Back to the diversions of the Beas. Presently, from the balancing reservoir at Sundarnagar, the waters of the Beas go through the 12.38 km long Sundarnagar-Salappar tunnel to the 990 MW Dehar power plant, and thereon to the Bhakra reservoir. At this time of year, almost all the waters of the Beas are diverted into these tunnels. There is a very small flow that is allowed along the main Beas riverbed. The river runs practically dry from here for about 10 km, till the confluence of the Beas with the Uhl river. A steady flow of the Uhl river into the Beas will not be for long either, because a 100 MW hydro-power project is coming up on the Uhl.

The next dam we visit is the last one on the mainstem of the Beas, the 126 MW Larji HEP near Aut. It is run by the Himachal Pradesh State Electricity Board (HPSEB)[54]. The dam is constructed a little downstream of the confluence of the two main tributaries upstream, the Sainj and the Tirthan, at the narrowest part of a spectacular gorge, towering with limestone cliffs. The impounded waters of this dam have, since its construction in 2006, drowned the access road to the entire upper Kullu valley including Manali and the hundreds of villages upstream, including access to the entire Lahul valley and the region of Ladakh over the high passes from this end. The HPSEB then constructed a 3 km long tunnel to enable passage of traffic, and many people have warned of the hazardous nature of the tunnel. The 220 odd gods that descend from different

[54] The 126 MW Larji project is also infamous for being the costliest hydro-power project per unit electricity generated so far in India. Finally built at a cost of R.s 10.27 billion, which was twice the estimated cost, the Vigilance department unearthed major financial misappropriation by HPSEB officials.

valleys, on the backs of people to the lower Kullu valley every year in autumn however, refuse to use this tunnel. This is what compelled the HPSEB to build and maintain this tunnel, and during autumn to winter, to keep the water-storage in the dam low to enable the passage of gods, who have been traveling this route for over three and a half centuries. It is remark-worthy though, that this dam constructed as recently as 2006, seems to be heavily silted-up already and the dark shadows of sediment-shoals are visible just below the waters of the reservoir[55].

Being among the most recently completed, the Larji dam is the only dam on the Beas that has a fish-ladder, so it was of particular interest to us. Seeing no guard at the security booth, we walk in to the HPSEB dam operating office, and ask to speak to an officer about the fish ladder. To our complete surprise, we are spoken to and even taken on a tour of the ladder by a foreman who has worked on the dam for many years.

The Larji dam reservoir filled with sediment. The sediment shoals are clearly visible

Having seen an elaborate fish ladder on the Kuri Chhu river in Bhutan of doubtful effectiveness[56], we could not help but look at this one with hope and excitement. Located at an altitude of around 1,000 meters altitude, this dam was clearly in the way of a host of migratory species of fish. If this ladder design was effective, then surely the 'barrier' problem to seasonal migration for breeding and dispersal would have been addressed. Here though, is what we saw and heard.

1. For one, the flow through the fish-pass seems too small to create an 'attraction flow' for fish. But even more obviously, the downstream entrance of the fish ladder is a steep cascade over a couple of meters of broken masonry and rock, that would clearly be un-negotiable by any fish that does not jump that high[57].
2. The outlet from the dam reservoir into the fish ladder is blocked off by a metal grill-mesh that is narrow enough to trap flotsam like Bisleri water-bottles. The mesh seemed too fine to let Mahseer of breeding-age pass through, either upstream or downstream.

[55] The Larji Dam became infamous in June 2014 when 25 students were washed away downstream from the dam due to sudden and unannounced release of water from the dam, see: http://sandrp.wordpress.com/2014/06/12/nadiya-bairi-bhayi/

[56] http://sandrp.wordpress.com/2014/02/02/fish-ladder-at-kurichhu-hydropower-project-bhutan-some-thoughts/

[57] Other than loaches, those tiny finger sized fish that can even climb (squiggle technique) up high waterfalls, provided there is something like a water-slide at the margins of the fall. They however, are not migratory fish.

3. The fish ladder was in a serious state of disrepair. To our questions about whether the ladder worked or not, the foreman says honestly that it does not. We see the reasons for this when we walk down the ~100 meter length of the fish-pass channel.

Downstream of the Larji dam. Broken-down fish ladder visible on the right bank in the photo

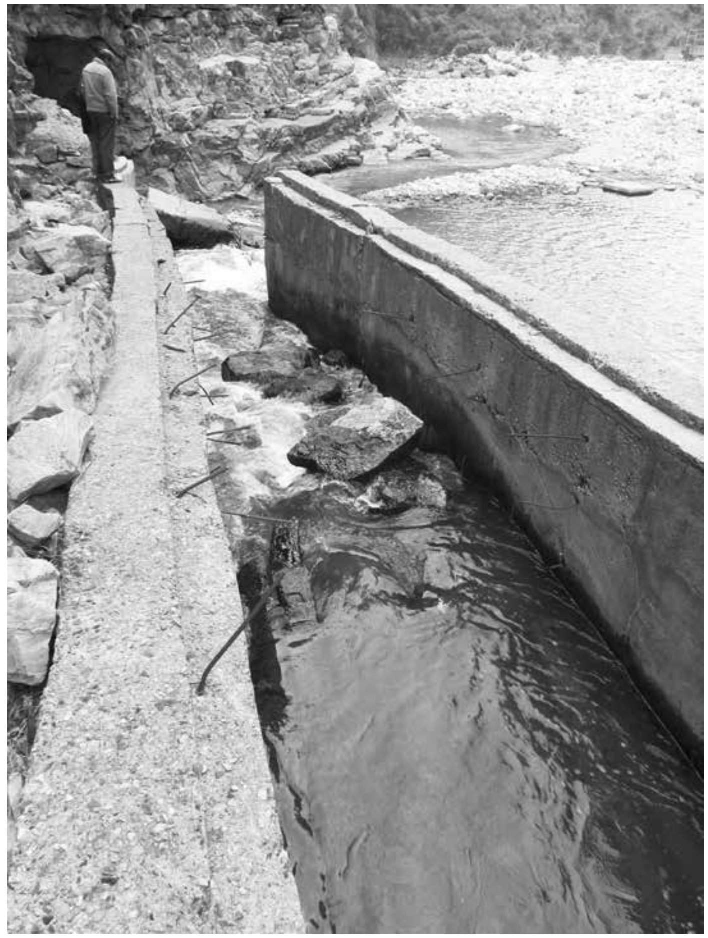
4. The Larji fish ladder seemed to be a hash of different designs of fish passes. There were four different design elements in this one fish-pass. It had a slotted-weir fishway design, a low gradient Denil fishway, a steep-pass Denil fishway and a plain concrete culvert on a grade design. Most of these slotted weirs were clogged with fallen rocks and debris from the slope above, and in places, the pools in them were over-flowing the weir in a vertical fall almost 2 meters high.
5. The oblique baffles on a Denil fishway are supposed to be placed in a manner that provides staggered partial-obstructions that slow the water down at variable velocities to make it passable for fish. However, here we saw that the water picks up momentum down an extremely steep slope with the baffles at 45 degrees to the flow, not offset to slow the water, but concentrating the force of the water in mid-stream flow. The slope seemed to be at almost 40 degrees angle, and the water was turbulent in the extreme in this section. A workable Denilway slope, even for the strongest of swimmers among fish, is not designed to exceed a slope of 20% at most. This was close to a 100% slope[58].

The last part of the fishway was a plain concrete culvert on a grade channel, essentially a sloping channel, where even the concrete sides of the channel had toppled over into the river-bed, and the final drop was over a two meter fall into the downstream flow. I asked the foreman whether he knew whether fish managed to make it over this extreme gauntlet. He said that they did not, but that he often saw fish gather and concentrate at the bottom of the dam under the sluice gates, and make futile leaps in an attempt to get over the dam. Clearly, the Larji dam fish ladder is just an unlovely trinket, a deceptive ornament.

It seemed to me that the dam builders and operators, the HPSEB in this case, both at the design and the executive levels, were not serious about constructing a fish-pass that would work, and neither were they serious about this at the operation and maintenance aspects. Whether they were serious at all even at the conceptual level, to put in place a mitigation measure that

[58] CIFRI recommends that the speed of flow of water in a fish-pass should not exceed 2 meters per second. Please see 'Status of fish migration and fish passes with special reference to India'. MK Das and MA Hassan. CIFRI 2008.

actually helped migratory fish bye-pass the barrier of the dam, or was this part of the design merely to obtain environmental clearance, can only be conjectured about. That hydropower projects can devise deceitful strategies for obtaining environmental clearance is one thing, but what does this tell us about the Union Ministry of Environment and Forests, the Expert Appraisal Committee on River Valley Projects appointed by MoEF, the regional office of the MoEF, the state Fisheries Department and also the state pollution Control Board, who are all variously part of the approval processes for hydropower projects, when they get their environmental clearances based on such 'mitigation measures'?



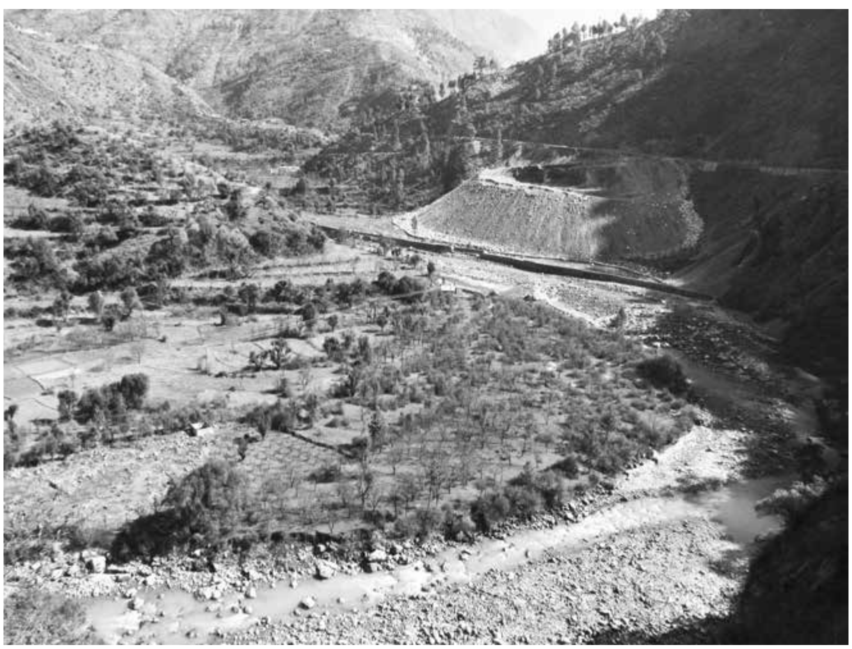
The broken and blocked fish ladder at the Larji dam

The Sainj and Tirthan Valleys:

You need to drive over the road that is built on top of and across the Larji dam to get to the next two valleys upstream of this, the Tirthan and the Sainj. There are many similarities in the lay of both these valleys. The upper reaches of both fall within the Great Himalayan National Park, an area of very high biodiversity values. They are both fairly densely inhabited through most of their lower and mid basins. However, today there is a very fundamental difference in the two valleys with regard to the rivers that run through them, and indeed the respective states of the entire basins because of it. The difference between the two river valleys becomes evident even before you enter either of them. At their confluence just above the Larji dam, the Tirthan river on which there are no hydropower projects, is a beautiful blue-green, the colour of a laughing-thrush's egg, only darker and translucent. The Sainj, on which

The confluence of the Sainj and Tirthan rivers. Note the difference in sediment. The clear river is undammed

The state of the Sainj valley at Siun. This is just a little downstream the Great Himalayan National Park



Muck dumped illegally right on the river-bed on the Sainj

there are a slew of hydro-power projects in various stages of completion all along its length, an opaque turbid khaki.

We drive up the Sainj valley first. There are two large hydro-power projects coming up in the valley, the construction of both being in an advanced stage. Parbati II and III are located on the Sainj, but are named after a larger river Parbati, whose basin is further north, and whose waters are proposed to be intercepted fairly high up in the Parbati valley at Pulga above Barshani, pushed into a tunnel and right through the high ridge that separates them, and into the Sainj river and down a series of dams and tunnels, including the Sainj Project, till they meet the Beas. Hydro-power projects on the Sainj-Parbati valleys will between them generate 1,420 MW of electricity. Inaugurated in 2003 by A.B. Vajpayee, the Parbati project by NHPC has a momentum about it that is palpable. If anyone wishes to see first-hand the visible impacts of hydro-power projects in a mountain valley, visit the Sainj anytime soon. The term that comes to mind is vandalized. It would not look very different if war were being waged there. Roads being ripped wide for the heavy machinery to pass, massive dumps of excavated debris piled in numerous places, the wreckages of tank-tread earth-movers and dumper trucks lying strewn along the road, armed guards at frequent barricades, and a pall of dust overhanging much of the valley because of the massive crushers pulverizing rock for construction. The river, bleeding mud from all of this.

The Parbati II HEP under construction.

Just one dumping site by the river has 19, 65,200 cubic meters of excavated debris. Don't miss the 'thank you'

During our drive through and up to the highest diversion in the Sainj valley, on the Jiwanala that was still snowed out, we enquired about the fish in the river. We were told that there used to be fish right up to Siun, which was now the location of the exit of tunnel from the Parbati river, the powerhouse of Parbati II, and a dam to divert the river again to the next powerhouse downstream. With the state of the river with all this construction work, let alone the actual dams, the river had pretty much died even before the beginning of operation of the hydro-power projects here.

The Tirthan river however, was a completely different story. There is not a single hydro-power project existing or coming up along this tributary of the Beas. What is more, the state Government resolved in 2005 not to allow any dams and diversions on this tributary of the Beas. The Tirthan is a relatively small river, and it runs unfettered, like it has for millions of years. How did this come to be, when every single river of similar size in the state already has numerous dams on it? Simply put, the people of Tirthan valley did not allow it. And at the centre of the whole story, are fish.

Starting somewhere in 1997, the Swastik Company and the Cosmos company initiates work to build a series of small (<5 MW) hydropower projects on this small beautiful river. Brown trout had been introduced into the Tirthan as well as the Beas mainstems by the early 1900's. By the time the hydro-power projects were coming up, fishing and wildlife-related tourism had already picked up in this valley, so there was sufficient awareness of the costs to be paid locally and for a long time to come. However, like elsewhere, there were also local interests who stood to gain from the hydropower companies, and from commerce with the large influx of migratory labour who accompany such projects during the building phase. While the companies had given advance payments for the purchase of private lands from local people, they had not put it to any use for the six following years, by when the pledge to sell was no longer valid. Local resistance from villages built up and grew, and with the backing of some elected representatives such as Dileram

The Tirthan river, alive and undammed

Shawab, an MLA from the Tirthan valley as well as Harsh Mahajan, the Minister for Fisheries in Himachal Pradesh then, they succeeded in stalling the various moves to build hydropower projects in the valley. In view of the fact that this tributary was a part of the Great Himalayan National Park for most of its upper reaches, and in view of the importance of the Brown trout-dependent tourism industry, the government of Himachal Pradesh resolved in the year 2005, to disallow the building of any hydropower projects in the Tirthan valley.

Today, there is a thriving tourism industry in the valley, and the Fisheries department regulates fishing in the river through the issuance of licences to tourists. While driving through the valley, and seeing a young boy fishing along an open stretch of river, we stopped to speak to him about the various species in the river and related matters. He looked wary as soon as we stopped the vehicle, and as soon as he saw us approaching him, he waded into the cold river on the cold winter evening, and swam away as fast as he could from us, clearly in a panic. We were told by others close-bye, that the boy probably did not have a licence and thought we were from the Fisheries department. Speaking to a Fisheries official later in the valley, we were informed that there was a heavy penalty and confiscation of fishing tackle in the event of being caught without a licence. And to the question as to why it was that local people should also need to buy a licence for fishing, there was the predictable reply about careless villagers and over-extraction and so on. It occurred to us that if this young boy and others like him were prevented from fishing in their 'own river', why should they care if the dispossessors are hydro-power companies instead?

The Parbati river. We also drove up the Parbati river right up to the Pulga dam under construction near Barshani that will divert the waters of this river, through tunnels in the mountain to Hurla Nallah, and thereafter, with a tunnel bringing additional water from the Jiwa Nallah as well, into the Parbati II and III powerhouses in the Sainj Valley. The road along this valley right till Manikaran, the location of hotsprings and a Gurudwara is a public road. From there onwards is the road for about 20 kilometers that has been constructed by the hydropower company, and has a notice-board warning that this is a private road, and entry is restricted. On public land. The Parbati river and valley are in my view, the most scenic among all the others along the Beas.

The river will soon be ferreted away in a tunnel to another valley, and the intense building activity, of roads and many smaller hydropower projects along its smaller tributaries, are already transforming this valley very rapidly.

The Pulga dam on the Parbati, under construction

The last hydropower project we visited was the Allain-Duhangan project on two tributaries just below Manali, on the true-left[59] bank of the river basin. There was far too much snow to be able to drive up to the dam-site, and we did not have the extra days it would have taken to walk there and back. We did however get to see the powerhouse, which was in an underground cavern. I was somewhat familiar with this particular project since the time when it was being built about 10 years ago. The project had run into trouble with local protests, not only because of the opaque land-purchase transaction, but also because the project was dispossessing a downstream village of the river by diverting it entirely to an adjoining valley. The South Asia Network of Dams Rivers and People (SANDRP) joined the campaign of the local communities, and this led to some remarkable processes being put in place, as well as outcomes.

The EIA that had previously been conducted stated, among other things that there were no fish in the Duhangan river, and the local people protesting, knew that this was not so. The Project was being financed by the International Finance Corporation, private sector arm of the World Bank, and an environmental case was initiated against the Bhilwara Group who was setting up the hydropower project. A fresh EIA was ordered as was a fresh Public Hearing. A full translation in Hindi was ordered and panels of independent people set up to help the community understand impacts, as well as additional studies on certain environmental aspects. The organization I was working with had been asked by independent environmentalists to verify the presence or absence of fish in the Duhangan river and we had done so. We cast for fish in three seasons of the year and found both snow-trout as well as the exotic brown-trout in the lower reaches. No fish, they had said. We also visited the upper reaches of the valley where the dam was proposed to be built, and saw first-hand the massive deforestation that was happening in conjunction with road-building contracts as well as forest department logging at an accelerated pace.

[59] True left would be on your left if you were looking downstream, in the direction of the flow of the river.

The collapsed Alleo sedimentation tank

I am unaware of the 'negotiations' the company must have undertaken to have successfully waded through the protests and controversy, with both the regulatory and funding agencies, but it was a curious visit after all these years, incognito. The Allain Duhangan powerhouse we visited was built in a deep sub-terranean cavern. Perhaps it was the theatrical lighting there, but there was something like a movie-set about it. Of the James Bond spoof, Goldmember, in particular. Soon after the tailrace of the Allain Duhangan project flushes water back into the Alleo stream, just a few hundred meters from its confluence with the Beas, there was another sight to see. It was the collapsed siltation chamber for the 3 MW Alleo HEP, recently built on a fresh loose mud embankment on the river-bank. The sight just seemed to sum up and typify all that I had seen all through my travels up the Beas, Bhagirathi and Alaknanda. Severely damaged hydropower projects, poor conception, toothless regulation, non-existent monitoring, and entirely unmindful of the consequences to the rivers, and to all life dependent on them.

My exit-drive all the way down the Beas basin and into Punjab, through all of Himachal Pradesh's valleys crowded with pylons and criss-crossed with high tension wires, crawling in heavy traffic past cement factories and drawn-down reservoirs, was one full of unease and foreboding. As I drove on through Punjab, I continued to feel a sense of displacement every time I crossed a huge canal carrying the blue waters of the Beas to distant agriculture fields, even hundreds of kilometres away from the river-course. I stopped at a bridge above one of these canals and stepped out of the jeep to feel the gathering storm. Above me, the sky was thick with huge bales of dark, grey-blue clouds advancing with the deep rumble of a distant avalanche. The air was electric, and you could feel, even on the hair standing on the nape of your neck, what was coming.

Punjab Canal carrying Sutlej-Beas waters

Discussion:

A closer look at the impacts of hydro-power on fish and aquatic habitats along the Upper Ganga and the Beas

On a more prosaic note, to sum up what I witnessed in terms of the impacts of hydro-power projects on fish and aquatic habitats:

1. Dam and diversions on both river systems seriously disrupted flow volumes and rhythms. Being the transition period between winter and early spring, almost all hydropower projects were leaving no flow during the day, other than what escaped from under leaking sluice gates into the river course, leading to long dry river reaches, or those with negligible basal flows. Fragmentation and loss of connectivity was extreme. Since species-volume relationships in the aquatic realm are the equivalent to species-area relationships on the terrestrial realm, even just the quantum of habitat for fish can be seen to be greatly fragmented and reduced.
2. The quality of habitats in such greatly reduced flows in the river, in terms of changed temperatures due to greater surface-area to volume, and therefore dissolved-oxygen levels, reduced trophic levels, reduced habitat, and reduced refugia, would also make these reduced flows inhabitable for many species. This was most starkly evident in the Nandakini and Birahi tributaries of the Ganga.
3. The building of dams and powerhouses along the river-course, as well as the massive road-building to enable the transport of machinery and materials, had radically increased the sediment-flows and resultant turbidity in the river, killing off, and making it uninhabitable for many species. The Bhagirathi and the Sainj were the most glaring examples.
4. Conversations with people revealed that fish species diversity, and fish populations had been greatly reduced in all the rivers where these hydropower projects had been built. In the Tehri reservoir, the Pong reservoir and along the upper reaches of the Beas, species composition was radically altered due to habitat change and due to the introduction of non-indigenous species. Conversations with fishermen and other people along the Bhilangana and at the Pong reservoirs, as well as with the Fisheries Department officials at Hamni along the Beas were most illustrative.
5. The availability of fish to local people had greatly reduced, or denied to them altogether. This was clearly evident along the Bhagirathi and Sainj rivers and the Pong reservoir in particular.
6. The dams and diversions had caused insurmountable barriers for migratory fish in all the tributaries with dams. The single fish ladder on any dam in all the tributaries visited during the study was the one at the Larji HE Project, which was completely ineffective.

Our observations and conversations during this study apart, I looked for specific studies and information on the impacts of hydro-power project for the two river-systems, with some detail of what is happening to fish in these particular tributaries. What is available variously for the Ganga and the Beas basins may be a patch-work of information on impacts for different locations in different tributaries, but even so, pulling them together for an essential understanding of similar phenomena across basins can be useful.

For the headwaters of **the Ganga**, the most recent and comprehensive study that I could access on the profile of fish fauna in the Bhagirathi and Alaknanda rivers and their major tributaries is the Comprehensive Environmental Impact Assessment (CEIA) undertaken by the Wildlife Institute of India[60]. While research literature is now available on the assemblage of species along different tributary basins of the Alaknanda and Bhagirathi, including the work done by WII, we do not have a stream-wise baseline to compare with. The most comprehensive compilation of species assemblages for this area before this was perhaps the one by S.P.Badola[61], which has also been referred to for secondary information by the CEIA by WII, in addition to the good work by P Nautiyal and others in the region.

I am informed that there is also no comparative quantitative data on what is happening to fish populations or population structures for specific locations in the Bhagirathi and Alaknanda rivers over time[62]. There are a few scattered studies in terms of location, on differences in catch for species like the Golden Mahseer, but the comparison over time is for catches in the terai sections, or for different rivers in different basins, and not for the same location in the same basin[63]. While such studies could reflect larger trends, their usefulness for location-specific trends would be limited.

Since the WII did a fairly rigorous assessment of the cumulative impacts of Hydro-power projects, including verifying for themselves the presence of fish species in the main tributaries of these two rivers only recently, their assessment is a good place to start. The impacts as per their analysis is summarized as follows:

The WII CEIA recorded a total of 76 fish species belonging to 32 genera and 13 families from the Alaknanda and Bhagirathi basins. Of these, 66 species were reported from the areas (or Zone of Influence) where there is a build-up of hydropower projects here. The Cyprinidae (carps) was the major dominant family along with presence of other families like, Balitoridae (loaches) and Sisoridae (catfish). The complete list is in Annexure B.

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60 CEIA, WII 2012. The research and analysis on the aquatic biodiversity aspects were done by K. Sivakumar and J.A.Johnson.

61 S.P.Badola. Ichthyology of the Central Himalaya. Transmedia Publications 2009.

62 Pers. Comm. P. Nautiyal of HNB Garhwal University and K.B. Ralhan, Ex-Director, Fisheries Department, HP.

63 Various papers by P.Nautiyal and JP Bhatt. You could see J.P.Bhatt, P. Nautiyal and H.R.Singh. Status (1993-1994) of the Endangered Fish Himalayan Mahseer *Tor putitora* (Hamilton) in the mountain reaches of the River Ganga. Asian Fisheries Science 17 (2004) 341-355. And P. Nautiyal, AF Rizvi and P Dasmana. Life History Traits and decadal growth parameters of Golden Mahseer *Tor putitora* (Hamilton 1822) from the Himalayan stretch of the Ganga System. Turkish J. of Fisheries and Aquatic Sciences. 8: 125-131 (2008)

WII's assessment delineated three zones for indigenous fish along these two rivers.

The No Fish Zone: Above 1,600 meters altitude.
Snow Trout Zone: Below 1,600 meters in streams with low temperatures.
Mahseer Zone: Warmer waters and lower altitude rivers and streams.

These are generalized zones and are named after the predominantly characteristic fish of that zone. Each come with their host of associated species within that zone. While this is a useful zonation for rivers in Uttarakhand, there are some exceptions that provide a finer grain to the picture. The 1,600 meter upper limit applies generally to indigenous fish of these rivers only. Even here, the presence of snow trout has been reported from above Sonprayag in the Son tributary of the Mandakini which is above 1,716 meters altitude[64]. Also while WII's CEIA recorded no fish above 2,400 meters asl, there are records of the exotic Brown trout (*Salmo fario trutta*) that was introduced in Dodital lake and that still survives at 3,077 meters asl.

WII assessed and ranked each of the 18 sub-basin for biodiversity values on the basis of a fairly comprehensive matrix that included both aquatic and terrestrial biodiversity. The values were based on six criteria. These included species richness, Rare Endangered and Threatened Species (RET), endemicity, breeding and congregation habitats, migratory habitats, and habitats of biodiversity value.

They found that the lower three sub-basins had "very high" fish biodiversity values as per the parameters just mentioned, and ten of them in the next elevational level harboured "high" fish biodiversity. This was due to the presence of breeding/congregational sites and migratory pathways for species such as Golden Mahseer and snow trout which have high conservation values. Twenty-seven species were reported from the exclusive trout zone including the exotic brown trout. No fish were reported from the Zone of Influence of 24 HEPs located within the high altitude ranges. The ones that did not score very high on their matrix for the aquatic aspects were either the no-fish zones, or those that were already greatly altered and degraded due to the presence of numerous hydro-power projects.

Confirming many studies worldwide, the species diversity of fish in the Alaknanda and Bhagirathi was observed to increase with the increase in flow-volumes as well. The two tributaries which are rain-fed and relatively less disturbed namely the Balganga (tributary of Bhagirathi/ Bhilangana) and the Nayar (tributary of Ganga) were identified as important breeding grounds for Mahseer and Snow trout. These were designated by them as Critically Important Fish habitats.

On the potential impacts of hydropower projects (both existing and proposed HEPs) on aquatic biodiversity and their habitats, the CEIA by WII analysed for major changes in the river resulting from the build-up of hydropower projects namely 1) habitat modification and loss, 2) barrier effects and fragmentation, 3) changes in flow volumes and rhythms of water, and 4) changes in sediment and nutrient flows.

[64] Pers. Comm resident Nepali workmen at Sonprayag during my visit.

The river-lengths affected most directly, either drowning by inundation or running dry due to diversion, of both existing and proposed hydro-power projects were detailed by them as under:

Sl no.	Tributary	Total river stretch (km)	% River length diverted	% River length submerged[65]	% River length affected
	Bhagirathi basin				
1	Bhagirathi	217	31%	39%	70.71%
2	Asi Ganga	205	53%	0%	53.39%
3	Bhilangana	109	19%	17%	36.12%
4	Bal Ganga	37	40%	0%	39.79%
5	Smaller tributaries	73	22%	0%	22.47%
	Alaknanda basin				
6	Alaknanda	224	27%	21%	48.00%
7	Dhauliganga	50	94%	0%	93.59%
8	Rishiganga	38.5	27%	2%	28.64%
9	Birahiganga	29.5	74%	0%	74.32%
10	Nandakini	44.5	35%	0%	34.85%
11	Mandakini	81	43%	1%	43.67%
12	Pindar	114	22%	9%	30.68%
13	Smaller tributaries	83	23%	0%	22.63%

After the CEIA, WII. Note: The upper reaches without hydro-projects have not been factored in.

Even a cursory look at the column on the far right above, gives an idea of the enormous scale of disruption of all the tributaries. They range from 22% to almost 94% of the entire river-length of various tributary streams. And this is just by either submergence or diversion. The changes wrought in the entire remnant sections, by means of habitat modification and loss, barrier effects and fragmentation, changes in flow volumes and rhythms of water, and changes in sediment and nutrient flows, clearly mean that the entire river would be radically altered and negatively impacted.

As mentioned earlier, while the construction of some of these hydropower projects have been stayed by the Supreme Court pending a final decision by them or due to agitations, it is well known that the Hydro-power companies are biding their time.

[65] The 0% submerged length for the several rivers that are diverted for any lengths clearly seems wrong.

From studies on **the Beas,** we have some specific information as well. K.L. Sehgal of the then National Research Centre for Cold Water Fisheries (now designated the Directorate of Cold Water Fisheries), studied the ecological changes and impacts of dams and diversions in the Beas between 1985-87[66] and he describes some of the smaller-grain changes as well. "There were changes in water temperatures, current velocity, total alkalinity and silicates concentrations. Among the benthic invertebrates[67], there was a decline in the density of stonefly and caddisfly larvae, and in the aufwuchs (small animals and plants that encrust hard substrates, such as rocks, in aquatic environments) community on stones, as compared with pre-impoundment conditions (Sehgal 1990). This led to changes in fish populations. The average weight of *S. richardsonii* declined from 300 gms in 1965 to 260 gms in 1985-87".

Sehgal's study on the Beas further revealed considerable impact of water abstraction on aquatic life below the dam. "The diversion of the Beas river to the Sutlej river brought nearly 61% reduction in water discharge and an increase in water temperatures by 4 degrees C. The reduction in water discharge resulted in an increase in benthic microbiota. Among the benthic invertebrates, there was a sharp decline in density of stonefly nymphs as a result of the sharp reduction in current and increase in water temperatures". It is obvious that when food for particular kinds of indigenous fish declines, so do fish populations.

Regarding the effects on migratory fish he writes: "A dam on the Beas resulted in a change in the proportion of Mahseers and schizothracines in the winter catches between Mandi and Nadaun from 10.2-13.5% in 1964 to 1.0-0.5% in 1985-87." Golden Mahseer which used to migrate in the Beas upto Sultanpur, Kullu valley, prior to completion of the Beas dam, now cannot proceed upstream of Pandoh. The Juni tributary which used to be the main spawning grounds for *Tor putitora* at Pandoh, has disappeared as a result of the accumulation of debris.

Studies carried out particularly on the Bhakra dam on the Sutlej-Beas waters and the Pong dam reservoir on the Beas[68] between 2001 and 2007, show that the Bhakra dam had 51 species of fish and that the Pong dam reservoir has 28 species of fish. They record a very sharp decline in the catch of fish over time. In the Bhakra dam the annual catch declined from 1,174 tons in 2001 to just 484 tons in 2006. In the Pong dam reservoir fish catch declined from 390 tons in 2001 to 311 tons in 2006. The study points the sharp decline in fish catches to the changes in the reservoir due to the building of hydro-power projects upstream, the effects of which include rapid sedimentation, leaching and loss of nutrients from the soil, excessive decomposition of organic matter, destruction of spawning grounds of fish, and blocking of migration channels of fish. The impacts of these dams listed would therefore have serious consequences all along their downstream sections too.

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[66] Sehgal KL. Coldwater fish and fisheries in the Indian Himalayas: Culture. In T. Petr (ed). Fish and fisheries at Higher Altitudes. Asia Issue 385.

[67] Benthic invertebrates are small insects or insect larvae that live on and in the substrate at the bottom of a river or stream. They are among the most important components of the aquatic food-chain in a river.

[68] Negi RK. Impact of Hydrological projects on the fishery of Pongdam reservoir wetland and Gobindsagar reservoir in Himachal Pradesh (India)

The species composition of fish was seen to change rapidly from riverine species towards lake species, despite some species adapting to the changed environment. In line with the general decline in catch (reflecting a decline in fish populations) the catch of the golden Mahseer in the Pong reservoir declined from 102 tons in 1982 to 50 tons in 2006.

It may be relevant to mention here that this kind of degradation in all such reservoirs in mountain areas is a common phenomenon. Take the example of the Harike dam reservoir at the confluence of the Sutlej and the Beas. The dam was built in 1952, and the reservoir declared a Reserve in 1987, a Bird Sanctuary in 1992, and a Ramsar site soon thereafter. The reservoir that "initially covered 41 km^2, now stands reduced to 28 km^2, of which only 8-10 km^2 is open water, and the rest is weed infested."[69] The study cites precisely the same causes and results of degradation as those in the Bhakra and Pong reservoirs.

On the related aspect of how dams are said to provide an opportunity for commercial fish production that can benefit local fishermen, we have many instances that indicate the contrary. Take for example the experience at the Pong reservoir on the Beas. I gathered from the very self-congratulatory official website of the Himachal Pradesh Fisheries Department website[70] that the Department has organized 15 fishermen cooperatives around the reservoir. There are 2,825 active fishermen recruited from 4,000 oustees (what an appropriate term, and without a self-conscious blink) from around the reservoir. They say that "Prior to the impoundment of the river Beas, a subsistence fishery of inconsequential nature existed in the river and adjoining streams, and the average catch hardly exceeded 2 to 4 kg per fisherman per day…". They go on to say that "The fishermen at Pong are mostly full time fishermen. Their monthly income ranges from Rs. 500 to 1,200 per month, which has gone to Rs. 1,500 during 2009-10." Wait a minute. The subsistence fishery of 'inconsequential nature' resulted on average in a catch of 2 to 4 kgs per fisherman per day. While a fisherman could keep at least a kilo for his family to eat every day, he still had between 1 and 3 kilos to sell. At today's prices of fish caught and sold locally by fishermen in the Gori river where I live (as yet undammed), fish fetches a fisherman Rs. 200 per kilo. So at today's prices a fisherman could earn upto between Rs. 200 to 600 a day after keeping enough for his family. If a fisherman on the Beas earned on average upto Rs. 1,500 a month three years ago, and you bump that up to even twice the sum at today's prices, a full-time fisherman on the Pong earns only Rs. 100 per day now. The daily wage for *unskilled* labour in a remote mountain location like Munsiari today is Rs. 300 per day plus one meal.

For whatever the fisherman's cooperative is worth, they are in effect a labour cooperative only. The website goes on to say that "for the sale of fish the practice of appointing contractors by open auctioning at the beginning of each year was started. The fish caught by the fishermen are required to be brought to the fixed landing centres. The representatives of the contractors

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69 Moza U and Mishra DN. Current status of Harike wetland vis a vis its ecology and fishery. Sengupta M and Dalwani R. eds. Proceedings of Taal 2007. The 12th World Lake Conference: 1470-1476.

70 http://hpfisheries.nic.in/reservoir.htm

receive the fish at the fixed landing centres while the departmental staff charges the Royalty and records the quantity of catch species-wise". The contractors make weekly payments to the Societies, who in turn pay the fishermen after deducting a commission of 5% to 7%. The fishermen are also required to pay a Licence Fee per net, and "the department also charges 15% Royalty on the price of the fish caught by each fisherman". A Royalty. So now the state plays monarch.

Incomes from fishing have also proven to be very unstable. The catch spectrum, in terms of species mix and volumes caught at the Pong dam has greatly fluctuated over the years "owing to the effect of the dam, the establishment of exotic varieties, vagaries of the monsoon and fluctuating water levels of the reservoir." During major flood years, such as in 1988, dam waters are suddenly released, leading to "heavy escape of stock". In the year 2009-10 for example, the total catch was just 8.46% of their average annual catch. It is useful to remember all this, every time we hear how enhanced fisheries are going to benefit local populations.

The website also speaks glowingly about the Himachal Pradesh government having enacted the Fisheries Act 1976, where fishing without a licence or during the closed season has been made a cognizable and non-bailable offence, inviting imprisonment of upto two years or a fine of upto Rs. 3,000, or both simultaneously. All this, against a people who have for generations, chosen to live by the river precisely because of the sustenance it provided them.

Back to direct impacts. While we are not going into the impacts of dams on the terrestrial realm here, apart from fish, there are many mammals in the aquatic realm whose futures are also closely tied with flow volumes and fish populations in rivers. Otters and freshwater dolphins for example. We now know that all cetaceans, that is whales and dolphins, originated and evolved not far from the shores of the former Tethys sea, just prior to the rise of the Himalaya[71]. The evolution has been traced from fossils to a small, partially aquatic mammal progenitor, the Indohyus (~48 mya) in Kashmir, and the Pakicetus, (~50 mya) in north Pakistan, not far from the shores of the former Tethys sea. Freshwater dolphins are among the world's most threatened mammals. Just a few years ago, in 2007, one of the four freshwater dolphins on earth, the Yangtse river dolphin *Lipotes vexillifer*, the only surviving member of its family, was declared extinct. In South-Asia we have the *Platanista gangetica minor* in the Indus river system, and the Platanista gangetica gangetica in the Ganga-Brahmaputra systems. Another indication that the two river systems have in the past been connected. Both the Indus and the Ganga dolphins are greatly endangered because of habitat loss and degradation due to water diversions, and due to fragmentation of their habitats due to dams and barrages. The highest sub-population of the Ganges river dolphin has been pushed down to near Garhmukteshwar, hundreds of kilometres from Rishikesh. The Indus river dolphins persists in five small fragmented populations, but its range has declined by 80% in the tributaries of the Indus in Pakistan.[72] A sixth, very small

[71] Thewissen, J. G. M.; Cooper, Lisa Noelle, Clementz, Mark T., Bajpai, Sunil, Tiwari, B. N. (20 December 2007). "Whales originated from aquatic artiodactyls in the Eocene epoch of India". *Nature* 450 (7173): 1190–1194.

[72] Braulik GT et al. Endang Species Res. Vol. 17: 201-215. 2102.

sub-population, located more than 600 km away from the other sub-populations has recently been discovered in the Beas river in India[73]. This is the only sub-population of the Indus river dolphin in India, and is found in the stretch between Beas city and Harike barrage which is at the confluence of the Beas with the Sutlej. Their futures too are intimately tied with the security of water flows in the headwaters of the Beas and the Ganga .

There is also now a great deal of science literature that examines the impacts of hydropower projects on fish and aquatic habitats. To quote a few, on some overarching and critical aspects:

One, it is well established now that the hydrologic connectivity and the contribution of stream waters are essential to ecological integrity at regional scales[74]. Headwater streams compose over *two-thirds* of the stream-length in a typical river drainage, and directly connect the upland and riparian landscape to the rest of the river ecosystem. Cumulatively, their contribution spells out at a regional scale. Freeman describes hydrologic connectivity here as "the water mediated transport of matter, energy and organisms within or between elements of the hydrologic cycle". Altering headwater streams she says, by channelization, diversion through tunnels, impoundment and burial, modifies fluxes between uplands and downstream river segments and eliminates distinctive habitats. The paper goes on to describe how large-scale ecological effects of altering headwaters, are amplified by land-uses that alter run-off (road-building, deforestation, mining like the two examples already cited on the Beas and the Kopili rivers for instance) and nutrient loads to the streams, and by widespread construction of dams on large rivers, which frequently disconnects free-flowing upstream portions of the river systems, essential to sustaining aquatic biodiversity.

Two, of all the factors that affect and determine species richness in rivers worldwide, numerous studies converge on a consensus that river discharge, or the volumes of flow in a river are the biggest driver and determinant of such diversity[75]. In a study that looked at data from 325 river basins in different countries[76] it was found that fish species richness *increases logarithmically* with discharge, which is really an index of habitat space, similar to a species-area curve in terrestrial landscapes. There are other clearly documented positive relationships of discharge to species number[77]. The extinction of several species worldwide can also be attributed to reductions in river discharge from a variety of human activities, including dams and diversions. They applied a statistical species-discharge model to build scenarios of change in riverine species richness from

[73] Bahera SK, Nawab A, Rajkumar B. (2008). Preliminary investigations confirming the occurrence of Indus river dolphin *Platanista gangetica minor* in river Beas, Punjab, India. J. Bombay. Nat. Hist. Soc. 105: 90-126.

[74] Freeman, MC et al. Hydrologic connectivity and the contribution of stream headwaters to ecological integrity at regional scales. Journal of the American Water Resources Association. Vol43. No1. 2007.

[75] Oberdorf, T et al. Global scale patterns of fish species richness in rivers. Ecography 18: 345-352. Copenhagen 1995.
Also Hawkins A. et al. Energy, water, and broadscale geographic patterns of species richness. Ecology. Vol 84. No 12. 2003. Pp 3105-3117.
And Guegan, J. et al. Energy availability and habitat heterogeneity predict global riverine fish diversity. Nature. Vol 391. 1998.

[76] Xenopoulos MA, and Lodge DM. Going with the Flow: Using species-discharge relationships to forecast losses in Fish Biodiversity. Ecology. Vol 87. No 8. 2006. Pp 1907-1914.

[77] Oberdorff, T et al. Global and Regional Patterns in Riverine Fish Species Richness: A Review. International Journal of Ecology. Vol. 2011. Article ID 967631.

anthropogenic drivers that reduce river discharge. Such analyses of course must be applied river-wise, and in consideration of the particular species that inhabit the river. Using this statistical approach, at a global scale they predict fish losses upto 75% using climate and water consumption scenarios from the IPCC. When applying this to the Mississippi river, they forecast that a reduction in the river discharge between 50% (loss of 14 species) and 75% (loss of 26 species) would imperil most of the large river species in the basin. Fish found in exclusively high discharge environments would be most vulnerable to such changes.

Koteshwar Dam and Reservoir on Bhagirathi River, note the scarred hills on the left

There are other hypotheses regarding what determines the nature of diversity in rivers. Very briefly, these include factors such as climate and resultant productivity (this explains latitudinal and altitudinal variations), environmental heterogeneity (a function of flow volumes and slope variation, among other things), biotic interactions, and dispersal history[78]. It is well established then, that radically decreasing flow volumes, as hydropower and multipurpose dams do, would therefore correspondingly reduce species diversity.

Three, studies worldwide including those in the Himalaya, conclude that the maximum species richness along the continuum of a river are found along the mid-domain[79], in terms of numbers, and in terms of endemicity, the upper reaches of a river[80]. In both the Ganga and the Indus tributary systems that are under consideration, the locations, scale and frequency of dams and diversions are highest *exactly* along those zones where species richness as well as the endemicity values of fish are the highest. Negative impacts are therefore bound to be direct, immediate and severe.

Looking at just these three fundamental aspects; disrupting headwaters that are critical to ecological security along the entire length, disrupting and reducing flow volumes which is

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[78] Field, R. et al Spatial species richness gradients across scales: A meta-analysis. J. Biogeogr. 2009. 36. 132-147.

[79] Dunn,R. et al. The river domain: Why are there more species half-way up the river? Ecography. Vol 29. No.2. 2006. Pp 251-259.

[80] Bhatt JP, Manish K, Pandit MK (2012) Elevational gradients in fish diversity in the Himalaya: Water discharge is the Key Driver of Distribution Patterns. PLoS ONE 7 (9) e46237.

Damaged Hydropower projects on Assiganga

the largest driver of diversity, and doing so where the species richness and endemicity is the greatest, give us an idea of the nature and scale of impact that hydropower projects can have on rivers.

Now here is the scariest part. Extinctions are believed to lag by an unknown but substantial time behind reduction in discharges[81]. Populations often decline slowly depending on life-cycle length and other characteristics such as trophic relations and so on. Which is why there are very probably many fish species that are currently vulnerable and may be headed towards extinction, and we don't quite know it. Unless we restore flow-volumes in rivers at a regional scale; at scales that affect populations and meta-populations of fish assemblages, we are falling headlong towards river extinctions.

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[81] McKinley WL et al. 2003. A conservation Plan for Native Fishes of Lower Colorado river. BioScience: 53: 2109-234.

Discussion:

The role of Environmental Impact Assessments, Environmental Management Plans, Fisheries Plans, and government approval processes

You may have wondered, as I have, how all these dams pass muster on the environmental front in our country, with such overwhelming evidence of them being so damaging and deleterious to rivers and all life in them? Were it a polemic or aggressive controversy for and against dams, openly weighing the 'benefits' with the 'costs' (including who pays the costs, and for whose benefit), the matter would be more straightforward. What we see instead, in the Environmental Impact Assessments and Environmental Management Plans of hydropower projects, let us face it, is dishonest and third-rate assessments, obscured and couched in the language of 'science'. Look a little closer at the institutions who undertake EIAs routinely, look at who pays them, and the whole exercise appears *fait accompli*[82]. Let us take that closer look now.

Every single Environmental Impact Assessment or Environmental Management Plan document I came across that deals with hydropower projects and their possible impacts, begins by describing the energy 'scenario', declaring a huge deficit or 'need', posing hydro-power as 'clean' and renewable source, and quantifying the 'untapped potential' of the various tributaries. That virginity trope, of the 'not yet but inevitable'. Some documents such as those dealing with dams and fisheries also begin by problematizing the scenario with another 'need', and presenting a positive outcome of dams. For example, R.C. Sharma, Department of Zoology, Garhwal University describing the giant reservoir of the Tehri dam and its fisheries potential, says that such projects add considerably to the existing potential for the development of India's fishery resource. "The basic aim of this programme", he says[83], "is to meet the ever increasing demand for low-priced animal protein to feed the regions human population, which is suffering from

[82] This includes institutions ranging from departments related to training people for the hydropower industry in IITs, departments for the study of Environment in universities, government agencies set up precisely for this purpose such as WAPCOS and NEERI, as well as Indian and overseas 'private' consulting touts.

[83] Sharma, RC. Aims and Strategies of Fisheries Management for the Tehri dam reservoir in the Garhwal Himalaya. India. In DeSiva SS ed. Proceedings. Reservoir Fishery Management and Development in Asia. Kathmandu Nov 1987.

malnutrition". You've got to go far to fetch this one, on both counts. The people of this fertile valley were malnourished and must have been till the drowning of their valley? And remind me, wasn't it 100,000 such malnourished people (official figures) that the government displaced and forcibly pushed out from their agricultural lands and homes here?

There seem to be some recognizable patterns to their method, to how hydropower projects manage to obtain environmental clearance on matters that relate to dams and their damaging effects on fish populations both upstream and downstream of proposed dams. The crudest and most common ploy is to dismiss the problem with regard to diversion dams by calling them run-of-the-river projects. This, as we have seen, is entirely misleading. Diversion dams or the so-called ROR, and many of them with large impoundments, create a whole set of damaging conditions as well.

Some of these are summed up well by Mr. Ramaswamy Iyer, rare former Secretary, Ministry of Water Resources, Government of India, and Research Professor at the Centre for Policy Research. He says that diversion dams of the so-called run-of-the-river projects "are the most harmful of all interventions - even worse than 'storage' dam (i.e., reservoir) projects. The term 'run of the river' (RoR) is a very misleading term. A layman might think that the project entails no structures on the river, and generates electricity on the river as it runs. Nothing can be farther from the truth. An RoR project does involve structures on the river, sometimes very big ones. Without a dam or a barrage it is not possible to create the head needed for power generation. What RoR means is that there is no 'storage', and that after passing through the turbines, the water goes back to the river. However, there is a break in the flow – a dry stretch - between the point of diversion and the point at which the water is put back into the river. This could be very long (ten km, or even a hundred km in some cases). If there is a series of cascading RoR projects on a river, there will be a series of such dry stretches in the river. There are instances in which the diverted water is made to flow through a tunnel (100km long in one case) before it rejoins the original course. Does it still remain a river?

A persistent myth is that hydroelectric power is environmentally 'benign', because (unlike thermal power) it does not generate CO2. However, it has other adverse impacts. As pointed out above, it may create a series of dry stretches in a river. Besides, the intermittent flow of waters through the turbines in response to the varying market demand for power creates huge *diurnal* variations in river flows: the range could be 0 to 400% of the flow. (There is one instance in which the river flow is *virtually zero for 20 hours in the day* when the turbines are not operating, but in the remaining 4 hours, when the power plant operates to meet peak demand, and the water held in 'pondage' is let out through the turbines into the river channel, *the river runs 8 m high for 4 hours.*) Aquatic life, vegetation and river-dependent communities have learnt to adapt themselves to periodical natural variations in river-flows but they simply cannot cope with huge diurnal variations of the order mentioned."

Mr. Iyer goes on to say that "The emerging idea that in working out lean-season environmental flows natural variations should be mimicked applies to storage projects; it cannot apply to daily variations in a RoR hydroelectric project. The idea of 'minimum or environmental flow' and that of a RoR hydroelectric project are incompatible with each other."[84]

We also know that most of these so-called RoR projects are designed and operated to meet peaking demands of electricity supply. In the words of the hydrologist Professor Thomas Hardy, "If its peaking, its not an RoR." He goes on to say "An RoR by definition cannot store water and cannot change the hydrographs of a river on a timescale. If it's doing that, it's not an ROR and should not be labelled as such. Period. If anyone is doing that, I would question their motives in being less than truthful. It's also a matter of wrong green labels to these projects. So we need to remember that RORs do not change the downstream hydrograph and hence cannot peak."[85]

The effects of radical flow manipulation, either through diversion or impoundment, on fish are many, and they are summarized again as follows:

Catchment scale impacts of dams are known to have both upstream and downstream effects stemming from inundation, flow manipulation and fragmentation. Inundation destroys terrestrial ecosystems and eliminates turbulent reaches, disfavouring lotic (flowing water) biota. It is known to cause anoxia, greenhouse gas emission, sedimentation, and an upsurge of nutrient release in new reservoirs. Flow manipulations also hinder channel development, drain floodplain wetlands, reduce floodplain productivity, decrease dynamism of deltas, and are seen to cause extensive modification of aquatic communities, especially fish. Dams obstruct the dispersal and migration of fish, and these and other effects have been directly linked to loss of populations of entire species of freshwater fish[86].

However, EIA analyses that consider this aspect at all, restrict themselves to the barrier aspect, and sometimes the flow regulation aspect as well. For flow requirements the ready recommendation is to leave only the minimum required by law in a particular state. The EIA for GMR Alaknanda HEP done by the CISHME, for example, mentions the mandatory flow of 10% as being adequate for fish in the downstream reaches[87]. The EIA by WAPCOS for THDC's Vishnugadh-Pipalkoti HEP only says that "a minimum flow shall always be released from the dam". It conveniently omits specifying any flow volume. The EIA by WAPCOS again for NTPC's Lohari Nagpala HEP magnanimously recommends that "In order to avoid the possible loss of aquatic life, a minimum flow of 3 cumecs shall always be released from the barrage". 3 cumecs past a dam built for generating 600 Megawatts on the Bhagirathi.

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84 Pers. Comm. Mr. Ramaswamy Iyer.

85 A peaking requirement is a predictable high demand and one that fluctuates during the day or night. You can see the whole interview with Dr. Hardy at http://sandrp.wordpress.com/2014/07/01/if-its-peaking-its-not-an-ror-interview-with-dr-thomas-hardy-iahr-and-texas-state-university/

86 Christer Nilsson et al. Fragmentation and flow regulation of the World's Large River Systems. Science 308. 405 (2005)

87 Only recently though, those projects have required to come to the EAC of the MoEF for approval, have been required to ensure a flow of 20% in the lean season, 25% in the non-lean non monsoon season, and 30% during the monsoon. A large number of Projects do not require clearance from the EAC, and therefore are able to evade any such increase in mandatory flows.

This bandying about of ‘environmental-flows’, where the percentages of mandatory releases can be higher than 10% of minimum flows, still does not address the critical role of the natural rhythms and flood-peaks required, among other things, for sediment and bed-load movement, that are critical not just to riverine ecosystems, but all the way down to estuarine ecosystems as well. It is in effect, just a euphemism for a somewhat raised bar being negotiated on minimum possible flows acceptable. In the name of e-flows then, you see recommendations ranging from 10% of minimum flows (Government of Uttarakhand), to barely enough to cover an otter’s back (IIT Roorkee’s CEIA of the Ganga)[88].

The Wildlife Institute of India, who is not a regulatory authority either, and who did an honest and relatively rigorous job of their Comprehensive EIA, recommended a Minimum Environmental Flow Required (MEFR) of 21.5% of mean seasonal flow for the Mahseer and Trout zones, and 14.5% of mean seasonal flow for no-fish zones. However, in view of the numerous studies already quoted in this paper[89] that indicate the clear co-relation between flow volumes and species richness, seen in conjunction with those findings on species-discharge relations and how great reductions would inevitably spell out in extinctions[90], the implications become crystal clear. As generous as WII’s recommendations are relative to all the others, more than 75% reduction in flow volumes would most likely imperil fish species in the Bhagirathi, the Alaknanda, their tributaries and thereon, the larger river systems of the Ganga. The Beas, like most other rivers have not seen any cumulative impact assessment or assessment of water required for different fish species in the river, but obviously, the principal drivers of both diversity as well as extinctions would hold good here too.

There are two thoughts here. One, that it is surprising at one level, and quite revealing at another, that the AHEC, a department of IIT Roorkee that actually designs turbines and trains engineers for the hydropower industry, should be asked to conduct a Comprehensive Environmental Impact Assessment of hydropower projects on the Ganga. While IIT Roorkee (earlier known as the Thomason College of Civil Engineering) was set up in 1848 by the East India Company to train engineers for their great colonial project, the Upper Ganga Canal[91], that it continues to produce good engineers, is one thing. But assigning it the job of assessing environmental impacts of the series of dams on the river is, to take an inverse example, like entrusting the Wildlife Institute of India to design appropriate dams and turbines for hydropower projects along the Ganga. Conflict of interests apart, as an institution, conducting an environmental impact assessment, is clearly not within the area of competence of AHEC of IIT Roorkee.

[88] You can see a critique of the CEIA conducted by IIT Roorkee here: http://www.sandrp.in/hydropower/Pathetic_Cumulative_Impact_Assessment_of_Ganga_Hydro_projects.pdf

[89] Field, R. et al Spatial species richness gradients across scales: A meta-analysis. J. Biogeogr. 2009. 36. 132-147. And Bhatt JP, Manish K, Pandit MK (2012) Elevational gradients in fish diversity in the Himalaya: Water discharge is the Key Driver of Distribution Patterns. PLoS ONE 7 (9) e46237.

[90] Xenopoulos MA, and Lodge DM. Going with the Flow: Using species-discharge relationships to forecast losses in Fish Biodiversity. Ecology. Vol 87. No 8. 2006. Pp 1907-1914.

[91] David Gilmartin. Water and Waste. Nature, Productivity and Colonialism in the Indus Basin.

Two, despite all these recommendations in EIAs and EMPs on the release of minimum flows, for whatever they are worth, there seems to be a complete absence of a working compliance mechanism on this, because other than the Maneri dam on the Bhagirathi and the Pandoh dam on the Beas which were releasing very small flows, no other dam was releasing any water during the day, at the time of my travels up both these rivers.

For the barrier effect, the standard 'solutions' proposed are either fish-passes, or more frequently, fish hatcheries that will supposedly produce fish-fry for seeding both upstream and downstream of the dams proposed. In order to design fish passes that work, the designers are required to know at least the precise swimming and jumping capabilities of the particular migratory species in the river concerned. I was told in confidence, by a senior scientist at the Directorate of Cold Water Fisheries at Bhimtal, that the cruising speed and burst speed of each species can realistically only be known if it is experimented for in a flume created for the purpose, where conditions can be controlled and measured. This has not been done anywhere in India, he confirmed, and all data used for those species for the construction of fish ladders in India, are either approximations or are from data on other fish in other countries. He also confirmed that there was no institution in the country, including CIFRI, that presently had the required expertise and experience for building appropriate fish passes in Himalayan rivers. The two fish ladders that I myself have seen so far, the one at the Larji dam described here, and one at the Kuri Chhu in Bhutan, were both ineffective, and did not seem like a serious effort by the hydro-power company either. In my view, they were a ploy to obtain environmental clearances.

There is also a widespread opinion that fish ladders do not work for anything but the smallest of barrages[92]. This is also confirmed by CIFRI, despite their being the prime institution in India designing and setting up fish ladders on dams[93]. Coupled with lack of critical information on species behaviour and capabilities, and all the uncertainties on technology, fish ladders can also be expensive to set up. For example, a fishway proposed by the HNB Garhwal University in an EMP for the relatively small 20 meter high barrage of the Naitwar-Mori 60 MW HEP was budgeted for Rs. 1 Crore. In fact, there are reports indicating that fish ladders do not work, and have rarely been successful anywhere, including the US, where fish ladder designs have been experimented with for long[94]. The critical question here is not just whether some fish are making it up the channel, but which species, how many, and are breeding populations making it up on time? Citing their study in a discussion in the April 2013 issue of the Yale Environment 360 titled 'Blocked migration: Fish ladders on US dams are not effective', one of the co-authors John Waldman goes on to say that *fishways on rivers in the U.S. Northeast are failing, with less than 3 percent of one key species making it upriver to their spawning grounds.*

92 CEIA WII 2012.

93 MK Das and MA Hassan. Status of fish migration and fish passes with special reference to India. Bull. No 156. CIFRI 2008.

94 J. Jed Brown et al. 'Fish and hydropower on the U.S. Atlantic coast: Failed fisheries policies from half-way technologies'. Conservation Letters, Vol 6. Issue 4, p 280-286, July-Aug 2013.

The more common solution then, or mitigation measure being proposed by agencies undertaking EIAs and making EMPs now, is to propose the setting up of hatcheries for the production of fish fry and seeding in the river on a continued basis. I came across several Environmental Management Plans (EMPs) that propose the setting up of hatcheries, mostly for Snow trout, and in some cases for Mahseer. There is even one where the NHPC funded the State Fisheries Department to set up a Brown-trout hatchery in the Tirthan valley, where there are no hydropower projects. A case of meddling in other rivers as well. The closest projects of the NHPC to the Tirthan valley, where people have succeeded in keeping hydro-power projects at bay, are on the Parbati and Sainj rivers. The reach of hydropower companies to other rivers are through money dished out for 'mitigation' of the damage they are doing in rivers where they have their hydropower projects[95]. Such meddling in other pristine rivers is not unique to the Tirthan. Another example is the EMPs prepared by the Department of Forestry and Natural Resources, HNB, Garhwal University for the Kotlibhel I A, I B and II HEPs, where they have recommended the setting aside of Rs. 92.62 million for "making the Nayar river a potential protected habitat", complete with hatcheries for Mahseer fish and provisions for capturing snow-trout for fish eggs as they congregate at damsites during migration. All they really need to do to conserve Mahseer, snow trout or any other indigenous fish in any river, is to not meddle. To lay off. And that does not take money to do. But there are other obvious reasons for setting aside money, and more on that follows.

I spoke to some of the foremost fish biologists[96] about the state of technology on indigenous fish in the Himalaya, and I was told that the technology on the culture of *schizothoracines* or snow trout is still in the experimental stages, and has not been successful anywhere in India. Yet you find numerous EMPs that smoothly propose the setting up of snow-trout hatcheries at substantial cost, and propose that the state fisheries departments, who have no clue on how to go about this, will implement the setting up and the running of these hatcheries. Cases in point are WAPCOS's EIAs for the Srinagar HEP for Duncans North Hydropower Company as well as for THDC's Vishnugadh-Pipalkoti HEP. More cases in point are the three separate EIAs and EMPs prepared by HNB Garhwal University for NHPCs three Kotlibhel hydropower projects, who even go as far as saying that "the technology for artificial spawning and rearing are widely available in the country". Have a look at their documents and you can see that both these consultants seemed to have economised so much on effort, that the texts and budgets for each of their projects are copied verbatim, including spelling mistakes.

In the case of Mahseer culture, while there is one report that says that the Directorate of Cold Water Fisheries at Bhimtal is producing 50,000 fingerlings annually[97], the question that

[95] There is a clear parallel here to money that comes to India, for example, under the oxymoron 'Clean Development Mechanism' (CDM) for financing the building of damaging hydropower projects (e.g. the 330 MW Srinagar HEP by GVK on the Alaknanda) from money paid by companies elsewhere with high carbon emissions, so that they may continue to have high carbon emissions.

[96] Pers comm P Nautiyal (Professor, Garhwal Univ) and KB Ralhan (Ex-Dir State Fisheries Department).

[97] Sehgal KL. Cold water fish and fisheries in the Indian Himalayas. Culture. In FAO document on Coldwater fisheries in the Himalaya.

both Professor Nautiyal of HNB Garhwal University, and Mr. Ralhan, Ex-Director, State Fisheries Department, Himachal Pradesh, raise is why are there no successful transfers of these fingerlings to be seen anywhere in the Himalaya? Stripping eggs from gravid females and mixing them with stripped milt in containers, and producing fish fry are just intermediate steps to successful breeding. There are critical stages thereafter, and it is when you are able to transfer fingerlings either to farmers or to other locations can a breeding programme be called successful. The much touted Mahseer culture set-up at the Tehri dam was a façade Dr. Nautiyal confirmed, and that while you would be shown a few captive Mahseer if you visited, there was no breeding and transfer of fingerlings being undertaken there. And any doubt as to the intentions of the Hydropower Company are laid to rest when you see one deceit ride another. The EMP of Vishnugarh Pipalkoti for THDC goes on to claim that "The Mahseer hatchery already constructed at the Tehri dam on the Bhagirathi river is used for propagation of the Mahseer, and will be utilized for the Vishnugarh-Pipalkoti HEP"[98].

Such insincere proposals seem to have traction for the same reasons that fish-ladders have. It enables an EIA to gain clearance, having 'addressed' an environmental problem. Furthermore, there is the attraction of the large sums of money involved for the State Fisheries Departments. An official of the State Fisheries Department posted in the Tirthan valley in Himachal Pradesh, who obviously would not like to be identified, said in a conversation on the matter, that the Fisheries Departments were complicit in these environmental clearances, and some officials just had to be paid up to do the necessary. But even individual bribes apart, State Fisheries Departments are happy to go along with such proposals because of the money involved in 'projects' proposed to be implemented by them. He who pays the piper, clearly calls the tune.

Since there are a whole orchestra of pipers in the hydropower ensemble, most Environment Management Plans can go quite far to see that they are adequately 'conducted'. Take for example the EMP for the 300 MW Alaknanda HEP for GMR by the Centre for Interdisciplinary Studies in Mountain and Hill Environment (CISMHE), Delhi University. For one, the dam is proposed to be located at an altitude of 2,940 meters asl and the powerhouse at 2,395 meters. Both these locations are at altitudes that are too high for any of the indigenous fish found in the Alaknanda. The EMP also states that they landed no fish during their survey, and that this stretch is in the No-fish Zone. But yet they go ahead and create budget for a "Proposed plan for fisheries development". They propose the construction of tiny 1.5 meter high check-dams and artificial riffles for non-existent fish fry and fingerlings, on one of the most turbulent stretches of this mountain river where the discharge is enough to run a 300 MW 'RoR' power-station. I quote the gist of their plan. This is not a quibble with their language; I would like you to see for yourself, what can pass in an Environmental Management Plan (EMP) from a reputed university:

Under the head of Check-dams they say, and I quote verbatim; "Though, Himalayan rivers are not experienced with these structures. However, for a sustainable livelihood approach they

[98] http://thdc.gov.in/writereaddata/english/pdf/emp.pdf

can be applied in the upper stretches of the river, which can carry relatively low water discharge even in the monsoon season." In the very next paragraph they go on to say "The high water discharge during the June and July is the major threat to these structures, which need a well-designed barrier, which could withstand in high discharge. On the other hand siltation would damage the check dam. Therefore, it would need maintenance every year." The next paragraph with the heading 'Design of Checkdam' has the following. "In order to the maintenance of pools, small check dams are needed in the rivers. The pool thus created is fished, often much later in the dry season. These structures are made of wooden posts, earth and clay-filled sacks in Senegal. After the construction of wall pools differ before and after damming. Generally, these check dams are used for aquaculture but here they would be used primarily for the conservation indigenous species not only the fish but other aquatic species also. 1.5 meter high wall of checkdam would be sufficient in this river. (Fig.3.1. which shows a small checkdam made of cobble sized stones) At least 4 dams would be required in the 12 km stretch of the river. Checkdams would be supplied through the regular water supply from the mandatory release of water (10%) from the barrage and other small tributaries." They add that "maintenance and construction of artificial riffles are included in the proposed fisheries management plan". Anyone who has seen the river in that section, would know that 4 km below Badrinath, the large river cascades steeply in a very turbulent flow, and dreams from a little river in Senegal with tiny check-dams and artificial riffles would be impossible to recreate, let alone maintain. And who is proposed to be entrusted with this fisheries management plan where there are no fish? The State Forest Department.

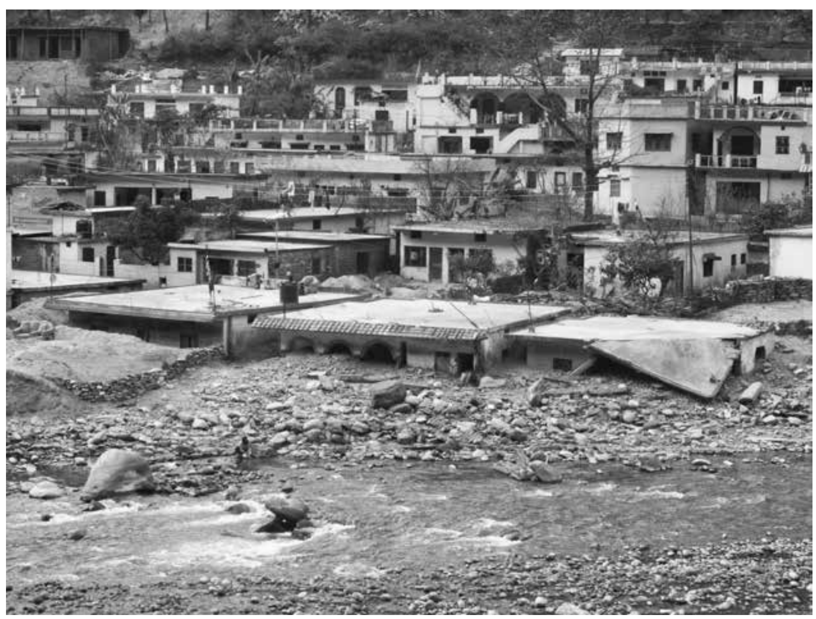
It is only when you read further, and see the categories of land that the project requires, that the penny drops. With a clang. After all the equivocating waffle, when you see the budgets, you also begin to see that the project proponents need another head to be able to pay the piper to play their tune. In this case it is the State Forest Department. Why should that be so? Of the 84 hectares of land that the HEP requires to build their dam and related structures, almost 74 hectares is Forest Land. The rest is private and other government land. Now there is a mandatory fund under the head of Catchment Treatment Plan (CAT Plan) that every hydropower Company has to put money to, and that goes into an account operated by the State Forest Department. Under the Alaknanda HEP under

Another look at stagnant Bhilangana River water with scarred river banks and a ferry for the stranded people discussion, the EMP has already set aside a sum of Rs. 54.58 million under the CAT Plan, of which Rs. 20.8 million is for direct expenditure by the Forest department under heads such as Infrastructure, Administrative Charges, Planning and Evaluation for 5 years.

There is an additional budget outlay in the EMP for the Alaknanda HEP of Rs. 58.5 million for what they call 'Biodiversity conservation and management works'. Here, the private hydropower company becomes a quasi-state conservation body, even one that will protect the environment from local inhabitants. They have budget heads such as 'habitat enhancement' and 'protection of wildlife', in which they set aside money to pay rewards to secret informers from within the village communities, to inform the Company of any 'poaching' of any wildlife in the area. This they propose to do by 'hiring local youth on a daily wage' as informers. A sure way to break down community cohesion, and create an environment of suspicion and animosity between people poor enough to jockey for a daily wage.

Under 'protection of wildlife', there is also a budget for "Anti-poaching measures to improve vigilance for anti-poaching, and better protection and enforcement by construction of anti-grazing, anti-poaching cum-check post." Anti-grazing. So with the arrival of a hydropower company into an area, the long-standing land-use strategies of local agro-pastoral communities become illegal.

The EMP also sets aside an additional amount of Rs. 59 lakh for this fisheries management Plan. Granted that this amounts is fish-feed compared to the CAT Plan outlay, but 30 lakh of this is an 'endowment grant', just for the maintenance of the impossible riffles and pools for non-existent fish.



Constructions encroaching on the Mandakini Riverbed clearly visible here

And it doesn't stop here. The private hydropower company goes on to assume the guise of the State. The seeming benevolence of the company extends to 'welfare' in the fields of Health-care and Education as well. The EMP has a budget of Rs. 29.7 million for the building and running of a hospital and some Primary Health Centres. Under Educational facilities for affected villages, there are budgets building schools, playgrounds, and scholarships for children. Oh and youth from an affected village will be 'trained' for alternative livelihoods. They will learn to stitch and knit clothes now, and process food. I guess that means the dream-jobs knitting socks and caps on the piece-rate, and making jams and pickles henceforth on a daily wage?

Large no of roads are built during construction phase of hydropower projects with huge impacts, this photo shows one such site in Beas basin in Himachal Pradesh

This is just one, somewhat detailed illustration of what has become rather common in the realm of Environment Impact Assessments and Environment Management Plans. I can't help see a few things here, as perhaps you do? Bluntly put, I see slush funds being dangled to a whole range of possible collaborators. The kindest term I can find for them is 'brokers'. I see in this particular example, a private company that otherwise builds urban infrastructure, roads and airports, come in and destabilize village communities, take on the appearance and functions of the State, even assuming policing powers over village communities. I also see a brash assurance that despite putting up trash for an EMP, it will pass muster with the approving authorities. I see an abuse of science in the complete disregard for the wealth of published work that clearly outlines the disastrous consequences of dam building and diversion of water on the scale proposed. I also see cronyism entrenched in regulatory authorities and even getting a foothold in academic institutions of standing.

In conclusion

Towards the end of my visit to the upper reaches of the Ganga and the Beas, I couldn't help but feel a deep sense of foreboding. The evidence was plain to see. We are in the midst of river extinctions in the Himalaya, but are surrounded by a tragic drama of double-speak and equivocation. And a horde of jostling brokers. Ranging from reputed universities, government departments, research institutions, everyday bureaucrats, and of course, politicians and contractors from within 'the community'[99] along the developers and regulators. They not only write the script of this drama, they even play all the parts.

And what about fish?

Worldwide, we see that freshwater biodiversity has declined faster than either terrestrial or marine biodiversity over the past 30 years[100]. In many countries, declining river-flow rates due to dams and diversions have been a major cause of species loss[101]. With the present scale of the build-up of hydropower projects on every major river in the Himalaya, the region will soon be the most densely dammed area anywhere.

There is, if anything, perhaps a critical cue that we could take from the most recent extinction that we know of. The K-T extinction[102] 65 million years ago, when a combination of an asteroid smacking the Yucatan Peninsula, and the up-welling of lava onto the Deccan plateau in India is said to have wiped out 75% or more of all species on Earth. While many anomalies are still a mystery, one thing stands out. More freshwater species survived compared to terrestrial and marine species. And why was this so? It has been suggested that animals in food chains that begin with detritus, or eroded and washed away organic debris, rather than with primary productivity would survive a catastrophe better than others. Freshwater communities are fuelled largely by stream detritus, which includes the nutrients running off from land vegetation[103]. This seems to

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[99] Caveat, there are honest exceptions, but this is a generalization that describes the predominant phenomenon.

[100] Jenkins,M. 2003. Prospects for biodiversity.Science 302. 1175-1177. And UNESCO 2003. The United Nations World Water Development Report. Water for people, water for life. UNESCO and Berghahn books.

[101] Postel, S and Richter B. 2003. Rivers for life. Managing water for people and Nature. Island Press. Washington DC. USA.

[102] Cretaceous–Tertiary (K–T) extinction, see: http://en.wikipedia.org/wiki/Cretaceous%E2%80%93Paleogene_extinction_event

[103] Cowen, R. 1994. History of Life. 2nd edition. Blackwell Scientific Pubs.

be true for freshwater communities at the K-T boundary, but such communities would survive any ecological crises better under stress, catastrophic or not.

As a matter of fact, the seas don't seem to have quite recovered even after 65 million years or so. The number of valid marine fish species as of the last published count I have seen (19th Feb 2010), is 16,764, which is not very different from that of freshwater fish species at 15,170. This, despite freshwater fish inhabiting a tiny fraction of the area and volume of water that marine fish do. New marine species are being described at a rate of about 100-150 a year, with freshwater numbers slightly higher[104]. Apart from fish that still migrate between rivers and the sea, all indications are that it was in fact freshwater fish that helped re-colonize the sea. Not to mention that we humans were once fish.[105]

With the scale and intensity of the build-up of hydro-power development and water withdrawal from rivers now, we seem to be adding the one kind of stress that fish will not be able to withstand; we are disrupting and taking away the very basis of their lives; freshwater flows, its rhythms, and its interactions with the terrestrial and aquatic realms.

This study attempted to understand the impact of hydropower projects in the mountain sections of the Ganga and the Beas on fish, and on those dependent on them. Both, through travel up the entire fish-zones of these rivers to see and hear first-hand, and also through deepening and widening the understanding through good science from published sources. Today however, despite abundant evidence already staring us in the face, both of impacts we can see in and near rivers, and those in the realm of published science in India and worldwide, we see a concerted effort at disinformation. The behemoth called 'development,' that Trojan-horse of commercial interests, rolls on. The 'under-developed', it turns out, are really those who have not experience this destructin as yet.

Wasn't it Antonio Gramsci who said that the moment of hegemony is revealed when the dominant bloc "also poses the questions around which the struggle rages…"? That moment, it seems, has arrived.

[104] William Eschmeyer et al. Marine fish diversity: History of knowledge and discovery (Pisces). Zootaxa. 2525: 19-50 (2010).

[105] For an accessible discussion on this, you could see Kevin Berger. When We Were Fish. Nautilus Magazine. http://nautil.us/issue/14/mutation/when-we-were-fish.

Annexure A

List of Operational, Under Construction and Under Development Hydropower Projects in Alaknanda and Bhagirathi Basins (Source WII)

S. No.	Project Name	Basin	Name of River/ Tributary	Installed Capacity (MW)
In Operation				
1	Agunda thati	Bhagirathi	Dharamganga	3
2	Badrinath II	Alaknanda	Rishi ganga	1.25
3	Bhilangana	Bhagirathi	Bhilangana	22.5
4	Debal	Alaknanda	Kailganga	5
5	Jummagad	Alaknanda	Jummagad	1.2
6	Maneri bhali I	Bhagirathi	Bhagirathi	90
7	Manaeri bhali-II	Bhagirathi	Bhagirathi	304
8	Pilangad	Bhagirathi	Pilangad	2.25
9	Rajwakti	Alaknanda	Nandakini	3.6
10	Tehri stage-I	Bhagirathi	Bhagirathi	1000
11	Urgam	Alaknanda	Kalpganga	3
12	Vanala	Alaknanda	Nandakini	15
13	Vishnuprayag	Alaknanda	Alaknanda	400
			Total Capacity	**1850.8**
Under Development – At Construction Stage				
1	Bhilangana-III	Bhagirathi	Bhilangana	24
2	Birahi Ganga	Alaknanda	Birahi Ganga	7.2
3	Kail ganga	Alaknanda	Kailganga	5
4	Kaliganga-I	Alaknanda	Kaliganga	4
5	Kaliganga-II	Alaknanda	Kaliganga	6
6	Koteshwar	Bhagirathi	Bhagirathi	400
7	Lohari Nagpala	Bhagirathi	Bhagirathi	600
8	Madhmaheshwar	Alaknanda	Mandakini	10
9	Phata Byung	Alaknanda	Mandakini	76
10	Rishi Ganga	Alaknanda	Rishi ganga	13.2

S. No.	Project Name	Basin	Name of River/ Tributary	Installed Capacity (MW)
11	Singoli Bhatwari	Alaknanda	Mandakini	99
12	Srinagar	Alaknanda	Alaknanda	330
13	Tapowan Vishnugad	Alaknanda	Dhauliganga	520
14	Vishnugad Pipalkoti	Alaknanda	Alaknanda	444
			Total Capacity	**2538.4**
		Under Development – At Other Stages		
1	Alaknanda	Alaknanda	Alaknanda	300
2	Asiganga-I	Bhagirathi	Asiganga	4.5
3	Asiganga-II	Bhagirathi	Asiganga	4.5
4	Asiganga-III	Bhagirathi	Asiganga	9
5	Balganga-II	Bhagirathi	Balganga	7
6	Bharon Ghati	Bhagirathi	Bhagirthi	381
7	Bhilangna-II A	Bhagirathi	Bhilangana	24
8	Bhilangna-II B	Bhagirathi	Bhilangana	24
9	Bhilangna-II C	Bhagirathi	Bhilangana	21
10	Bhyundar ganga	Alaknanda	Bhyundar ganga	24.3
11	Birahi Ganga-I	Alaknanda	Birahi ganga	24
12	Birahi Ganga-II	Alaknanda	Birahi ganga	24
13	Bowla Nandprayag	Alaknanda	Alaknanda	300
14	Devsari	Alaknanda	Pinder	252
15	Dewali	Alaknanda	Nandakini	13
16	Gohana Tal	Alaknanda	Birahi ganga	50
17	Jadh Ganga	Bhagirathi	Jadhganga	50
18	Jalandharigad	Bhagirathi	Jalandhari	24
19	Jelam Tamak	Alaknanda	Dhauliganga	126
20	Jhala koti	Bhagirathi	Balganga	12.5
21	Kakoragad	Bhagirathi	Kakoragad	12.5
22	Kaldigad	Bhagirathi	Kaldigad	9
23	Karmoli	Bhagirathi	Jadhganga	140
24	Khirao ganga	Bhagirathi	Khaiaoganga	4
25	Kot Budha Kedar	Bhagirathi	Balganga	6
26	Kotli Bhel-I A	Bhagirathi	Bhagirathi	195

S. No.	Project Name	Basin	Name of River/ Tributary	Installed Capacity (MW)
27	Kotli Bhel-I B	Alaknanda	Alaknanda	320
28	Kotli Bhel-II	Ganga	Ganga	530
29	Lata Tapovan	Alaknanda	Dhauliganga	170
30	Limcha Gad	Bhagirathi	Limcha Gad	3.5
31	Malari Jelam	Alaknanda	Dhauliganga	114
32	Melkhet	Alaknanda	Pinder	15
33	Nandprayag Langrasu	Alaknanda	Alaknanda	100
34	Pala Maneri	Bhagirathi	Bhagirthi	480
35	Pilangad- II	Bhagirathi	Pilangad	4
36	Ram Bara	Alaknanda	Mandakini	24
37	Rishi Ganga-I	Alaknanda	Rishi ganga	70
38	Rishiganga II	Alaknanda	Rishi ganga	35
39	Siyangad	Bhagirathi	Siyangad	11.5
40	Suwari Gad	Bhagirathi	Suwari Gad	2
41	Tamak Lata	Alaknanda	Dauliganga	250
42	Tehri Stage-II	Bhagirathi	Bhagirathi	1000
43	Urgam-II	Alaknanda	Kalpganga	3.8
			Total Capacity	**5174.1**

Annexure B

List of Projects under operation in the Beas Basin in Himachal Pradesh (Source: Himdhara)

S.No.	Projects	Installed Capacity (MW)	District	Developer
1	Bassi	60	Mandi	State
2	Larji	126	Mandi	State
3	Malana	86	Kullu	Private
5	Mukerian	207	Kangra, Punjab	Punjab state
6	Pong	396	Kangra	Central
7	Shanan	110	Mandi	Central
8	Allian Duhangan	192	Manali	Private
9	Malana II	100	Kullu	Private
10	Binwa	6	Kangra	State
11	Gaj	10.5	Mandi	State
12	Baner	12	Kangra	State
13	Khauli	12	Kangra	State
14	Dehar I	5	Chamba	
15	Maujhi	4.5	Kangra	Himurja
16	Raskat	0.8		
17	Baragran	3	Kullu	Private
18	Aleo	3	Kullu	Private
19	Marthi	5	Private	
20	Pandoh	990	Mandi	State
21	Dehar II	1.5	Chamba	Private

List of projects proposed and under construction in Beas Basin in Himachal Pradesh

S.No.	Projects	Installed Capacity (MW)	District	Developer
1	Uhl III	100	Mandi	State
2	Sainj	100	Sainj	State
3	Khauli II	6.6	Kangra	State (cancelled)
4	Parbati II	800	Barshaini, Kullu	NHPC
5	Parbati III	520	Sainj	Central
6	Patikari	16	Kullu	Private
7	Neogal	15	Kangra	Private
8	Lambadug	25	Kangra	Private
9	Baragaon	11	Kullu	Private
10	Fozal	9	Kullu	Private
11	Baner II	6	Kangra	Private
12	Parbati I	750	Kullu	NHPC
13	Kilhi Balh	7.5	Kangra	cancelled
14	Dhaulasidh	66	Hamirpur, Kangra	Central
15	Thana Plaun	141	Mandi	State
16	Triveni Mahadev	78	Mandi	State
17	Nakthan HEP	520	Kullu	State
18	Gharopa	99	Kullu	

Annexure C

Fish-list for the Alaknanda and the Bhagirathi sub-basins of the Ganga. Source: CEIA, WII

Sl. no	Fish Species
1	*Salmo trutta fario* Linnaeus
2	*Salmo gairdnerii gairdnerii* Richardson
3	*Tor tor* (Ham.)
4	*Tor putitora* (Ham.)
5	*Tor chelinoides* (McClell.)
6	*Neolissochilus hexastrichus* (McClell.)
7	*Labeo dyocheilus* (McClell.)
8	*Labeo dero* (Ham.)
9	*Labeo boga* (Ham.)
10	*Labeo bata* (Ham.)
11	*Chagunius chagunio* (Ham.)
12	*Puntius ticto* (Ham.)
13	*Puntius conchonius* (Ham.)
14	*Puntius sophoue* (Ham.)
15	*Puntius chola* (Ham.)
16	*Puntius sarana* (Ham.)
17	*Puntius phutunio* (Ham.)
18	*Barilius bendelisis* (Ham.)
18	*Barilius shacra* (Ham.)
20	*Barilius barna* (Ham.)
21	*Barilius barila* (Ham.)
22	*Barilius vagra* (Ham.)
23	*Raiamas bola* (Ham.)
24	*Danio (Brachydanio) rerio* (Ham.)
25	*Devario aequipinnatus* (McClell.)
26	*Devario devario* (McClell.)
27	*Esomus danricus* (Ham.)
28	*Rasbora daniconius* (Ham.)
29	*Schizothorax richardsonii* (Gray)
30	*Schizothorax plagiostomus* Heckel
31	*Schizothorax progastus* (McClell.)
32	*Schizothorax esocinus* (Heckel)
33	*Schizothoraichthys micropogon* (Heckel)
34	*Schizothoraichthys longipinnis* (Heckel)
35	*Schizothoraichthys curvifrons* (Heckel)
36	*Schizothoraichthys planifrons* (Heckely)
37	*Garra gotyla gotyla* (Gray)
38	*Garra lamta* (Ham.)
39	*Crossocheilus latius latius* (Ham.)
40	*Psilorhynchus balitora* (Ham.)
41	*Balitora brucei* Gray
42	*Lepidocephalus guntea* (Ham.)
43	*Botia dario* (Ham.)
44	*Botia almorhe* Gray
45	*Acanthacobitis botia* (Ham.)
46	*Schistura rupicola* (McClell.)
47	*Paraschistura montanus* (McClell.)
48	*Schistura beavani* Gunther
49	*Schistura savona* (Ham.)
50	*Schistura denisonii* (Jerdon.)
51	*Nemacheilus multifasciatus* Day
52	*Nemacheilus scaturigina* (McClell.)
53	*Schistura corica* (Ham.)
54	*Mystus tengara* (Ham.)
55	*Rita rita* (Ham.)
56	*Clupisoma garua* (Ham.)
57	*Amblyceps mangois* (Ham.)
58	*Bagarius bagarius* (Ham.)
59	*Parachiloganis hodgarti* (Hora)
60	*Glyptothorax madraspatanum* (Day)
61	*Glyptothorax pectinopterus* (McClell.)
62	*Glyptothorax telchitta* (Ham.)
63	*Glyptothorax conirostris* (Steind.)
64	*Glyptothorax cavia* (Ham.)
65	*Glyptothorax trilineatis* Blyth
66	*Glyptothorax kashmirensis* Hora
67	*Glyptothorax brevipinnis* Hora
68	*Pseudecheneis sulcatus* (McClell.)
69	*Xenetodon cancila* (Ham.)
70	*Channa gachna* (Ham.)
71	*Mastacembelus armatus* (Lacep.)
72	*Trichogaster fasciatus* (Schn.)
73	*Glyptothorax alaknandi*
74	*Glyptothorax Garhwali*
75	*Cyprinus carpio carpio*
76	*Ctenopharyngodon idella*

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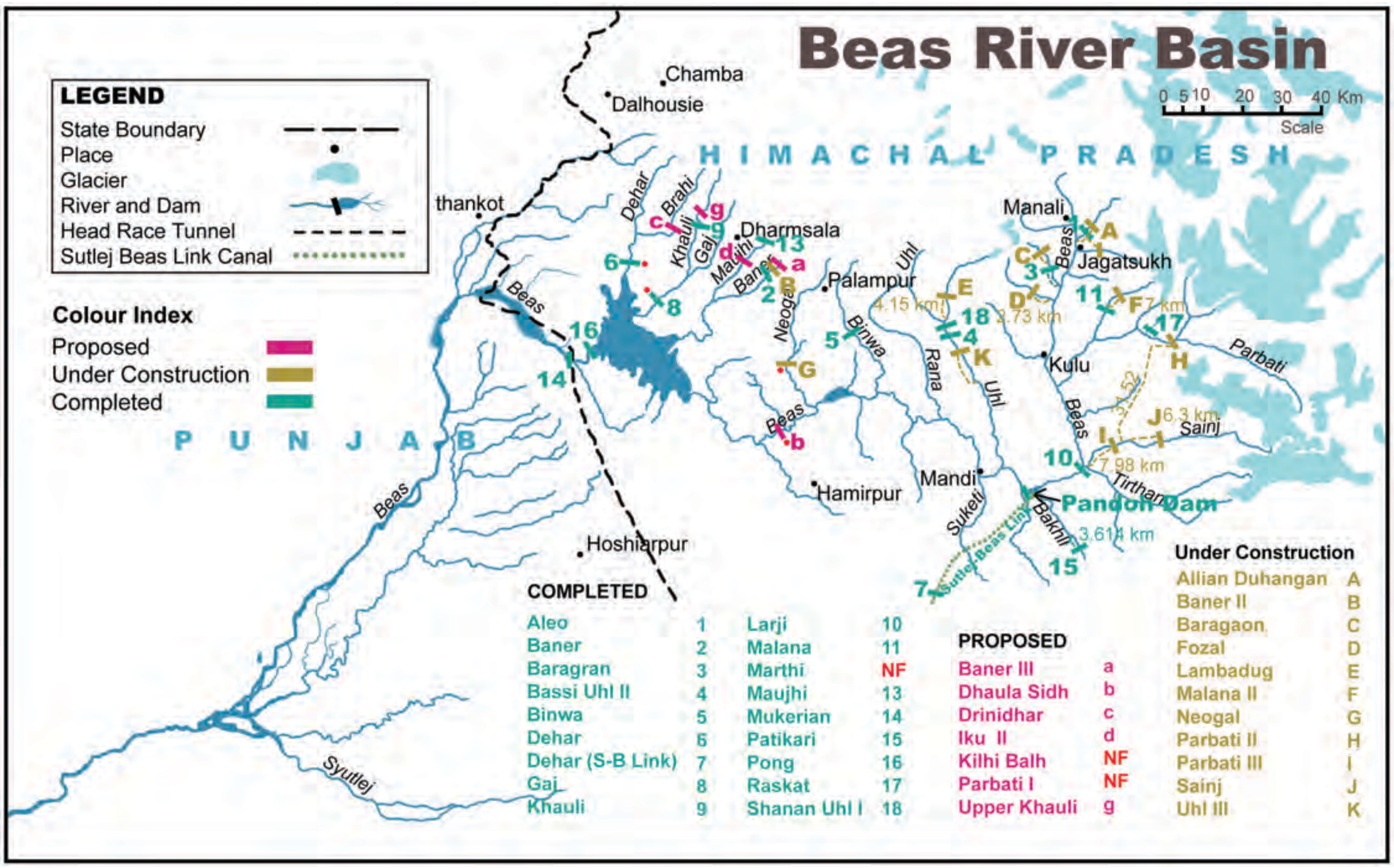
Hydro Electric Power Projects in Beas River Basin



Ganga at Devprayag at risk due to Kotli Bhel 1A, 1B and 2 Hydropower Projects - Photo by Pansul Mehta

"The damaged HEP seemed to sum up and typify all that I had seen all through my travels up the Beas, Bhagirathi and Alaknanda. Severely damaged hydropower projects, poor conception, toothless regulation, non-existent monitoring, and entirely unmindful of the consequences to the rivers, and to all life dependent on them"

"I felt I was in an Occupied territory: Even as you drive up from the plains up the first rise of the mountain roads, you are greeted by large signboards put up by Hydro-power Companies. They 'welcome' you into the state, like owners and they tell you how many hydro-power projects you will encounter, the mileage to each one of them, and all the major towns enroute. Not the Highways Authority, but private hydropower companies, Government hydropower companies, cement companies, and companies that conveniently do both cement and hydropower. Roads ripped wide, giant transport vehicles crawling up with either fly-ash for cement, or building material and towering machinery for hydropower plants hogging the highway. Wreckage of trashed earth-movers with rusted tank-treads, and twisted trucks abandoned by the side of roads as if in a battlefield. There are billboards that tell you that entry is restricted to the entire road even though there are many villages upstream, and this is the only public access to entire valleys. Near every hydropower installation, your vehicle will be stopped and you will be questioned by armed men in uniform. And you are being constantly watched. On a mountain highway, of all places."

SOUTH ASIA NETWORK ON DAMS, RIVERS AND PEOPLE
Let Rivers Flow
No Destructive Project
Harvest Rain
S A N D R P