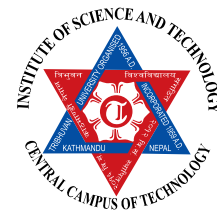




Original Research Article



Diversity of Aquatic Fauna in Upper and Middle Tamor River and Possible Impacts of Hydropower Dam in Taplejung, Nepal

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Abstract

Tamor River is originated from Eastern Himalayan region of Kanchenjunga range and ends in Tribeni of Saptakoshi. Within 15 km distance between Tapethok and Thumba region, upper and middle Tamor hydropower projects will be constructed in near future. To protect the river environment, It require the knowledge of species richness of aquatic flora and fauna as the dam construction may adversely affect them. Besides natural factors, the socio-economic conditions, culture of ethnic people, educational status, population densities, occupations etc. influence the biodiversity. Local people (Limbu), who consider Tamor and Arun rivers as *Basa* (king), have the pioneer concept to protect the river environment by not pouring any effluents and poison into them. Fishing apparatus and methods being used by the local people were: *Paso* (nylon loop trap), *Balchhi* (bait), *Jal* (net), *Duwali thunne* (diverting water bodies), crushed root of *Karkus* plant (irritating poison), crushed *boke timur* (*Zanthoxylum armatam*), leaves and young stems of *titepati* (*Artemisia vulgaris*) and current fishing. After the survey of aquatic species from six stations within study sites, fish species found in Upper Tamor Hydropower Project (UTHP) area was 11 and 28 in Mid Tamor Hydropower Project (MTHP). Several insect larvae, Cyclops, crustaceans, amphibians, reptiles, aquatic birds and mammals were also found in both areas. The effect of dam construction can be reduced by adopting several mitigating measures and by the strict follow of protection acts and amendments.

Key Words: Tamor river, fishes, diversity, migration, hydropower dam, environment

Introduction

Tamor River originates from the Eastern Himalayan region of Kanchenjunga range and ends in Tribeni of Saptakoshi. Its total length is about 190 km with 5817 km² catchment area among which UTHP occupies only 1850 km². The Eastern Himalayan region is considered as an earth's biodiversity hot spot (Shrestha et al., 2009).

Upper Tamor Hydropower project (UTHP) is one of the high power hydroelectricity generating project which is located at Tapethok VDC of Taplejung District. First point having Longitude 87° 48' 03"E to Latitude 27° 30' 00" N and 4th point having Longitude 87° 42' 30 "E to 27° 30' 00" N. Middle Tamor Hydropower project is other high power hydroelectricity generating project which is located in between Sawadin to Khokling VDCs of Taplejung District. First point having Longitude 87° 48' 03"E to Latitude 27° 24' 47" N and 4th point having Longitude 87° 40' 18"E to 27° 30' 00"N. Hydroelectric energy generation is one of the basic needs to overall

development of the country. However, impoundments in rivers impact adversely on fish and other aquatic biodiversity and fisher community who depend on fishing for their livelihood (EIA, 1996; Swar, 2001). Tamor River has several tributaries along the length of Hydropower project areas. Nepal's biodiversity is a reflection of its unique geographic position and variations in altitude and climate.

The Initial Environment Examination (IEE) study carried out by Sanima Hydro-Power (P.) Ltd. on aquatic fauna (especially Fish) survey reported only 4 dominant species of fishes in UTHP and 8 in MTHP among 21 species of fishes in this region. Some insects' larvae, Cyclops, crustaceans, amphibians and reptiles, several aquatic birds and semi-aquatic mammals were also commonly seen in surrounding wetland and river bank. In assessment of fish communities, index of biotic integrity (IBI) of physical and chemical characteristics of the stream, and the variables like species composition and richness, fish abundance

and migratory behavior were taken into consideration. Every organism in this universe has equal rights for the survival as man. But there is also a natural food chain and struggle between organisms which automatically controls the population size. So, fish species also can be managed properly up to an unharmed level by the human efforts.

There are about 90% Limbu community and 10% Rai, Tamang, Sherpa, Gurung, Chhetri, Brahmin and others. Most of them involve in agriculture (Cardamom, paddy at river side, millet, potatoes, soybeans, maize etc.) and livestock farming. Population of 7 VDCs (Tapethok, Lelep, Ikhabu, Linkhim, Khejenim, Sawadin and Phurumbu) was 12,567 of 2785

households and average literacy rate was 44.94% (NPC, 2008/09). The population of same area before seven years was 15,270. In Hangdewa and Khokling mixed population of Limbu 80%, and others Rai, Tamang, Gurung, Chhetri and Brahmin are 20%. It clearly shows that emigration is increasing each year. Some of the people who have not enough land for agriculture are involving in trekking as porter and *Khetala* (laborers). However, none of them are involving in fishing as occupation. Fishing is being done for recreation purpose once or twice a year according to interview with the local people. With the help of Kanchanjanga Conservation Area, many awareness programmes have been launched to raise consciousness in the people.

Methodology

Study sites

Field visit was done by the help of guide and map provided by the Sanima Hydropower project. During study, six stations were selected within the range of Hydropower first Tapethok and Lelep area (Dam area of UTHP) (Figure 1), second Chhiruwa and Ikhabu, third Siwa and Sawadin, Fourth Sisne, Mitlung and part of Sawadin (Dam area of MTHP), fifth Chitubank high current flowing water (riffle) galchhi, near Hangdewa khola dovan and sixth station was taken at Thumba region. The study site UTHP (Figure 1) is located in between Tapethok / Lelep (Alt. 1300m) to Siwa (Alt. 1180m). MTHP (Figure 2) includes Sawadin, Phurumbu, Linkhim, Khejenim, Hangdewa and Thumba (Thapagaun) of Khokling VDCs.

Fishing apparatus being used by the local fisherman were *Jal* (net), *Paso* and bait during winter month. Interview with fisherman and local people also provided a lot of information about fishes found in different seasons because the EIA study is carried out in winter month. Some dominant fishes in those

areas were caught on the spots by the help of trained local fishermen and after observation released in the same places. The some collected unidentified fish species were preserved in 8-10% formaldehyde solution and they were identified using standard method of Talwar and Jhingran (1991), K.C. (1999), Shrestha (1994), Shrestha (2008).

Fishing apparatus and methods using by local people

1. *Paso / Damali* (loop trap of long, flexible and strong nylon thread) 2. *Balchhi* (bait) 3. *Jal* (net, most common) 4. *Duwali thunne* (fish catch was done after diverting water bodies at the sides of river) 5. Poison commonly used to kill fish by ethnic groups. i. Crushed root of Karkus plant (irritating). ii. Crushed boke timur (*Zanthoxylum armatum*) also used to kill fish. iii. Crushed leaves and young stems of titepati (*Artemisia vulgaris*). 6. Current fishing was done occasionally at Kabeli Dovan area only according to local people.

Results and Discussion

The water of Tamor River is very clear due to its origin from Himalayan and topographical features and mythological concepts of ethnic people (mainly Limbu). Local people, who consider Tamor and Arun rivers as *Basa* (king), have the pioneer concept to protect the river environment by not pouring any effluents and poison into them.

Fish Fauna in Upper Tamor hydropower Project (UTHP) Area

On the Upper Tamor region the dominant fish species identified were Buche Asala (*Schizothorax plagiostomus*) (Heckel) 1838, maximum size 600 mm, wt. 2kg., Asala /soal (*Schizothorax richardsonii*) (Gray) 1832, maximum size 300mm, wt. 2kg., Chucho Asala (*Scizothoraichthys progastus*) (McClelland) 1839, maximum size 300 mm and Tilchagre (*Glyptothorax cavia*) (Hamilton) 1822, maximum size 175 mm.

The other species identified on the same region were Kabre (*Pseudocheineis sulcatus*) (McClelland) 1842, Maximum size is 175mm and appeared during rainy seasons. Kabre (*Pseudocheineis crassicauda*) (Ng and Edds) 2005, was found

during rainy season. Tite machha (*Psilorhynchoides pseudecheneis*) (Menon and Datta) 1964, found during September to November (Bhadra/Asoj/ Kartik) and maximum size has 200mm. Gadela (*Noemacheilus elongates*) (Sen and Nalbant) 1981 and gadela (*Noemacheilus bevanii*) (Gunther) were found tributaries of Tamor upto Tapethok area. Baghi/Segna (*Botia almorhae*) (Gray) 1831 and Budhuna (*Garra gotyla gotyla*) (Gray) 1832 were found at tributaries of Tamor River. Migration occurs more frequently for overwintering and breeding (spawning) but less frequently for alimetal and osmoregulatory purposes (Nikolsky, 1999).

Long Distance migratory fishes of the UTHP were *Tor putitora* (maximum size 1800mm, wt. 48 kg), *Tor tor* (maximum size 1200 mm wt. 60 kg) and *Chupisoma garua* (Hamilton-Buchanan) (maximum size 609 mm, wt. 3kg). These fishes have same migratory pattern. The downstream migration occurred from January to May and upstream migration occurred from June to December. Others migratory fishes like *Tor putitora*, *Acrossocheilus hexagonolepis* could not cross the

Chitubank riffles just below Khokling dovan according to fishermen. So, long distance migratory fishes were not seen in UTHP region. Mid-distance migratory fishes were *Scizothorax plagiostomus*, *Scizothorichthys progastus* and *Scizothorax richardsoni*. The resident species *Noemacheilus elongates*, *Botia almorhae*, *Garra gotyla* etc. were also found in UTHP. None of the fishes of Nepal belongs to endangered categories of

IUCN and CITIES lists. Among 187 species only 32 species were categorized as threatened species and 8 species were categorized into vulnerable category (Shrestha, 2003). *Tor tor* (at lower Tamor, Dovan area) is a single species of endangered categories in Nepal. *Myersglanis blythi* and *Psilorhynchoides pseudocheneis* are endemic fish species of Nepal found in Tamor and its tributaries (Shrestha *et al.*, 2009).

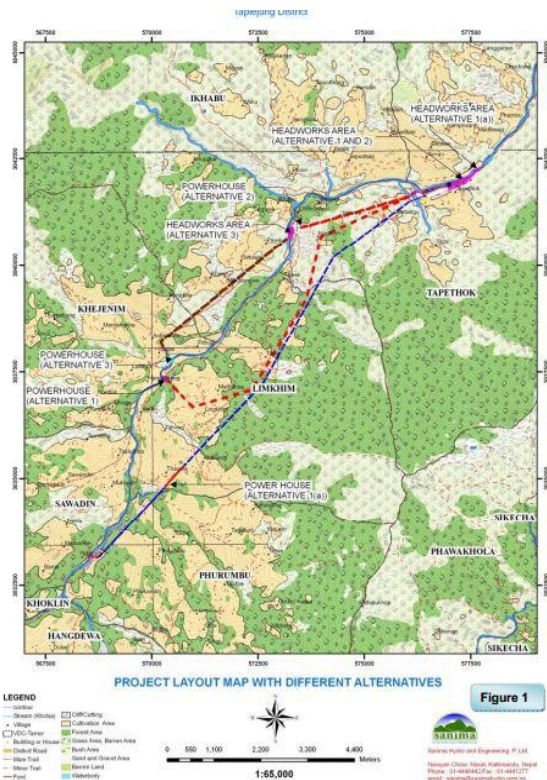


Figure 1: UTHP

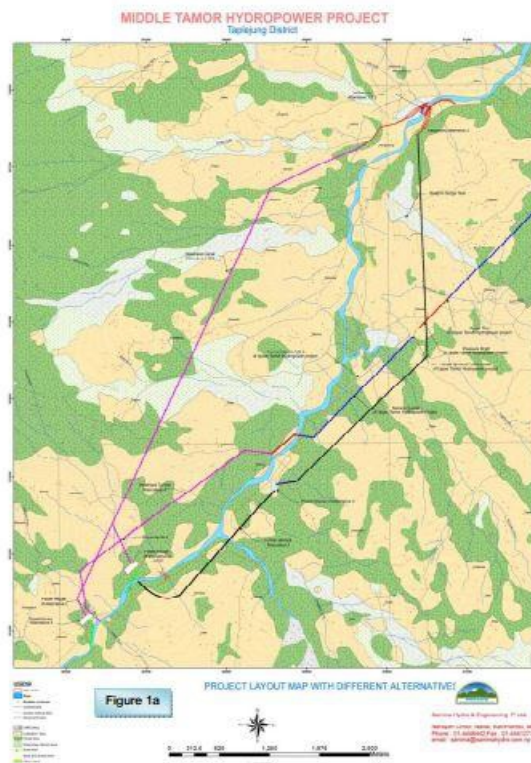


Figure 2: MTHP



Figure 3: Catching trout through Paso by ethnic people

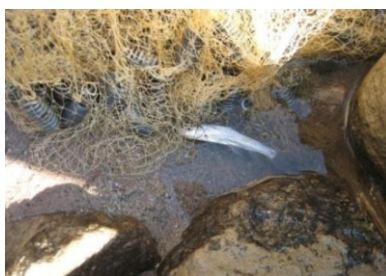


Figure 4: Catching *Schizothorax* sp. (Cucho Asala) by net



Figure 5: *Schizothorax* sp. at Sisne area

Fish Fauna in MTHP

There were 8 dominant fish species out of 28 species found in MTHP region. Buche Asala (*Schizothorax plagiostomus*); Chuche Asala (*Scizothorichthys progastus*); Tilchapre (*Glyptothorax cavia*); Kabre (*Pseudoecheneis sulcatus*) and Kabre (*Pseudoecheneis crassicauda*) were found during rainy seasons. Tite machha (*Psilorhynchoides pseudocheneis*) appeared during September to November. Lohori Buduna (*Garra annandalei*); Fageta (*Barilius shacra*), *Glyptothorax cavia*, *Psilorhynchoides pseudocheneis* and *Pseudoecheneis* spp. can cross the high flow water (riffle) Chitubank galchhi

region. Others migratory fishes like *Tor putitora* and *Acrossocheilus hexagonolepis* cannot cross the Chitubank galchhi according to fisherman. Gardi (*Labeo dero*) was found below Mitlung. Kursa (*Labeo dyocheilus*), thilke (*Labeo angara*), faketa/pogati or khabate gardi (*Barilius vagra*) and gurdi/fageta/Jhojho (*Barilius bendelisis*) were recorded at Thumba region. *Barilius Jalkapoorei* was found below Thumba Dovan. *Noemacheilus bevani* and *Noemacheilus elongates* found in tributaries of Tamor upto Tapethok area. *Botia almorhae* found at tributaries of Tamor River.

20	<i>Amblyceps mangois</i> (Hamilton - Buchanan)	Bokshi macho	-	-	Mid dist. endemic	MTHP
21	<i>Barilius vagra</i> (Hamilton- Buchanan) 1822.	-	-	-	-	MTHP
22	<i>Clupisoma montana</i> (Hora)	-	-	-	-	MTHP
23	<i>Psilorhynchus balitora</i> (Hamilton- Buchanan)	Balitora minnow	-	-	-	MTHP
24	<i>Glyptothorax telchitta</i> (Hamilton- Buchanan) 1822.	Kabre/kotel	-	-	-	MTHP
25	<i>Labeo angara</i>	Thilke	-	-	-	MTHP
26	<i>Labeo dyocheilous</i>	Kursa	-	-	-	MTHP
27	<i>Barilius bendelisis</i>	Gardi/Fageta/ Jhojho	-	-	-	MTHP
28	<i>Shizothoraichthys labiatus</i> (McClelland) 1842.	Chuche Asala	-	-	-	MTHP

Chuche asala (*Shizothoraichthys labiatus*) (McClelland) 1842 and kabre/kotel (*Glyptothorax telchitta*) were found in MTHP.

Long Distance migratory fishes were *Tor putitora* (maximum size 1800mm, wt. 48 kg.), *Tor tor* (maximum size 1200mm wt. 60 kg) and *Clupisoma garua* (maximum size 609mm,wt.3kg) found in MTHP. Mid-distance migratory fishes *Scizothorax plagiostomus*, *Scizothoraichthys progastus* (McClelland) 1839, *Labeo dero* and *Neolissocheilus hexagonolepis* were also recorded. *Garra annandalei*, *Garra gotyla*, *Noemacheilus elongates* and *Barilius vagra* were of resident species. *Meyrsglanis blythi* and *Psilorhynchoides pseudedecheensis* are endemic fish species of Nepal. In comparison to fish diversity at UTHP area (11 species), MTHP possess more fish fauna (28 species).

Other aquatic and semi-aquatic fauna in UTHP and MTHP areas

Amphibians found in the study area were of frog (*Hoplobatrachus* sp.), Toad (*Bufo melanostictus*) and krikwa / Phuchhe /small sized paha (*Nanorana minica*). Pirre (*Amolops formosu*), Sise Paha (Combat dress like), Man Paha (Hungama) or Sigare Bhyaguto (*Hoplobatrachus tigerinus*) and Nigale Paha (*Nanorana liebigii*), *Nanorana anandalii*, *N. blanfordii* in Lelep and Tapethok areas were commonly found. *Amolops marmoratus* (dalle pani Bhyaguto), *Amolops nepalicus* (Nepale Panibhyaguto) and *Microhyla ornate* (Thutune Bhyaguto) were also found in MTHP (Kastle *et al.*, 2013). Helix species were dominant among molluscs.

In reptiles, snakes: Sanbe (*Orthryophis hodgsoni*), Gurbe (*Ovophis monticola*), Sirise (*Dendrelaphis tristis*), Green pit viper (*Trimersurus tibetanus*) and *Ptyas mucosa*; Lizards: Garden lizards (*Geko* spp.), wall lizards (*Hemidactylus* spp.), *Laudakia tuberculata* (Bhir Chheparo) and Bhalemungro

(*Asymblepharus sikkimensis*), a long striped lizards were most commonly found (Kastle *et al.*, 2013).

In birds fauna, black water duck (Jalewa), brown and white water duck (malewa) seen during March to November (Falgun to Asoj / Kartik) were dominant species along the river bed. Tare Chara (male has red tail feathers and head bears white star like sign but female is black without star) was also found. Kalchuda (*Myiophoneus caeruleus*) with a black body and pink beak found at the bank of the riverine forest. Kalij (*Lophura leucomelana*), pahelo fisto (*Rhipidura hypocantha*), patle fisto (*Culicicapa ceylonensis*) and haleso (*Streptelia senegalensis*) were also recorded (Majupuria and Majupuria, 1998). Besides these, Kanchenjunga Conservation Area Project has listed some birds in Lelep / Tapethok area distributed along the bank of Tamor river were of great parrot bill (*Conostoma oemodium*), brown parrot bill (*Paradoxornis unicolar*) and Fulvus parrot bill (*Paradoxornis fulvifrons*) (Inskipp, 1989). Otter (*Lutra perspicillata*) found there was the common fish eater mammal of that area.

Adverse Impacts of Dams in riparian ecology

Reduction in fish population and loss of fish diversity and changes in species density occurred due to degradation of natural habitat. Obstruction of movement of some migratory fishes like *Tor putitora*, *Psilorhynchus* spp. and *Garra* spp.(young and adult) cannot cross the dam and may not found the suitable upstream and downstream route which uses the shallow gravel in upstream for spawning and nursery ground. There is reduction of water flow in the stream channel with consequent reduction of living spaces, spawning success, nursery ground and food production zones. Aquatic birds, amphibians, reptiles and some semi aquatic mammals are also affected ecologically. If we construct the dam (reservoir) like Kulekhani (Indrasarovar), it adversely affects the several

Table 1: shows list of the recorded fishes in UTHP and MTHP area of Tamor river.

SN	Scientific name	Local name	Max. length and Wt.	Migratory behavior	Dominancy Season/Area
1	<i>Schizothorax plagiostomus</i> (Heckel) 1838.	Buche Asala	600mm, wt.2kg.	Mid distance	UTHP and MTHP
2	<i>Schizothorax richardsonii</i> (Gray) 1832	Asala /soal	300mm,wt.2 kg	Mid distance	UTHP and MTHP
3	<i>Scizothoraichthys progastus</i> (McClelland) 1839.	Chuche Asala	300 mm	Mid distance	UTHP and MTHP
4	<i>Glyptothorax cavia</i> (Hamilton) 1822.	Tilchapre	175 mm	Can cross Chitubank riffles	UTHP and MTHP
5	<i>Pseudoecheneis sulcatus</i> (McClelland) 1842.	Kabre	175mm	can cross Chitubank riffles	Rainy, MTHP
6	<i>Pseudoecheneis crassicauda</i> (Ng and Edds) 2005.	Kabre			Rainy, MTHP
7	<i>Psilorhynchoides pseudecheneis</i> (Menon and Datta) 1964.	Tite machha	200mm	can cross Chitubank riffles	Bhadra/Asoj/ Kartik) MTHP
8	<i>Noemacheilus elongates</i> (Sen and Nalbant) 1981.	Gadela	-	-	tributaries upto Tapethok
9	<i>Noemacheilus bevani</i> (Gunther)	Gadela	-	Resident	"
10	<i>Botia almorhae</i> (Gray) 1831.	Baghi/ Segna	-	Resident	"
11	<i>Garra gotyla gotyla</i> (Gray) 1832.	Budhuna		Resident	
12	<i>Tor putitora</i> (Hamilton-Buchanan)	Pahela Sahar	1800mm, wt. 48 kg	Long distance	not found in UTHP
13	<i>Tor tor</i> (Hamilton-Buchanan)	Phalame Sahar	1200mm wt. 60 kg	Long distance	not found in UTHP
14	<i>Chupisoma garua</i> (Hamilton-Buchanan) 1822.	Jalkapoor	609mm, wt. 3kg	Long distance	
15	<i>Garra annandalei</i> (Hora1921)	Lohori, Buduna	150mm.	-	MTHP
16	<i>Barilius shacra</i> (Hamilton-Buchanan) 1822.	Fageta	130mm.	-	MTHP
17	<i>Labeo dero</i> (Hamilton-Buchanan) 1822.	-	-	-	MTHP
18	<i>Neolissocheilius hexagonolepis</i> (McClelland) 1839.	Copper Mahaseer	-	-	MTHP
19	<i>Meyrsglanis blythi</i> (Day) 1852.	-	-	Mid dist. endemic	MTHP

Continued

aquatic species and lead to displace or extinction.

In flat basins large dams cause flooding of large tracts of land, destroying local animals and habitats. Large amounts of plant life are submerged and decay anaerobically generating greenhouse gases like methane. It is estimated that a hydroelectric power plant produces 3.5 times the amount of greenhouse gases as a fossil fuel powered thermal power plant. Dams restrict sediments that form the fertile lands downstream and farmers have to use chemical fertilizers to compensate the loss of productivity. Large dams are breeding grounds for mosquitoes and cause the spread of disease.

Farmers downstream who used to wait for the flooding of the fields to plant their seeds are affected. People have to be compelled to change life style and customs. About 40 to 80 million people have been displaced physically by dams worldwide. Dams serve as a heat sink, and the water is hotter than the normal river water. This warm water when released into the river downstream can affect animal life.

Positive impacts of Hydropower on fish diversity and composition

After the study of fish diversity in Kaligandaki –A, Kulekhani and Phewa lake behind Phewa dam, loss of some species in upstream and downstream areas has been seen but no serious depletion has occurred. In Kaligandaki-A HPP, no major changes has been observed in total species diversity as compared to pre and post construction scenario (Shrestha and Chaudhary, 2003). In spite of such defects, several positive impacts were also observed e. g. aquaculture development, caged fishery development in reservoir and employment to local fishermen in dam of Hydropower projects. Employment opportunity and high production of fishes can be done by establishing the nursery of indigenous fishes and releasing the fingerlings upstream and downstream in the project area.

Conclusion

If the mitigation measures are strictly followed, environmental conditions of the river can be maintained more or less similar to the existed condition even after the construction of Hydro

We should strictly follow the aquatic animals conservation acts 2017 B.S. with amendment 1999, to protect the aquatic animals and their habitats. When about 10% water is being released in its natural path and several tributaries are being mixed with the river, HPP will not deteriorate the quality of ecological environment seriously.

Mitigating Measures

- i. More than 10% of total water should be released in its natural path as the legal provision of EPA, 1997.
- ii. New dam sites should be chosen with the environmental impacts in mind to minimize its effects on people and the environment.
- iii. Local people should be led into confidence and must be suitably re-settled.
- iv. Religious monuments of historic significance should be shifted.
- v. Endangered species can be relocated.
- vi. Hatchery should be established and run at its full capacity to implement the open water stocking program so that enough fries can be released upstream and downstream. The livelihood should be involved for hatchery establishment after giving training by skilled technical manpower. Fish trapping and hauling program should be launched at least for project operation period.
- vii. It is cheapest way to maintain the species diversity.
- viii. Monitoring of annual fish diversity and population in dry (April) and wet (Sept. - Oct.) seasons should be done.
- ix. Fish ladder of pool and weir type can be established but it has question of security. Because migratory fishes may trap by fishermen illegally and mass mortality (declination) may occur. So in many countries, it is not recommended.
- x. Awareness of people to protect the environment should be increased through formal and informal education.

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power dam. The density of indigenous species can be sustained by establishment and regulation of hatchery.

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