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Impacts of Damming on Ichthyo-faunal Diversity of Marshyangdi River in Lamjung district, Nepal

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Abstract
A study was conducted to assess the impacts of dam on fish diversity of Marshyangdi River and its tributaries in Lamjung district. Twenty six species of fishes belonging to 5 orders, 6 families and 18 genera were recorded from the different localities. Cyprinidae was the most dominant among the families represented by 53.8% species followed by Cobitidae (23.0%), Sisoridae (7.7%) and Channidae (7.7%) while Anguillidae and Synbranchidae accounted each by 3.9% only. Gut contents of fish species recorded were studied. Site specific presence of fish species indicated that damming on the main river affected the movement of migratory fishes.

***Key words*:** Fish diversity, migratory fish, cobitidae, dam impacts, food items, Lamjung

Introduction

Nepal is a small land linked country possesses 2.27% of the water resources in the world has great potential for hydropower generation (Rai, 2008; Gubhaju, 2012). Most of the river systems in Nepal are the shelter of 217 indigenous fish species (Shrestha, 2008). The aquatic lives of the precious water resources of the nation are mostly threatened when compared with other ecosystems (Rai, 2008). Marshyangdi River is one of the hydropower potential rivers owing its gradient topography that extends from Himalayas region to terai region. The Middle Marshyangdi hydro-electric concrete dam is situated at Phalia Sangu of Lamjung district.

Lamjung district is located at the northeastern corner of the western development region of Nepal. It has subtropical climate at an average altitude of 776 msl. This region is drained by feeder streams of Majuwa, Dordi, Paundi, Naundi and many small feeder streams that finally join into Marshyangdi river. The Marshyangdi river runs 153 km then joins with Trisuli river at Muglin bazaar. This river originates in the Himalayas at an altitude of 6400 m and average slope of this river is 0.0417 m (Shrestha, 1999). Ichthyo-faunal diversity refers to the variety of fish species; depending on context and scale, it could refer to alleles or genotypes within fish population to species of life forms within a fish community and to species or life forms across aqua regimes (Burton *et al.*, 1992).

Site specific negative impacts of dams in different river systems in the world and Nepal have been reported (Agostinho *et al*.,

2008; Rai, 2008; Shrestha, 2008; Gubhaju, 2012; Sarkar *et al*, 2012). The damming operation should require harmonious technologies to sustain fish diversity (Jha *et al*., 2007). Development of appropriate technologies would be challenging for native fish conservation, general awareness, inclusion of academic courses in education (Gurung, 2012). Fish fauna are the part of National Biodiversity Conservation Strategy of Nepal (HMG/MFSC, 2002). For conservation of aquatic animals including fish, the government has promulgated Aquatic Animal Conservation Act 2005 with amendment 2001. The Act prohibits indiscriminate killing of fish and aquatic animals by unconventional methods. According to the ordinance, certain fish has been banned to be captured during the spawning season. In near future, hydropower and irrigational dams with interference to conservation of fish and fisheries would be challenging.

This paper aims to classify different fishes and their feeding behaviors. It also aims to highlight on conservation aspects of migratory fishes and damming effects and how damming has disrupted breeding habitats in Marshyangdi River.

Materials and methods

The study area along the Marshyangdi River (Fig. 1) was divided into five different localities based on abundance of fishes at confluence site of feeder streams. They were (I) North-eastern bank of Marshyangdi river at Vulvule, (II) Majuwa and Marshyangdi confluence at Besisahar, (III) Marshyangdi and Dordi confluence at Phalia sanghu, (IV) Paundi and Marshyangdi confluence at Paundi bazaar and (V) Chepe and Marshyangdi confluence at Dhameli kunwa, all lie in Lamjung district. They were visited seasonally from September 2010 to July 2011 (after the construction of middle Marshyangdi dam), to collect fish fauna of that region.

Fishing was carried out in all sampling sites with the help of locally hired fishermen. Fishes were collected with cast net and gill net. At each site, these gears were used at least ten times during each sampling event. Fishes were also collected from local market. The foregut (about 10 cm to esophagus) contents were removed from the specimen of all 26 species within 4 hr of harvest and transferred into a sterile petri-dish and viewed under a compound microscope of 10x, 40x magnifications for identification of planktons (phytoplankton and zooplankton). Planktons were analyzed according to the system developed by (Xie, 1999; Goswami, 2004; APHA, 2005; IOC, 2010). Breeding and spawning periodicity of fishes were confirmed by applying pressure on abdomen towards the genital aperture, dissection and fisherman field survey report.

Fish specimens were preserved in 10% formalin. Ecological features of the fish habitat and color of fish species were recorded throughout collection. The large specimens were incised lengthwise along the abdomen while the smaller ones were directly put into the formalin. The fish were kept upside down to avoid any damage to caudal fin in the container. For species identification, counts of lateral line scales and fin rays as well as measurement of body were made according to the system developed by Shrestha (2008). The identified specimens were preserved and kept with proper labeling in the laboratory of Lamjung Campus. The catch composition of individual fish was determined using following formula.

$$\text{Catch composition by number (\%)} = \frac{\text{Total catch of an individual species}}{\text{Total catch of all species}} \times 100$$

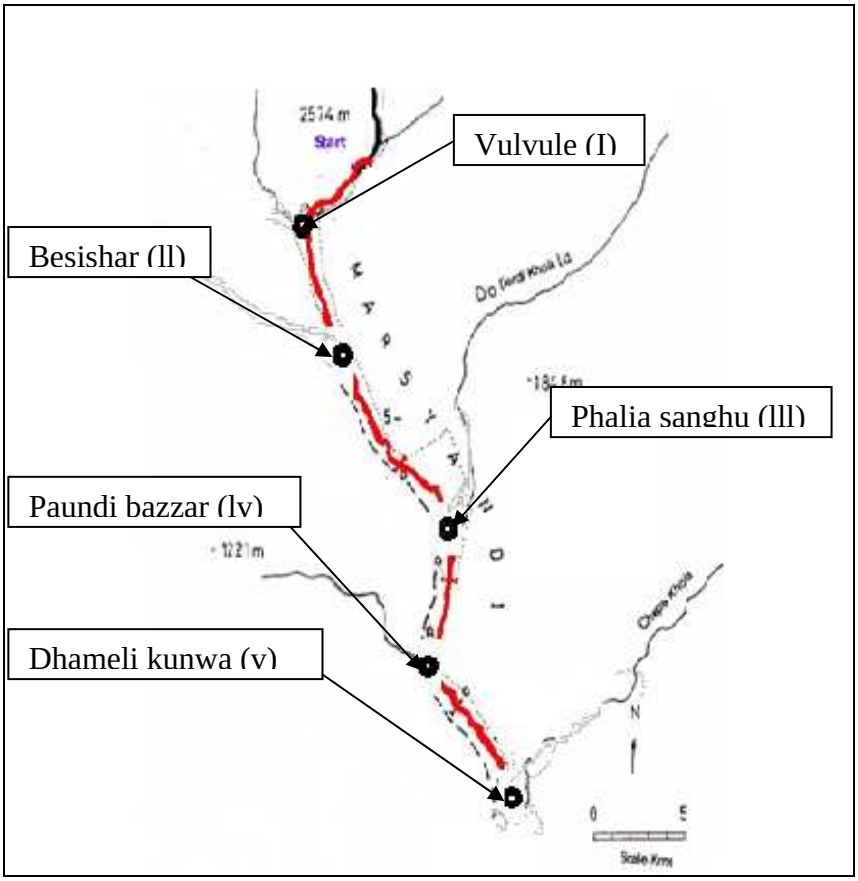

Figure 1. Map of the Marshyangdi river system of Lamjung. ● (Black dot) = Fish sampling points.

Results

A total of 26 species of fishes belonging to 5 orders, 6 families and 18 genera were recorded from the different localities of Marshyangdi river system in Lamjung district. Cyprinidae were most dominant group among the families represented the highest number of species (53.8%) followed by Cobitidae (23.0%), Sisoridae (7.7%) and Channidae (7.7%) while Anguillidae and Synbranchidae accounted each by 3.9% (Fig. 2). Systematic position of the fishes,

local names and occurrence, status and abundance are listed in the table 1. Large numbers of fishes were recorded in locality 4th and 5th (58% to 50%) of the Marshyandi River (Tab. 1, Fig. 3) than dam-affected area of section 1st, 2nd and 3rd (15%, 23% and 42%). Laboratory studies of gastro-intestinal contents of phytoplankton and zooplankton and feeding behavior and spawning periodicity of fishes are listed in table 2. Migratory fishes like *Anguilla bengalensis* and short migratory fishes like *Cprinion semiplotus* and *Mastacembelus* armatus were rarely found in Marsyangdi River.

Discussion

In the assemblage structure cyprinids constituted the major group. Marked differences were evident between fish assemblages at the different sampling points during the study. Different water flows have direct influence on the population of *Anguilla bengalensis*, *Tor putitora* and *Neolissochilus hexagonolepis* in upper section of dam (locality I and II).

Dam significantly blocks nutrient flow (Welcomme, 1985) throughout the ecosystem affecting fisheries production in downstream owing reduction in water flow in winter season; hence fries, fingerlings and adult of migratory and residential fishes will be affected. Aquatic ecology and river biology from both upstream and downstream has been affected by damming as well as water quality, quantity and breeding grounds (Helland-Hansen *et al*., 1995). Hydropower generation enhances the development of the nation, but the river ecosystems are adversely affected especially to the fish species by damming which changes water quality (Shrestha, 2008). Mahaseer or Sahar (*Tor tor* and *Tor putitora*), Rajbam (*Anguilla bengalensis*) are long range migratory fishes that cannot move up and down the closure of dam. Overexploitations, water pollution, destruction of habitat, low water level and flow modification have been categorized as the ultimate forcing factors that threaten global freshwater biodiversity (Naiman *et al*., 1995; Jackson *et al*., 2001; Malmqvist and Rundle, 2002; Rahel, 2002; Dudgeon *et al*., 2006).

Impact of dam on fish species

The Middle Marshyandi hydro dam extends near about more than 10 km and is situated by the side of Dumre-Besisahar road at about 33 km north-east from Dumre Bazar. Dam situated at Phalia Sangu in Lamjung District is a 55 m high of concrete dam constructed across the Marshyangdi River.Water represents one of the main resource opportunities for developing electric power generation for Nepal's future economic development (Jha and Chaudhary, 2003). The dam in Marshyangdi River has obstructed the seasonal migratory fishes from the Terai as well as local migratory fishes from the lower parts of Hilly region. According to the local people and fishermen, before the establishment of dam in the river, shoals of Gounch (*Bagarius bagarius*) and Thedi (*Labeo angra*) used to visit the areas above dam, and now they are completely disappeared. A continuous flow of water is regulated to the downstream from the dam. Many current loving species of fishes cannot migrate upstream because of physical barrier of the dam. Generally, discharge of water altering water volume influence composition of fish species especially migratory fishes (Agostinho *et al.*, 2008). Long distance migratory fishes like *Tor putitora*, *Anguilla bengalensis*,

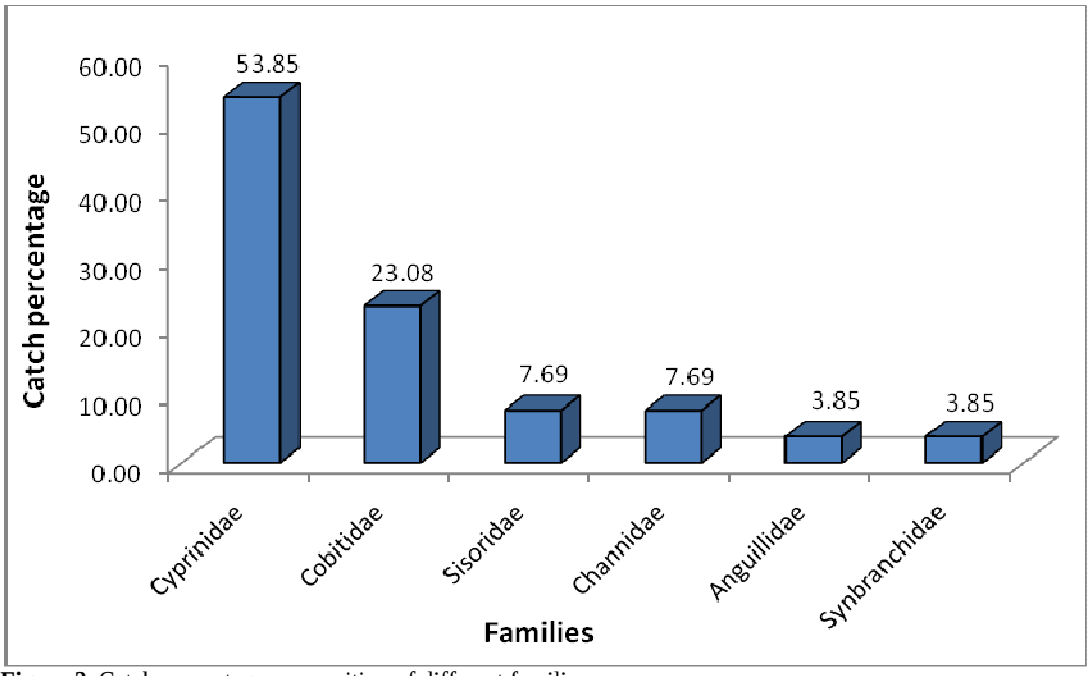

Figure 2. Catch percentage composition of different families.

Table 1. Systematic position, status and abundance of fishery resources in the different localities of Marshyangdi River.

Systematic position	**Local name**	**Status**	**Abundance**
A. Order: Cyriniformes Division: Cyprini Family: Cyprinidae Sub family: Cyprinini			
Genus:***Neolissochilus* Rainboth**			
1. *Neolissochilus hexagonolepis* (McClelland)	Kate	Migratory	Common in IV, V.
Genus: *Labeo* Cuvier			
2. *Labeo boga* (Hamilton-Buchanan)	Thike	Short distance migratory	Common in IV, V
3. *Labeo dyocheilus* (McClelland)	Gardi	Short distance migratory	Common in IV, V
Genus: *Tor* Grey			
4. *Tor tor* (Hamilton-Buchanan)	Sahar	Migratory	Common in II to IV
5. *Tor putitora* (Hamilton-Buchanan)	Sahar	Migratory	Common in II to IV
Genus: *Chagunius* Smith			
6.*Chagunius chagunio* (Hamilton-Buchanan)	Pathar chati	Short distance migratory	Common in IV,V
Genus: *Cyprinion* (*Semiplotus*) Bleeker			
7. *Cyprinion semiplotus* (McClelland)	Chepti	Short distance migratory	Rare in IV, V
Sub family: Schizothoracinae			
Genus: ***Schizothorax* Heckel**			
8. *Schizothorax molesworthi* (Chaudhari)	Chuche asla	Short distance migratory	Common in I to III

9. *Schizothorax richardsonii* (Grey)	Buche asla	Short dist. migratory	Common in I to III
Genus: ***Schizothoraichthys*** **McClelland**			
10. *Schizothoraichthys progastus* (McClelland)	Chuche asla	Short distance migratory	Common in I to III
Sub family: Danioninae (Rasborinae)			
Genus: ***Barilius*** **Hamilton**			
11. *Barilius barna* (Hamilton-Buchanan)	Tite	Non migratory	Common in III to V
12. *Barilius bendelisis*(Hamilton-Buchanan)	Fageta	Non migratory	Common in IV,V
13. *Barilius vagra* (Hamilton-Buchanan)	Fageta	Non migratory	Common in IV,V
Genus: *Danio* Hamilton-Buchanan			
14. *Danio aequipinnatus* (McClelland)	Bhite	Non migratory	Rare in IV,V
Family: Cobitidae			
Sub family: Nemachilinae			
Genus: *Schistura* (*Nemachilus*) McClelland			
15. *Schistura beavani* (Gunther)	Gadela	Non migratory	Common in III, IV
16. *Schistura rupecula* (McClelland)	Gadela	Non migratory	Common in III to V
Genus: *Acanthocobotis* Peter			
17. *Acanthocobotis botia* (Hamilton-Butchanan)	Gadela	Non migratory	Common in III, IV
Sub family: Garrinae			
Genus: *Garra* Hamilton			
18. *Garra gotyla* (Gray)	Buduna	Short distance migratory	Common in III to V
19. *Garra annandalei* (Hora)	Buduna	Short distance migratory	Common in III to V
Genus: Crossocheilus Kuletvan Hasselt			
20. *Crossocheilus latius* (Hamilton-Buchanan)	Besuro	Local migrants	Common in IV,V
B. Order : Siluriformes			
Family: Sisoridae			
Genus: *Glyptothorax* Blyth			
21. *Glyptothorax pectinopterus* (McClelland)	Nakato	Short distance migratory	Common in III,IV
Genus: *Pseudecheneis* Blyth			
22. *Pseudecheneis sulcatus* (McClelland)	Kabre	Short distance migratory	Common in IV to V
C. Order: Anguilliformes			
Family: Anguillidae			
Genus: *Anguilla* Shaw			
23. *Anguilla bengalensis* (Gray)	Rajbam	Migratory	Rare in IV to V
D. Order: Perciformes			
Family: Channidae			
Genus: *Channa* Gronovius			
24. *Channa orientalis (Bloch and Schneider)*	Hile	Short distance migratory	Common in III to V
25. *Channa punctatus* (Bloch)	Hile	Short distance migratory	Common in III to V
E. Order: Synbranchiformes			
Family: Synbranchidae			
Genus: *Mastacembelus* Scopoli			
26. *Mastacembelus armatus* (Lacepede)	Chuche Baam	Short distance migratory	Rare in IV to V

Locality I = Vulvule, locality II = Besishar, locality III = Phalia sanghu, locality IV = Paundi and locality, V = Dhamelikunwa

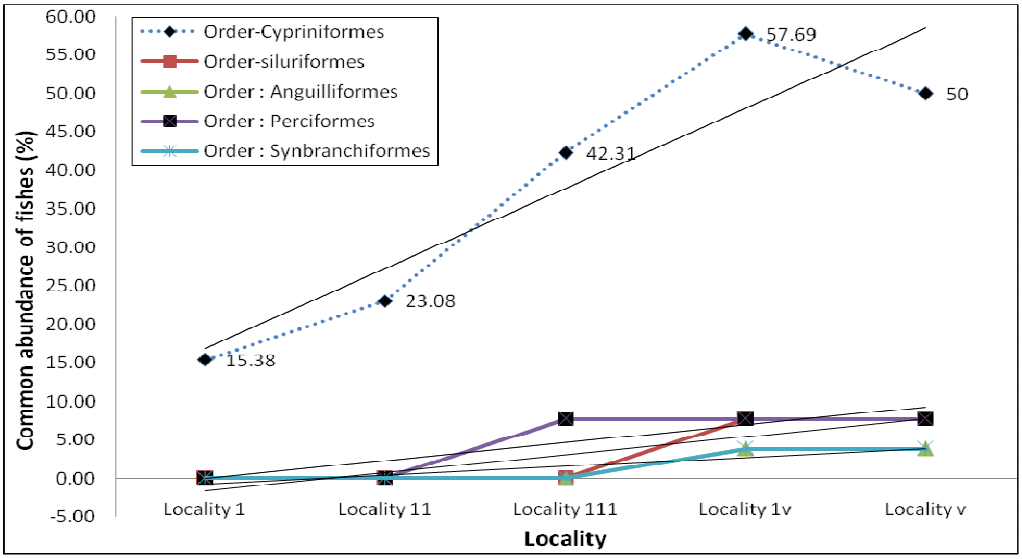

Figure 3. Abundance of fishes (%) in different localities.

Table 2. Laboratory study of gastro-intestinal contents of fishes

S.N.	Name of species	Gastro-intestinal contents		Spawning period
		Phytoplankton	Zooplankton	
1	*Neolissochilus hexagonolepis*	*Spirogyra*, *Oscillatoria* etc.	*Branchionus,polyarthra*, etc.	Spawning period rages from Sep. to Oct.
2	*Barilius barna*	*Spirogyra*, *Chlorella*, *Oscillatoria* etc.	*Diaptomus*, *Daphnia*, *Cyclops* etc.	April. To Aug.
3	*Barilius bendelisis*	*Spirogyra*, *Chlorella*, *Oscillatoria* etc.	*Ephimera*, *Diaptomus*, *Daphnia* etc.	July to August.
4	*Barilius vagra*	*Spirogyra*, *Oscillatoria* etc.	*Diaptomus*, *Daphnia*, Cyclops larva etc.	July to Sep.
5	*Chagunius chagunio*	*Spirogyra*, *Oscillatoria* etc.	*Polyarthra*, *Filina* species.	Aug. to Sep.
6	*Crossocheilus latius*	*Spirogyra*, *Chlorella*, *Oscillatoria* etc.	0	March To April.
7	*Danio aequipinnatus*	*Spirogyra*, *Oscillatoria* etc.	*Diaptomus*, *Daphnia* etc.	July to August.
8	*Garra annandalei*	*Spirogyra*, *Oscillatoria*, *Volvox* etc.	*Polyarthra*, *Filina*,*Branchionus* species.	May To June.
9	*Garra gotyla*	*Spirogyra*, *Oscillatoria*, *Volvox* etc.	*Polyarthra*, *Filina*,*Branchionus* species.	May To June.
10	*Labeo boga*	*Spirogyra*, *Oscillatoria*, etc.	0	June to August.
11	*Labeo dyocheilus*	*Spirogyra*, *Oscillatoria*, etc.	0	June to August.
12	*Cyprinion semiplotus*	*Oscillatoria*, *Vallisnaria* etc.	*Penaeus*, *Anax* etc.	June To July.
13	*Tor putitora*	*Spirogyra*, *Oscillatoria*, etc.	*Branchionus,polyarthra*, *Branchionus* etc.	Sep. to Oc.

14	*Tor tor*	*Spirogyra, Oscillatoria,* etc.	*Branchionus,polyarthra,* fishes.	Small Sep. to Oc.
15	*Schizothorax molesworthi*	*Spirogyra, Chlorella, Oscillatoria* etc.	0	Breeds twice a year, Oct. to Dec. and June. to March.
16	*Schizothoraichthys progastus*	*Spirogyra, Chlorella, Oscillatoria* etc.	0	Breeds twice a year, Oct. to Dec. and June. to March.
17	*Schizothorax richardsonii*	*Spirogyra, Chlorella, Oscillatoria* etc.	0	Breeds twice a year, Oct. to Dec. and June. to March.
18	*Schistura. beavani*	*Spirogyra, Chlorella* etc.	*Cyclops, Anax, Hemiptera* etc	April to May.
19	*Schistura rupecula*	*Spirogyra, Oscillatoria* etc.	*Pheritima, Hamiptera, Anax* etc.	July to August.
20	*Acanthocobotis botia*	*Spirogyra, Oscillatoria* etc.	*Pheritima, Hamiptera, Anax* etc.	May to June.
21	*Glaptothorax pectinopterus*	0	*Diaptomus, Daphnia*, Cyclops etc.	March to July.
22	*Pseudecheneis sulcatus*	0	*Anax*, *Ranatra*, Cyclops etc.	May to June.
23	*Anguilla bengalensis*	*Oscillatoria*, decaying matter.	Crustaceans and small fishes.	July to August.
24	*Channa orientalis*	0	*Ephimera, Penaeus,* small fishes etc.	June to August.
25	*Channa punctatus*	0	*Ephimera, Penaeus,* small fishes etc.	June to August.
26	*Mastacembelus armatus*	*Oscillatoria*, decaying matter.	Crustaceans and small fishes.	It breeds July to August.

Mastacembalus armatus are rarely found in Marshyangdi River. Localities I, II, III, IV and V constituted 15%, 23%, 42%, 58% and 50% fishes respectively which indicated that less number of fishes occurred due to damming effect in upper sections of the river (Fig. 3).

Socioeconomic impact on local fishermen community

Several ethnic groups like Kami, Damai, Sarki, Kumal, Majhi, Gayane etc. residing at the river bank adopt fishing as their traditional profession. These fishing communities are very poor, uneducated and highly vulnerable; so their livelihood is highly affected by heavy decline of fish catch after the hydropower projects.

Recommendations

Following recommendations are suggested:

- Development of fish ladder especially for the population of cold water fishes like *Schizothorax* spp, *Tor* spp, *Neolissochilus hexagonolepis* and other migratory fishes (*Anguilla bengalensis*) are affected by the dam.
- Maintenance of fish population by constructing spawning channel or stocking with hatchery-produced fish seeds.
- Establishment of international coldwater center in Nepal to carry out programs of research, conservation and development of coldwater fishery of the Himalayan region.

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