

**ENVIRONMENTAL IMPACT ASSESSMENT
(SPECIAL INVESTIGATION)
ON
HYDROPOWER DEVELOPMENT OF
AYEYAWADY RIVER BASIN ABOVE MYITKYINA,
KACHIN STATE, MYANMAR**

Biodiversity And Nature Conservation Association (BANCA)



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**Report on Survey of
Aquatic Ecological Conditions and Mitigation
Measures of Hydropower Development of
Ayeyarwaddy River Basin above Myitkyina.**

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ABSTRACT

A survey on aquatic ecological conditions in the EIA (Environmental Impact Assessment) for the project of hydropower development in Ayeyarwaddy River basins above Myitkyina, Kachin State was carried out from January 2009 to June 2009. The surveyed areas were Lasa on Mali Hka River, Yenam, Kaunglanghpu, Pisa, Wusok and Chibwe on May Hka River and 5.4 kilometers downstream from the confluence of May Hka River and Mali Hka River, locally known as Myitsone, on Ayeyarwaddy River. The data were collected from the main rivers and its' tributaries within 10 kilometers range upstream and downstream from the dam sites. Data of the lowest dam, Myitsone and the farthest dams, Lasa and Yenam covered more than 20 kilometers range from the dam sites to find out suitable habitats for the migratory fish. Preliminary survey results of the aquatic ecological conditions, aquatic organisms and fish species check list are described. The possible impacts on the aquatic ecosystem including economically important fish species, aquatic organisms and aquatic environmental conditions are predicted. Because of the dams, the aquatic ecosystem of the flooded areas will change and some of the economically important migratory fish will be lost in some parts of the main rivers. On the other hand, valuable benefits of regional aquaculture after dam construction are discussed in general. Due to the essential of dam construction for the development of the region, mitigation measures and recommendations are also described to reduce the impact on the environment and biodiversity. The prioritized action of mitigation measures on the aquatic biodiversity of this region needs to be undertaken immediately in collaboration with international institutions.

1. INTRODUCTION

Dams have been constructed on the rivers for the benefit of saving the people since ancient times. They generally serve the primary purpose of retaining water, while other structures such as floodgate or dikes are used to manage or prevent water flow into specific land regions. Water resources can be profitably utilized for power generation, irrigation, flood control, domestic uses, aquaculture and recreational fisheries. Among them, hydropower development has become the most attractive as a reliable, cheap, green and safe energy source. Hydropower and hydroelectricity are often used in conjunction with dams to provide clean electricity for development of the regions and millions of consumers. Conversely, many people have suffered and a lot of environmental damage has occurred as a consequence of dam construction.

Reservoirs of the dams permanently flood extensive natural habitats, with local and even global extinctions of aquatic organism, terrestrial animal and plant species. One occasional exception to this rule is that shallow reservoirs in dry zones can provide a permanent oasis, sometimes important for migratory waterfowl and other terrestrial and aquatic fauna.

Storage dams alter the natural distribution and timing of stream-flow. They compromise the dynamic aspects of rivers that are fundamental in maintaining the character of riverine aquatic ecosystems. Richness of species in the rivers depends on the function of the flow, the quantity of the sediment in the river, and the character or composition of the materials that composed the bed and banks of the river. The river discharge includes both high- and low-flow elements. These dynamics determine a river's physical foundation, which in turn ensures ecosystem integrity. The extent of impacts will also depend on whether water is extracted or diverted for consumption, or left in-stream. Loss of system dynamics, loss of the ability to maintain continuity of an ecosystem, introduction of non-native species and modified water quality (temperature, pH, oxygen and chemical composition) result in ecological modification in the river systems. The establishment of a new dynamic has positive effects on some species and negative effects on others.

As a physical barrier, the dam disrupts the movement of species leading to changes in composition of upstream and downstream species and even loss of the species. River-dwelling species have several migratory patterns. These include anadromous fish such as salmon and catadromous fish such as eels. Adults of the anadromous fish migrate upstream of the rivers to spawn and the young descend to the sea. Catadromous fish spawn in the sea and the young migrate upstream of the rivers. Many freshwater fish species move upstream of rivers or tributaries to spawn. Dams block these migrations to varying degrees. Migratory fish require different environments for the main phases of their life cycle such as reproduction, production of juveniles, growth, and sexual maturation.

The blockage of sediment and nutrients, the re-regulation of stream-flow, and elimination of the natural flood regime can all have significant, negative effects on downstream fisheries. Substantial losses in downstream fishery production as a result of dam construction have been reported globally. Along with subsistence agriculture, fisheries constitute an important livelihood activity among large rural populations in the developing countries. Many of these households depend on fisheries either as a primary or supplementary source of livelihood.

Dams can enhance some riverine fisheries, particularly tail-water fisheries immediately below dams that benefit from discharge of nutrients from the upstream reservoir. Productive reservoir fisheries often follow from dam construction, although they are not always anticipated as a part of project design proposals. Mitigation or compensation

measures have been used to reduce the impacts of changes in fisheries. Compensation measures must be implemented such as establishing fish hatcheries and stocking programs to reproduce the productivity of the fishery.

The dominant aquatic ecosystem of the rivers of surveyed area is lotic ecosystem (rapidly moving water). Damming any specific area along the river will change from lotic to lentic aquatic ecosystem (slow moving water). The ecosystem of a river is governed by many factors such as rainfall, melting of snow and ice, soil characteristics, vegetation and land use. These factors influence ecological parameters of aquatic ecosystem such as temperature, pH, conductivity, turbidity, chemical compositions of the water as well as composition and distribution of aquatic organisms.

Rainfall and melting waters from snow and ice govern water depth, soil erosion, water transparency, water temperature and even flow rate of the water. The rainfall of study area is high because of receiving south west monsoon wind and the wind from South China Sea. The surveyed areas are situated in Kachin State where the mean rainfall within 10 years (1999-2008 in Putao, Machanbaw and Myitkyina) was approximately 3347.88 mm. The highest rainfall was in Putao, 4696.69 mm., and the lowest was in Myitkyina, 2143.98 mm. In Putao, there is rain every month and mean rainy days are about 168 days/annum. The mean of rainy days in Myitkyina is about 106 days and there is rain every month except in December and January.

The environments of surveyed areas are covered with mountains of various heights, folded ranges and valleys. Most of the mountains and valleys are covered with various forest type especially secondary forests a result of long term shifting cultivation by local people. Some areas near the villages have terrace farms where permanent cultivation of rice and vegetables is found. Land slides have been observed near shifting cultivation along the rivers.

The surveyed areas are situated in the mountainous regions of the far eastern Himalaya mountain range. The prominent physical characteristic of the river in the region is high velocity flow in most parts of the river. Most of the parts of surveyed areas are characterized by a multitude of small streams and rills to large tributaries, with a very steep gradient. The fast-flowing water transports a considerable amount of eroded material downstream, where it is deposited on floodplains in the form of an alluvial.

The river bank is also steep where boulder and gravel are common environments for most of the parts. Gravel and pebble bottoms are also common. In some parts of the rivers where there is low flow areas with sandy bottoms are found. The speed of fast flowing river water is a key factor in the development of biological organisms. Fast flowing water sweeps the plankton population continuously which is an important food for aquatic organisms. In addition to lower temperature, water velocity constitutes an important factor for composition and distribution of fish species in the survey areas. The damming of the rivers will change this species composition and distribution.

The chemical and physical parameters also depend on the characteristics of water and bank condition. The concentration of the chemical constituents and the physical properties of water depend on the flow of water. The river basin of surveyed areas has low population density, with low irrigation intensity. Therefore, there are no major sources of organic pollution from agricultural farms. Most of the residents in the area use water from adjacent rivers and streams without disinfecting.

Colour of water of Mali Hka is more turbid than May Hka and Ayeyarwaddy. In the regions of May Hka above Chibwe, the upstream water is very clear compared to the downstream. The most prominent feature of the region is the various forms of gold mining from the river bed and banks. This is found from Putao to Myitsone confluence

(local name for the confluence of May Hka and Mali Hka) in Mali Hka, from Chibwe to Myitsone confluence in May Hka and down stream from the Myitsone confluence to Myitkyina. This is the most important business and employment for the local people in this region. Because of this business, coloration of the river water is turbid with heavy concentration of sand especially in Mali Hka. Local people say that mercury is the main chemical used in the gold purification process.

A significant turbidity was found in Ngawchang Hka, one of the major tributaries of May Hka at Chibwe dam area, which has been caused by heavy concentration of silt in the water. Due to the information from local people, this problem has started 3 years ago probably caused by the discharge of factory effluents upstream of the tributary. The problem of the water from this tributary starts in the region of agricultural farms and farmed animals such as cows.

The fundamental requirement of aquatic organisms is composition of nutrients in the water. Nutrients are taken up by primary producers such as phytoplankton, phytobenthos and algae. Important autotrophic organisms in aquatic environment are primary producers that generate organic compounds from inorganic materials or nutrients contained in the water. They use solar energy to generate biomass from carbon dioxide and nutrients in the water. Primary consumers such as zooplankton and herbivores, heterotrophic organisms, consume autotrophic organisms and use the organic compounds in their bodies as energy sources and raw materials to create their own biomass. The biomass created by these primary producers is important for the community because it is transferred to higher trophic levels such as secondary consumers (carnivores and omnivores) and tertiary consumers (higher rank carnivores and omnivores) via consumption. Therefore, any changing of nutrient composition in the aquatic ecosystem will severely effect the composition and distribution of aquatic organisms in any areas. In the aquatic food web or food cycle, changing or destruction of any steps along the linkage will affect the successive steps distinctly.

Aquatic organisms are highly dependent upon the characteristics of their aquatic habitat which supports all their biological functions. Any change of their environment will affect their biological responses to the environment prominently. This dependence is most marked in migratory fish which requires different environments for the main phases of their life cycle such as reproduction, production of juveniles, growth and sexual maturation. The migrants have to move or migrate from one environment to another regularly in order to survive in their life span. Damming will change the ecosystem and affect not only the aquatic organisms but also serve as a major obstacle for the migrants along the river, fish biodiversity and local fishing communities.

The building of a dam generally has a major impact on the density and distribution of fish population. Fish migrations and other fish movements can be stopped or delayed. The quantity and accessibility of their habitat, which plays an important role in population sustainability, can be affected. Fishes can suffer physical trauma during their transit through hydraulic turbines or over spillways. Changes in discharge regime or water quality can also have indirect effects upon fish species. Increased upstream and downstream predation on migratory fish is also linked to dams. Because of the dam, fish movement slows down and concentrates below and above the dam making them easier prey to certain predatory species.

Capture fishery is not a major profession and culture fishery is also not developed in this region. Due to increasing population and poverty, most of the local people living in this area undertake seasonal works such as shifting cultivation in the paddy season and fishing and hunting in the other seasons. Most of the families in these areas possess various tools such as farming and hunting apparatus and fishing gears for their

livelihood. Major threat for fishery found in the region is uncontrolled dynamite fishing along the rivers and tributaries. Although dynamite fishing is banned by fisheries regulation and laws, the local people use this method extensively because it is easy in fast flowing water. Using small mesh size nets and fishing even in the banned season are common in this area. All of these due to poor knowledge of the local people on the importance of environmental conservation.

No record is available on the aquatic ecology of surveyed areas except for a few fish identification list from Myitkyina, Putao fish markets and nearby townships along the Ayeyarwaddy River. There is no record on snow trout which is distinct cold water species in surveyed areas, until now. These fishes are very important in Trans-Himalayan countries as a game fish for recreational fishery as they fetch a good price for their excellent taste. WWF (World Wildlife Foundation) considered the eastern Himalayan region as a global biodiversity hotspot, where many species groups have been inadequately studied due to its remote location. New records of fish species and aquatic organisms along this project are very valuable not only locally but also internationally from the biodiversity point of view.

2. BRIEF LITERATURE REVIEWS OF DAM IMPACT ON AQUATIC ECOSYSTEM

The only one literature available on EIA on aquatic ecological condition on dam project in Myanmar is Tamanthi Dam, Hydropower and Multipurpose Project, Statement of Biodiversity Impact (2006) (A Rapid Assessment). The report pointed out that dams usually cause fragmentation of ecosystems. Dams not only alter the pattern of downstream flow (i.e. intensity, timing and frequency) they also change sediment and nutrient regimes and alter water temperature and chemistry. Dams disrupt dynamic processes and so have an impact on the ecological integrity of natural systems.

Human started to build dams and canals a long time ago and this influenced the natural flow regime. In 2600 BC, the first large dam (14 meters height, 113 meters crest length) was built at Sadd et Kafara in Egypt in the Garawi ravine facing Memphis (Schnitter, 1994). Dam construction and reservoir itself has variable impacts such as social, economical, geophysical as well as impacts on water quality, climate, flora and fauna. These impacts are related closely to each other. From all these, impacts on fish should be observed in more detail. Fish is important to our society not only as a living being but also as a basic food for thousands of years and fishing is a sport or recreational activity for a lot of people (Horvath et. al., 1998).

Human population growth and increased water usage are placing greater demands on the world's freshwater supplies (Postel, 2000). Consequently, alterations in the hydrologic regime due to structural and operational measures such as dam construction and associated water diversion, exploitation of groundwater aquifers, stream channelization and inter-catchment water transfer are producing global-scale effects on the environment (Rosenberg et al., 2000).

Dams represent a major cause of disruption in natural river flows which are built to store water, to compensate the water level fluctuation, or to raise the level of water upstream, either to increase hydraulic head or to divert water into a channel. The storage capacity allows dams to generate electricity, to supply water for agriculture, industries and municipalities, to mitigate flooding and to assist river navigation (Rosenberg et al., 2000).

Large dams and river diversions have proven to be primary destroyers of aquatic habitat, contributing substantially to fisheries destruction, the extinction of species and

the overall loss of ecosystem services on which human economy depends (Postel, 1998).

Some effects after the dam construction are immediate and obvious, for example dams obstruct migration pathways for fish, and reservoirs act as a sediment trap. Other effects are gradual and subtle, making them difficult to predict (Nilsson and Berggren, 2000).

The biodiversity of aquatic fauna is affected after dam construction because the natural seasonal flow patterns to which it is adapted are altered, normal seasonal migration paths are blocked and populations are therefore fragmented (Dudgen 2000). Although dams with spillways allow the passage of migratory biota, macrofauna abundance upstream of the dams is lower than in river reaches downstream of dams or in comparable reaches without dams (Conception and Nelson, 1999). Sometimes, low-head dams may act as a bottleneck, increasing the density of upstream migrating animals below the dam, attracting a large number of predators and, therefore, resulting in increased mortality among the migratory species (Benstead et al., 1999).

As riverine landscapes depend to a high extent of natural disturbances, the seasonal hydrological dynamics are crucial for maintaining ecological integrity (Junkwirth et al. 2002). Flood control by levees, land drainage, river bed dredging, river regulation by dams and various alterations of the natural hydrological regimes isolate rivers from their floodplains and have been the major factors in physical habitat degradation (Petts 1996). Flood-dependent fishes migrate regularly between the river channel and the inundated floodplain for spawning and feeding (Welcomme, 1979) and some invertebrates also exhibit movements between the channel and floodplain water bodies as part of their life cycles (Sodetstrom, 1987).

Anthropogenic impacts on riverine landscapes such as damming, dredging, channelization, disrupt natural disturbances regimes and truncate environmental gradients will effect severely on the migratory species (Ward and Stanford, 1989). Environmental gradients lead to high levels of spatio-temporal heterogeneity such as movements and migration also contribute to high biodiversity levels over an annual cycle (Ward, 1998). Ecosystem management, therefore, becomes a problem of re-establishing the environmental gradients, re-establishing the ecological connectivity between landscape elements and reconstitutes some semblance of natural dynamics (Ward, 1998).

Many morphological and hydrological alterations in the river resulted in irreversible damage of riverine ecosystems (Bloesch and Sieber, 2002). Therefore, when evaluating the effects of dams or other anthropogenic disturbances, it is important for managers to have a good understanding of the ecology of the specific rivers they are managing. Collaboration with biologists, which can provide information about river flora and fauna (e.g. life-cycle, reproduction, feeding patterns, migration, habitat requirements), can offer useful tools for mitigation of negative effects of dams or reservoirs construction.

Larinier (2000) discussed that the construction of a dam on a river can block or delay upstream fish migration and thus contribute to the decline and even the extinction of species that depend on longitudinal movements along the stream continuum during certain phases of their life cycle. Mortality resulting from fish passage through hydraulic turbines or over spillways during their downstream migration can be significant. Experience gained shows that problems associated with downstream migration can also be a major factor affecting anadromous or catadromous fish stocks. Habitat loss or alteration, discharge modifications, changes in water quality and temperature, increased predation pressure as well as delays in migration caused by dams are significant issues.

Adams (2000) proposed that dams impact fish in three ways. Firstly, dams can affect the physical stability of river channels. River bed degradation downstream of dams can also lead to the loss of important in-stream spawning grounds for fish. Secondly, dams can affect fisheries through impacts on water quality. Declines in water quality can have significance for human health, and for the economies dependent on the natural resources of the river. Water released from low outlets in a dam (e.g. turbines) tends to be cold and may be deoxygenated, or rich in hydrogen sulphide. Thirdly, and most importantly, dams affect fishing communities by changing natural flooding patterns. In temperate rivers there is a relatively detailed understanding of the impacts of dams on migratory game fish, and the development of responses in dam design (e.g. fish ladders), dam operation (the release of artificial floods) and downstream river management (e.g. in-stream, flow diversion structures) to minimize adverse impacts of control on fish stocks. Knowledge of the impacts of dams on fisheries in tropical rivers is not complete.

In the dams, fish such as snow trout, catfish and loaches may be pulled into the intakes and get killed. Even riverine fish adapted to fast current may be lost. Fish food organisms will be highly affected by reduced flow rates and new species will invade areas with a slow current. Golden and copper mahaseer are known to be affected directly by the changes in their habitat, which leads to stunted growth, diseases and parasite infestation and increased mortality (Petr and Swar, 2002).

Reduced winter flows after damming would probably have impacts on aquatic ecology and water quality in large part because the river's pollutant load would be less diluted and thus more concentrated. This could result in widespread die-off of species and long-term replacement of desirable species with less desirable but more pollution tolerant organisms (Kondolf and Hou, 1998).

Gubhaju (2002) discussed that cold water fish of Nepal are facing problems due to an increasing number of hydropower projects. Abundant indigenous fish stocks have been declining due to overfishing, harmful fishing practices (electrofishing, dynamiting, chemical usage), pollution and developmental works. Developmental works such as river damming have a major impact on river ecology, aquatic flora and fauna, including fish. Cold water fish of Nepal are affected by the increasing number of hydropower dams in the country.

Petr (2003) noted that there are a large number of obstructions on rivers and streams for developmental projects. The ever increasing numbers of weirs, barrages and dams have a harmful effect on the ecological well-being of the native fish populations, preventing many fish species from reaching their traditional areas of spawning and feeding. As a result of such disturbances, many fish species have declined in numbers, and in the worst situations, some species have become extinct in some rivers. Fishways (or fish passes) are an important means of redressing parts of the detrimental effects of obstructions. They assist in allowing fish to move over a dam or a weir to reach their breeding and feeding areas, or to reach the lower stretches of the river or the sea. Ensuring the free passage of fish protects stocks for future generations. To design the right type of fishway, one has to understand the requirements of the individual fish species, and these vary from species to species. Designing fishways requires skill in the fields of both biology and hydraulics, such as the swimming ability of migrators, and also their behaviour when faced with obstruction. Hydraulic and civil engineering must fully guarantee that the facilities will work throughout the usual range of river discharge experienced during the migration season. A recent visit to several dam sites in Nepal has shown that most of the existing fish passes require modification to be effectively used by the native migratory fish species. This will also require a better knowledge of the

biology and the behaviour of the indigenous species, especially of the behaviour in relation to obstacles and the fish's capacity to negotiate them. While this knowledge is available for salmonid stocks frequenting temperate waters of the northern hemisphere, little is known on such behaviour of non-salmonids inhabiting rivers of the Himalayas, Karakoram, Hindu Kush and some other mountains of Asia. As a result, valuable fish stocks are being lost.

Dams constitute obstacles for longitudinal exchanges along fluvial systems and as such result in the fragmentation (i.e. reduced connectivity) of ecosystems (Ward and Stanford, 1995). Dams not only alter the pattern of downstream flow (i.e. intensity, timing and frequency) they also change sediment and nutrient regimes and alter water temperature and chemistry. Dams may be viewed as anthropogenic alterations that disrupt dynamic processes and so they have impact on the ecological integrity of natural systems (McCarthy, 2000).

Dams may be good for some species such as water fowl and pelagophilic fish and in some areas in a dry desert like areas, where a reservoir may be beneficial to terrestrial as well as aquatic biota, because it constitutes a permanent water resource. However, because a river and its tributaries represent a more varied habitat than a large lake (particularly in the tropics) there is usually a decline in the total number of species (Bardach and Dussart, 1973).

The most common downstream effect of large dams is that variability in water discharge over the year is reduced such as high flows are decreased and low flows are increased. Reduction of flood peaks reduces the frequency, extent and duration of floodplain inundation. Reduction of channel-forming flows reduces channel migration. Truncated sediment transport (i.e. sedimentation within the reservoir) results in complex changes in degradation and aggregation below the dam. The temporal pattern of flooding is altered by regulation, one effect of which is to desynchronise annual flow and temperature regimes (Sparks et. al., 1990). These changes and others directly or indirectly influence a myriad of dynamic factors that affect habitat heterogeneity and successional trajectories and, ultimately the ecological integrity of river ecosystems (Ward and Stanford, 1995).

A dam will fragment and isolate upstream resident fish such as stone carp and catfish from downstream. The resident species may congregate in the tail-water release site. Fish from upstream will occasionally sweep downstream during the monsoon, stay in the tail-water or swim further downstream. A dam will obstruct the route of the long and mid-distance migratory fish. Upstream migrants will arrive at the dam site during the flow phase. Long distant migrants such as *Tor* sp., *Bagarius*, *Pseudeutropius*, *Clupisoma* and *Anguilla*, and mid-distance migrants *N. hexagonolepis* and *Labeo* species are most affected by a dam. These species will abandon the original pool and colonize deep pool regions downstream or upstream. Populations of snow trouts are less affected, as they make a small-scale migration to tributaries to breed in clear and cool water during the monsoon and return to the main stream during the low flow period (Shrestha, 1997).

Fish are affected directly by physical barrier of migration routes and movement of fish such as inundation of spawning grounds within the reservoirs, irregular releases of dam and periodic inundation or drying out of spawning grounds and refuge area downstream of the dam. Fish are affected indirectly to different level, depending on species, by modification of velocity, temperature and quality of water. The change in habitat caused by construction of a dam modified the fish community, population densities and areas utilized by a particular species (Horvath et. al., 1998).

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4. PROJECT LOCATIONS AND SURVEYED AREAS

There are 7 dams for construction in the project areas in Kachin State. 1 dam on Mali Hka River is Lasa Dam, 5 dams on May Hka River are Yenam Dam, Kaunglangphu Dam, Pisa Dam, Wusok Dam and Chibwe Dam and 1 dam on Ayeyarwaddy River is Myitsone Dam. The investigation on physicochemical parameters covered from below the reservoir heads of Lasa Hydropower Station on Mali Hka and Yenam Hydropower Station on May Hka to 20 kilometers downstream from Myitsone dam site on Ayeyawady River. Investigation on major branch tributaries covered 10 km above the estuaries of various branch tributaries.

Investigation on fish resource survey was focused on regional investigation, without fixed sections for investigation and monitoring. This investigation was set up along the trip in the main rivers, major branch tributaries and the villages near the camps for spot sampling. Interview surveys were also conducted along the trip for information on fisheries and water quality conditions.

4.1. Myitsone:

The Myitsone dam site is situated on the Ayeyarwaddy River in Myitkyina Township, 5.4 kilometers downstream from the confluence of May Hka and Mali Hka. The estimated GPS location of dam site is N 25° 41' 48.2" and E 97° 29' 39.4". The estimate elevation is about 138 m. There were 23 stations surveyed in January and February, 2009 and 8 stations in May, 2009. The positions are shown in Fig. (4.1).

4.2. Lasa (Laza):

Lasa dam, the one and only dam on Mali Hka River, located in Sumprabum Township, is situated in the middle part of Mali Hka River and the estimated GPS locations are N 26° 27' 21.7" and E 97° 48' 5.9". The estimated elevation of the dam site is about 214 m. Fig. (4.1) illustrates the 6 stations surveyed.

4.3. Yenam (Renam):

Yenam is the farthest on May Hka and located in Naungmung Township, 315 kilometers far from May Hka and Mali Hka confluence, the estimated GPS locations of

which are N 27° 41' 16.0" and E 98° 01' 29.3" and elevation about 852 m. The 6 stations of which aquatic ecological conditions are carried out are shown in Fig. (4.1).

4.4. Kaunglanghpu:

The smallest catchment area of the dams, Kaunglanghpu which is 14655 kilometer square in area, Kaunglanghpu is located 1.6 kilometers down stream from Mekh Rame Tributary and May Hka River confluence and situated in Kaunglanghpu Township. The estimated elevation is about 670 m. and estimated GPS locations are N 27° 01' 26.8" and E 98° 21' 28.9". Aquatic ecological conditions were studied for 8 stations in Khaunglangphu dam environment and the locations are as shown in Fig. (4.1).

4.5. Pisa:

This dam, of which the information was difficult to get, because of road accessibility, is situated about 1.6 kilometers downstream from the confluence of Mekh Rame Tributary and May Hka River and located in Tsawlaw Township. The estimated GPS locations are N 26° 43' 54.2" and E 98° 22' 34.6" and estimated elevation is about 533 m. Environmental Impact Assessment for 5 stations were undertaken for this dam environment and the locations are as shown in Fig. (4.1).

4.6. Wusok:

The second smallest installed capacity, 1800 kilowatts, of the dams of Wusot is situated on May Hka River. This dam is located in Tsawlaw Township, and the estimate values of GPS points are N 26° 25' 59.0" and E 98° 17' 27.1", and estimate elevation is about 430 m. From the main river and the major tributaries along the dam environment, 7 stations were surveyed and illustrations are as shown in Fig. (4.1).

4.7. Chibwe:

Chibwe dam, the second largest catchments area of the dams, is situated on May Hka River and located in Chibwe Township. The estimated GPS locations are N 26° 00' 04.1" and E 98° 10' 59.2" and 270 m. is estimated elevation. 5 sites were undertaken for environmental conditions of aquatic ecology and the positions are as shown in Fig. (4.1).

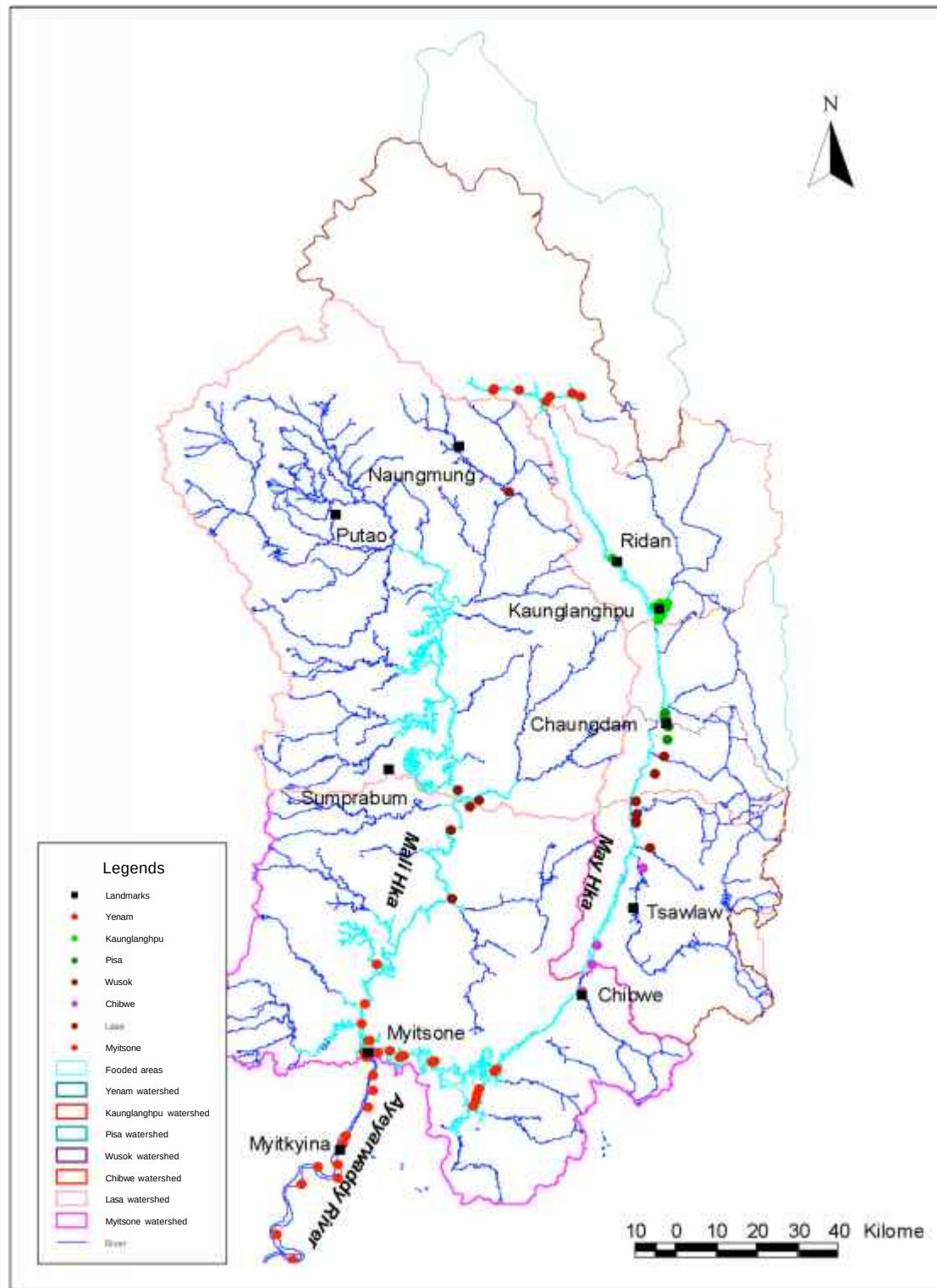


Fig. 4.1 (a). Sampling stations in the flood areas along May Hka, Mali Hka and Ayeyarwaddy Rivers.

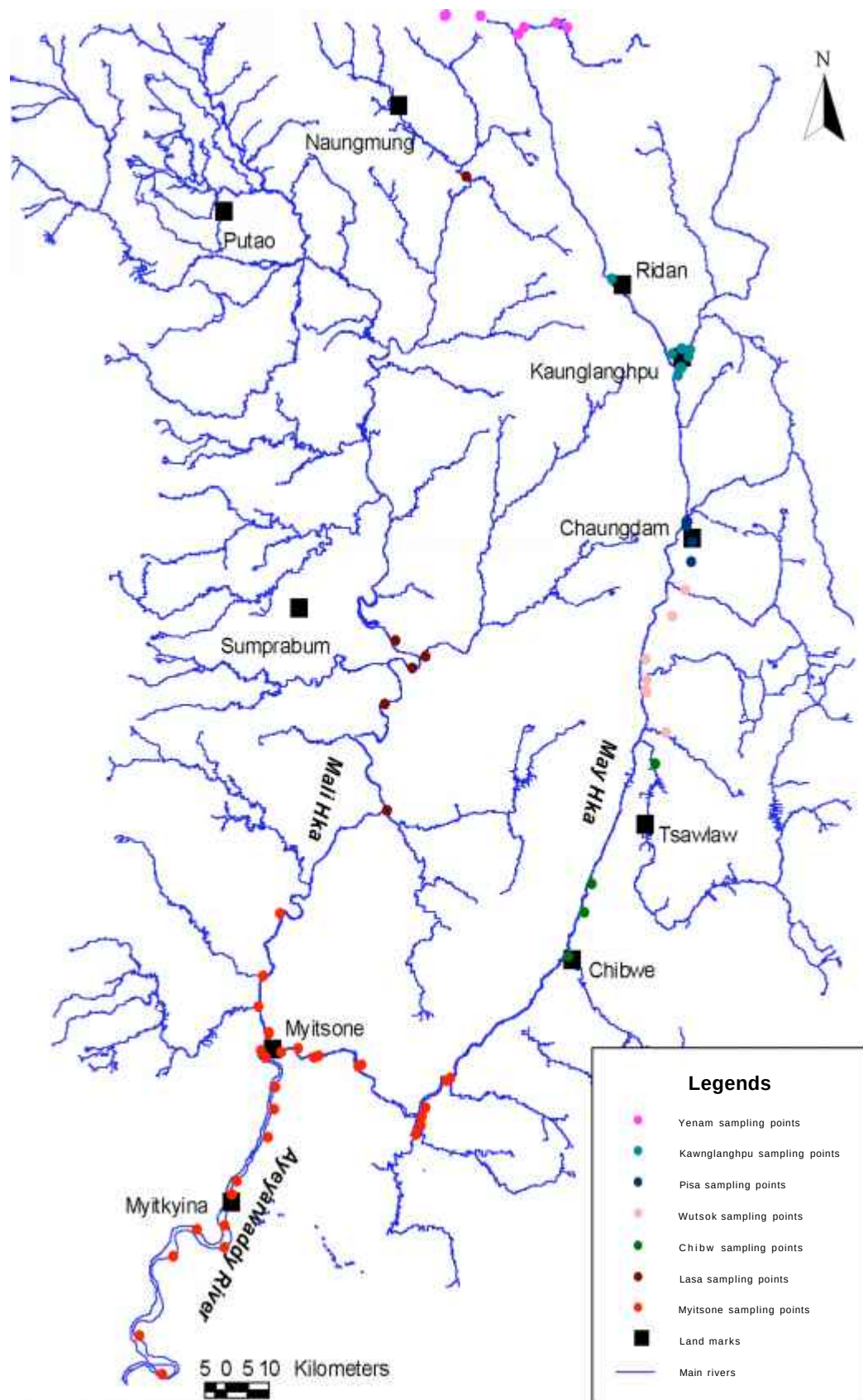


Fig. 4.1 (b) Sampling stations along May Hka, Mali Hka and Ayeyarwaddy Rivers.

5. MATERIALS AND METHODS

The data for physicochemical parameters, aquatic organisms composition and distribution and fisheries conditions were studied according to the "Terms of Reference of EIA on Hydropower Development of Ayeyarwaddy River above Myitkyina, Myanmar" for prediction of environmental impacts before and after dam construction on the aquatic ecosystem. Due to the difficulties of assessment to the dam sites and weather condition, surveyed stations were set up as close as possible to the guide lines.

Physical properties of water quality such as air temperature (degree celcius), water temperature (degree celcius), pH, water transparency (cm) and turbidity (NTU) were measured. Measured chemical properties were conductivity (mS/cm), Total Dissolved solids-TDS (mg/l), salty (g/l), Dissolved Oxygen (DO) (ppm and percentage), ORP (Oxydative Redox Potential) and nutrients of ammonia, nitrite, nitrate, total nitrogen and total phosphate in parts per million (ppm).

Water temperature, air temperature, pH, turbidity, conductivity, TDS, salty, ORP, DO were measured in situ using YSI (Yellow Spring Instrument) multipurpose model no. 6600 and TROLL multi-parameter series no. 9500 (Fig. 5.1). Temperature values were counter checked using mercury thermometer. pH was counter checked by INDEX model ID 1000. TDS and conductivity were checked using INDEX model ID 1020 (Fig. 5.2). The rest of the chemical properties were analyzed in the Institute of Hydroecology, Ministry of Water Resources and Chinese Academy of Science, Wuhan, Peoples Republic of China. The analytical procedures are followed in accordance with the Pollution Prevention Manual published by the World Bank.

Exact location of the surveyed sites was found using GARMIN GPS models etrex-Legend Cx and GPSmap 60CSx (Fig. 5.3). Environmental conditions of the surveyed areas were recorded by Nikon COOLPIX L18 and SONY Cyber-shot DSC-S730 digital cameras. Weather conditions were determined by overall naked eye view surveys (Fig. 5.4).

Phytoplankton was collected using 25' mesh and zooplankton was collected using 13' mesh plankton nets and preserved with formalin. Quantitative samples were collected with 25' mesh plankton net and fixed with lugol's solution for further calculation (Fig.5.5). Benthos was collected using D-shape kick-net and preserved with formalin (Fig. 5.6). Periphyton samples were taken from the submerged stones and preserved using formalin for further identification (Fig. 5.7). All of the samples are identified and analyzed at the Wuhan Institute of Hydroecology, Peoples Republic of China (Fig. 5.8).

Fish samples were bought from the local fishermen and markets (Fig. 5.9). The samples were preserved with formalin for further identification. Information on fisheries was taken by interviewed surveys from every place as a spot sampling method from the local fishermen and scholars. Frequent visit to Kachin State Fisheries Office, Myitkyina University and some local authority places were also made and collected secondary information about fish biodiversity and fisheries status. Fish samples are counter checked by Myanmar team members in the Fisheries Department, Ministry of Livestock and Fisheries, Union of Myanmar.

6. RESULTS

6.1. Water quality and environmental condition

6.1.1. Myitsone

The measured water quality values and environmental conditions are as shown in Table (6.1.1) and Fig (6.1.1.1 to 6.1.1.6). The recorded lowest water temperatures in January were about 12.5°C in May Hka, 16.0°C in Mali Hka and 15.3°C at the confluence to more than 20°C in the downstream of Ayeyarwaddy River. Water temperature of May Hka River is about 4 degrees celsius lower than the other rivers. Transparency of Mali Hka River is lower than the tributaries and other rivers.

Higher values of electrical conductivity were recorded from Mali Hka River and some tributaries along Ayeyarwaddy River. Oxygen concentration of all surveyed areas is very close to concentrated values.

River width of May Hka River is narrower and bank is steeper than the other rivers. Sandy banks are more common in the downstream of Ayeyarwaddy River. Gravel and pebble bottoms are common in Mali Hka and May Hka Rivers. Terrace and agricultural farms are common in the riparian areas of Mali Hka and Ayeyarwaddy Rivers, and secondary forests are more common in May Hka. Most of the banks are occupied by ye-ne plants (*Homonia riparia* Lour.) in this region. Gold mining is abundant in Mali Hka River and different forms of small scale to mechanized scales were observed along the river.

Table 6.1.1. Water quality and environmental conditions of Myitsone Dam area.

Station (January)	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
GPS	N 25° 22' 13.9" E 97°24' 32.5"	N 25° 44' 38.8" E 97°30' 11.6"	N 25° 44' 38.8" E 97°30' 11.6"	N 25° 42' 32.9" E 97°31' 44.6"	N 25° 42' 06.0" E 97°36' 23.6"	N 25° 25' 51.0" E 97°25' 26.3"	N 25° 47' 46.5" E 97°28' 46.1"	N 25° 51' 19.8" E 97°29' 25.3"	N 25° 58' 40.2" E 97°31' 30.6"	N 25° 04' 49.1" E 97°16' 39.2"	N 25° 09' 21.2" E 97°13' 48.6"
Elevation (m)	138	126	153	137	157	125	149	129	151	118	129
Date	15/1/ 2009	16/1/2 009	16/1/2 009	17/1/2 009	17/1/ 2009	17/1/2 009	22/1/2 009	23/1/2 009	24/1/2 009	31/1/2 009	31/1/2 009
Time	15:00	11:00	13:50	10:00	12:10	17:15	10:32	10:47	12:08	10:58	14:02
Locations Parameters		III	III	II	II		IV (III)	IV (III)	IV (III)	IV (I)	
Air Temperature (°C)	19	19	19	14.5	19	18	18	20	19.5	25	25
Water Temperature (°C)	15.3	16.8	16.07	12.5	12.5	16.51	16	18	16.5	21.5	20.5
pH	7.74	7.89	7.75	7.57	7.4	8.02	7.8	8	8.2	7.1	8.4
Transparency (cm)	65	37	27	-	-	55	55	-	-	90	60
Electrical Conductivity (mS/cm)	0.074	0.105	0.103	0.082	0.006	0.101	0.106	0.029	0.016	0.029	0.067
Dissolved Oxygen (ppm)	9.38	8.56	9.25	8.34	9.56	8.76	9.25	9.36	9.45	8.78	9.63
Dissolved Oxygen (%)	94.2	85.9	92.9	83.7	96.0	88.0	92.9	94.0	94.9	88.2	96.7
Total Nitrogen (ppm)	0.22	0.546	0.242	0.1516	0.2873	0.2524	0.3541	0.641	0.1195	0.1706	0.1463
NH ₃ -N (ppm)	0.011	0.036	0.089	0.001	0.002	0.008	0.006	0.065	0.006	0.003	0.001
NO ₂ -N (ppm)	0.006	0.007	0.001	0.005	0.001	0.006	0.004	0.002	0.002	0.001	0.006
NO ₃ -N (ppm)	0.054	0.211	0.004	0.005	0.007	0.024	0.036	0.088	0.003	0.033	0.014
Total Phosphorous (ppm)	0.0681	0.0419	0.0494	0.0805	0.0547	0.0373	0.0709	0.0433 5	0.058	0.0598	0.0423
Total Dissolved	.074	.081	.081	.067	.07	.05	.04	.06	.09	.08	.05

Solids TDS (mg/L)												
Turbidity (NTU)												
Oxidative Redox Potential ORP (mV)		-9.5	-13	103	45.3	452	54.8	436	-13	116	-20	145
Salty		0.05	0.06	0.06								
Weather		S	S	S	S	S	S	S	S	y ₂ C	S	S
Water Clarity		CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
Water Coloration		LG	G	LG	G	G	LG	LG	LG	LG	DG	LG
River Width (m) (estimate)		100-150	200-250	100	100-150	300	500	25	20	10	300	600
Bank Condition	Left	Sd. & Rc.	Rc. & Sd.	Sd. & Rc.	Sd.	Sd.	Sd.	Sd. & Rc.	Sd. & Rc.	Rc.	Sd.	Rc.
	Right	Rc.	Sd. & Rc.	Sd.	Sd.	Rc. & Sd.	Gv.	Sd. & Rc.	Sd. & Rc.	Rc.	Sd.	Gv. & Rc.
Bank Height (m) (estimate)	Left	30	5	5	10	5	10	10	15	10	7	7
	Right	30	5	5	10	5	10	10	15	10	7	7
Bank Width (m) (estimate)	Left	10	50	200	50	500	50	5	3	0	20	300
	Right	4	50	50	900	75	100	5	3	0	300	300
Bank Gradient (°) (estimate)	Left	60-70	10-15	70	10-15	5-7	5	50	50	50	40	20
	Right	80	5-10	5-10	5-10	10-15	5-10	50	50	45	30	20
Bottom Condition		Rc.	Gv.	Sd.	Gv. & Sd.	Sd. & Gv.	Gv.	Gv. & Sd.	Gv. & Sd.	Gv., Sd. & Md.	Sd.	Gv.
Biological Condition in the Water		-	-	-	-	-		Td. Larv.	Bent. & Alg.	Bent.	Pt. & Mp.	-
Biological Env. on the Banks	Left	-	-	-		-	-	-	-	Mos.	-	-
	Right	Bent.	-	-		-	Alg.	-	-	Mos.	-	-
Riparian Area Condition	Left	Sec.	Sec.	Sec.	Sec.	GM & Vil.	Sec.	Bam.	Sec.	Sec.	Vil.	Vil.
	Right	Camp.	Sec.	Vil.	Sec.	GM & Sec.	Vil.	Bam.	Sec.	Sec.	Vil.	Agr.

XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
N 25° 18' 39.4" E 97°18'0 4.5"	N 25° 21' 45.2" E 97°21'0 1.9"	N 25° 19' 40.1" E 97°24'3 4.0"	N 25° 32' 33.1" E 97°30'0 0.9"	N 25° 35' 50.0" E 97°30'4 8.3"	N 25° 38' 27.4" E 97°30'5 2.9"	N 25° 42' 37.7" E 97°29'0 6.7"	N 25° 34' 52.4" E 97°49'1 5.9"	N 25° 35' 57.7" E 97°49'4 4.9"	N 25° 40' 54.3" E 97°41'45.1 -	N 25° 40' 48.1" E 97°41'1 8.4"	N 25° 41' 50.2" E 97°35'4 1.2"
113	113	103	148	130	136	135	166	180	177	177	146
1/2/20 09	1/2/20 09	2/2/20 09	5/2/20 09	5/2/20 09	6/2/20 09	7/2/20 09	9/2/20 09	9/2/20 09	9/2/2009	10/2/2 009	11/2/2 009
10:00	11:20	9:30	9:00	12:07	13:56	12:26	10:45	12:58	14:38	11:38	9:58
1	1	1	IV (I)	I	I	IV (I)	IV (II)	II	II	IV (II)	IV (II)
21	24	19	15.5	18.5	28	26.5	21	20.5	20.5	22	22
17.5	18	16	16.5	22	17	19.5	16	14	14.5	19	19
7.4	7.5	7.2	7.8	7.5	7.5	8.3	7.5	7.4	7.4	8	7.5
-	-	-	-	50	70	-	-	-	-	-	-
0.047	0.066	0.106	0.026	0.009	0.006	0.22	0.006	0.005	0.007	0.008	0.010
9.89	8.65	7.54	10.02	8.99	7.76	10.1	7.65	8.63	10.63	9.12	7.65
99.3	86.8	75.7	100.6	90.3	77.9	101.4	76.8	86.6	106.7	91.6	76.8
0.323	0.592	0.1089	0.2375	0.111	0.608	0.265	1.2143	1.9187			
0.006	0.045	0.003	0.005	0.001	0.069	0.067	0.321	0.226			
0.007	0.008	0.007	0.005	0.007	0.008	0.008	0.009	0.008			
0.033	0.16	0.004	0.006	0.003	0.32	0.068	0.563	0.885			
0.0558	0.0457	0.0371	0.0475	0.0912	0.1537	0.1193	0.1106	0.081			

.04	.04	.04	.06	.06	.04	.15	.04	.04	.04	.07	.06
179	112	-423	-132	75.2	46.5	112	188	143	147	-46	46.9
S	S	S	S	S	S	S	S	S	S	S	S
CL	TB	TB	TB	CL	CL	CL	CL	CL	CL	CL	CL
LG	G	G	G	LG	G	LG	LG	G	G	LG	LG
300	500	300	4	500	400	15	30	300	400	7	2
Gv.	Sd.	Sd.	Gv. & St.	Gv. & Sd.	Gv. & Sd.	Gv. & Sd.	Gv.	Gv. & Sd.	Gv. & Sd.	Rc.	Rc.
Sd.	Gv.	Gv.	Gv. & St.	Gv. & Sd.	Rc. & Sd.	Gv. & Sd.	GV.	Gv. & Sd.	Gv. & Sd.	Rc.	Rc.
7	7	7	8	8	8	2	1.5	7	7	3	3
7	7	7	8	8	8	2	1.5	7	7	3	3
200	50	400	5	30	50	0	0	100	20	0	20
200	50	100	5	100	50	0	0	200	10	0	0
15	15	70	90	40	25	70	80	45	45	70	70
10	10	5	80	25	15	50	70	60	60	70	70
Gv.	Gv.	Gv.	Gv. & St.	Gv. & Sd.	Gv.	Gv.	Gv.	Sd.	Gv.	GV. & Sd.	Sd. & St.
Alg.	Bent.	Bent.	-	-	-	-	Bent. & Alg.	-	-	Alg.	Alg.
Bent.	Bent.	-	-	-	-	-	-	-	-	-	-
-	Bent.	Bent.	-	-	-	-	-	-	-	-	-
Agr.	Bus.	Vil.	Bam.	Vil.	Sec.	Vil.	Org.	Org.	Is.	Bam.	Bam.
Agr.	Bus.	Agr.	Bam.	Sec.	Sec.	Vil.	Org.	Sec.	Bam.	Bam.	Bam.

Station	XXIV	XXV	XXVI	XXVII	XXVIII (M1)	XXIX (M2)	XXX (M3)	XXXI (M4)
GPS	N 25° 39' 06.1" E 97° 52' 25.4"	N 25° 39' 24.6" E 97° 52' 53.5"	N 25° 33' 50.1" E 97° 49' 06.8"	N 25° 32' 49.2" E 97° 48' 35.0"	N 25° 44' 42.7" E 97° 30' 06.8"	N 25° 42' 54.6" E 97° 33' 45.7"	N 25° 41' 48.2" E 97° 29' 39.4"	N 25° 27' 25.6" E 97° 26' 04.7"
Elevation (m)	177	178	178	179	132	142	138	121
Date	7/5/20 09	7/5/20 09	7/5/20 09	7/5/20 09	8/5/20 09	8/5/20 09	9/5/20 09	9/5/20 09
Time	8:01	9:16	12:55	14:09	15:45	17:15	8:49	10:50
Locations								
Parameters	II	IV (II)	IV (II)	IV (II)	III	II	I	I
Air Temperature (°C)	24	27	28.5	29	33	30	21	29.5
Water Temperature (°C)	19.94	24.35	24.49	24.7	26	19.3	18.3	25.5
pH	7.43	7.37	7.71	7.72	7.5	7.56	7.45	8.49
Transparency (cm)	-	-	-	-	-	-	-	-
Electrical Conductivity (mS/cm)	0.034	0.031	0.039	0.047	0.05	0.034	0.057	0.039
Dissolved Oxygen (mg/L)	10.7	8.72	9.31	10.3	9.2	11.36	8.32	11.53
Dissolved Oxygen (%)	107.43	87.55	93.5	103.4	92.4	114.1	83.5	115.8
Total Nitrogen (ppm)	0.4446	0.2811	0.9422	0.1293	0.166	0.1903	0.5892	0.3523
NH ₃ -N (ppm)	0.006	0.001	0.122	0.003	0.003	0.003	0.005	0.004
NO ₂ -N (ppm)	0.007	0.007	0.005	0.006	0.002	0.003	0.007	0.008
NO ₃ -N (ppm)	0.123	0.004	0.356	0.008	0.009	0.06	0.552	0.078
Total Phosphorous (ppm)	0.0976	0.1032	0.0816	0.0737	0.1361	0.0812	0.0922	0.111
Total Dissolved Solids TDS (gm/L)								

Turbidity (NTU)		1.2	-1.8	0.3	7	12.1	5.3	9.5	~
Oxidative Redox Potential ORP (mV)		-180	155	-111	125	-154	85	87	80
Salty									
Weather		i C	j C	C	C	S	S	S	S
Water Clarity		CL	CL	CL	TB	CL	CL	TB	CL
Water Coloration		LG	LG	LG	G	G	G	DG	LG
River Width (m) (estimate)		200	15	20	15	100	100	150	200
Bank Condition	Left	Sd.	Gv. & Pb.	Ert. & Rc.	Ert. & Bd.	Pb.	Sd.	Sd. & Bd.	Gv.
	Right	Sd.	Gv. & Sd.	Ert.	Ert.	Pb.	Gv. & Sd.	Gv.	Sd. & Gv.
Bank Height (m) (estimate)	Left	10	10	5	5	10	10	10	10
	Right	10	10	5	5	10	10	10	10
Bank Width (m) (estimate)	Left	200	50	0	10	30	50	10	200
	Right	10	35	20	0	100	30	5	50
Bank Gradient (°) (estimate)	Left	80	80	80	80	45	60	45	5
	Right	80	70	80	45	45	45	70	30
Bottom Condition		Pb. & Sd.	Pb. & Sd.	Pb. & Sd.	Bd.	Pb.	Sd.	Sd.	Gv.
Biological Condition in the Water		-	Per.	-	Bent.	-	-	-	-
Biological Env. on the Banks	Left	-	-	-	-	-	-	-	-
	Right	-	-	-	-	-	-	-	-
Riparian Area Condition	Left	Vil.	Agr.	Vil. & Agr.	Agr. & Rd.	Bam.	Bam.	Bam.	Vil.
	Right	Sec.	Agr.	Vil. & Agr.	Sec.	Sec.	Bam.	Camp	Vil.

6.1.2. Lasa

The measured water quality values and environmental conditions are as shown in Table (6.1.2) and Fig. (6.1.2.1 to 6.1.2.5). Water temperatures are higher than May Hka in the rivers recorded in the same period. Electrical conductivity is higher compared to the other dam sites.

River width is wider in most part of the surveyed stations. Secondary forests are common in riparian areas except Sumpian. Sandy bottoms can be found in some areas especially in wider rivers and areas of low flow rate. Gold mining is common in this area.

Table 6.1.2. Water quality and environmental conditions of Lasa Dam area.

Station	I	II	III	IV	V	VI
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GPS		N 27° 24' 42.5" E 97° 54' 59.5"	N 26° 23' 09.5" E 97° 44' 41.6"	N 26° 10' 39.7" E 97° 44' 56.5"	N 26° 28' 40.7" E 97° 49' 45.2"	N 26° 30' 33.4" E 97° 46' 00.0"	N 26° 27' 21.7" E 97° 48' 05.9"
Elevation (m)		504	229		214	223	221
Date		24/3/2009			12/4/2009	13/4/2009	12/4/2009
Time		7:06			9:05	8:44	15:45
Location		IV (III)	IV (III)	III	III	IV (III)	III
Parameter							
Air Temperature (°C)		20			24		
Water Temperature (°C)		20.5			17.17	20.62	20.58
pH		7.69			7.79	7.73	7.71
Transparency (cm)		-			-	-	-
Electrical Conductivity (mS/cm)		0.067			0.007	0.105	0.093
Dissolved Oxygen (ppm)		6.93			13.11		
Dissolved Oxygen (%)		77			120.7		
Total Nitrogen (ppm)		0.2409	0.7946	0.8549	0.395	0.8301	0.7025
NHv-N (ppm)		0.006	0.156	0.189	0.039	0.078	0.067
NOq-N (ppm)		0.007	0.008	0.005	0.006	0.006	0.009
NO3-N (ppm)		0.011	0.19	0.65	0.07	0.037	0.34
Total Phosphorous (ppm)		0.121	0.08002	0.08	0.042	0.0464	0.02265
Total Dissolved Solids TDS (gm/L)		0.043			0.04	0.068	0.06
Turbidity (NTU)							
Oxidative Redox Potential ORP (mV)		-84			-139.3	-117	131.2
Salty		0.03					
Weather		S					
Water Clarity		CL					
Water Coloration		G					
River Width (m) (estimate)		50			60	90	80
Bank Condition	Left	Gv. & Sd.					
	Right	Gv. & Sd.					
Bank Height (m) (estimate)	Left	3					
	Right	3					
Bank Width (m) (estimate)	Left	50			30	30	30
	Right	0			30	30	35
Bank Gradient (°) (estimate)	Left	10					
	Right	80					
Bottom Condition		Gv. & Sd.			Gv. & Bd.	Sd & Bd	Sd., Gv. & Bd.
Biological Condition in the Water		-					
Biological Env. on the Banks	Left	-					
	Right	-					
Riparian Area Condition	Left	Sec.			Sec.	Sec.	Sec.
	Right	Sec.			Sec.	Sec.	Sec.

6.1.3. Yenam

The measured water quality values are as shown in Table (6.1.3) and Fig. (6.1.3.1 to 6.1.3.5). Water temperature is the lowest compared to other surveyed dam environments. Every temperature records were lower than 10°C. Water is also well

oxygenated because of high flow rate along the river. Bank gradient is also steep and rocky banks are common. Gravel and rocky bottoms are the most dominant along the river.

River width is narrow in most parts of the surveyed areas. Secondary forests are common along the river bank. No gold mining is observed in this region.

Table 6.1.3. Water quality and environmental conditions of Yenam Dam area.

Station		I	II	III	IV	V	VI
GPS		N 27° 43' 23.1" E 97° 52' 12.3"	N 27° 43' 29.1" E 97° 56' 40.2"	N 27° 42' 08.0" E 98° 02' 10.5"	N 27° 41' 15.4" E 98° 01' 28.7"	N 27° 42' 06.5" E 98° 07' 40.3"	N 27° 42' 42.2" E 98° 06' 14.9"
Elevation (m)		904	911	952	852	962	927
Date		28/2/2009	2/3/2009	8/3/2009	9/3/2009	11/3/2009	12/3/2009
Time		9:09	10:34	10:24	10:31	9:59	12:10
Parameter							
Location		II	II	IV (II)	II	IV (II)	IV (II)
Air Temperature (°C)		12	14	11	14.5	10	15
Water Temperature (°C)		9	9	10	10	9	9
pH		7.5	7.5	6.8	7.4	7.4	7.2
Transparency (cm)		40	260	-	-	-	-
Electrical Conductivity (mS/cm)		0.005	0.005	0.001	0.004	0.004	0.003
Dissolved Oxygen (ppm)		10.2	9.12	8.65	10.1	10.5	9.86
Dissolved Oxygen (%)		102.41	91.57	86.85	101.41	105.42	99.00
Total Nitrogen (ppm)		0.1941	0.1193	0.1302	1.0516	0.1695	0.562
NH ₃ -N (ppm)		0.004	0.006	0.003	0.087	0.006	0.078
NO ₂ -N (ppm)		0.007	0.008	0.006	0.003	0.005	0.007
NO ₃ -N (ppm)		0.063	0.021	0.009	0.65	0.009	0.232
Total Phosphorous (ppm)		0.0948	0.0596	0.0378	0.0837	0.0853	0.045
Total Dissolved Solids TDS (gm/L)		0.04	0.03	0.01	0.02	0.03	0.02
Turbidity (NTU)							
Oxidative Redox Potential ORP (mV)		45.9	66.7	112.6	115.6	265.4	126.1
Salty							
Weather		C & Sh.	C & Sh.	C & Sh.	C & Sh.	C & Sh.	C
Water Clarity		CL	CL.	CL	CL	CL	CL
Water Coloration		LG	LG	LG	LG	G	LG
River Width (m) (estimate)		30	30	5	30	50	100
Bank Condition	Left	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.
	Right	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.
Bank Height (m) (estimate)	Left	10	5	5	10	5	5
	Right	10	5	5	10	5	5
Bank Width (m) (estimate)	Left	0	5	0	0	8	0
	Right	15	3	0	0	0	0
Bank Gradient (°) (estimate)	Left	80	80	70	90	50	90
	Right	70	80	90	90	80	90
Bottom Condition		Sd. & Rc.	Rc., Gv. & Sd.	Gv. & Rc.	Rc. & Sd.	Rc.	Sd. & Rc.
Biological Condition in the		-	-	-	-	-	-

Water							
Biological Env. on the Banks	Left	-	-	-	-	-	-
	Right	-	-	-	-	-	-
Riparian Area Condition	Left	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
	Right	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.

6.1.4. Kaunglanghpu

The measured water quality values and environmental conditions are as shown in Table (6.1.4) and Fig. (6.1.4.1 to 6.1.4.5). Temperature is low and colour of water is very clear along the surveyed areas. Temperature of tributaries is lower and flow rate is also fast compared to the main river. Oxygen is well concentrated in the water because of high speed flow rate and common gravel bottom along the river and tributaries.

Surveyed areas along Kaunglanghpu dam environment were covered with rocky and steep banks. Gravel bottom is common in this region. Bamboo and banana forests can be found near Kaunglanghpu riparian areas and most parts are covered with secondary forests. Terrace farms were observed near major villages and Kaunglanghpu. No gold mining is found in this region.

Table 6.1.4. Water quality and environmental conditions of Kaunglanghpu Dam area.

Station	I	II	III	IV	V	VI	VII	VIII
GPS	N 27° 12' 45.8" E 98° 13' 15.7"	N 27° 03' 35.2" E 98° 21' 38.7"	N 27° 03' 45.1" E 98° 22' 55.7"	N 27° 04' 34.3" E 98° 21' 54.7"	N 27° 02' 23.0" E 98° 21' 57.7"	N 27° 01' 26.8" E 98° 21' 28.9"	N 27° 02' 25.6" E 98° 21' 44.5"	N 27° 04' 32.4" E 98° 23' 02.4"
Elevation (m)	788	696	728	781	703	670	659	739
Date	2/3/2009	5/3/2009	7/3/2009	10/3/2009	11/3/2009	13/3/2009	14/3/2009	15/3/2009
Time	10:00	11:22	11:16	10:54	15:00	9:54	11:04	11:18
Location								
Parameter	II	II	IV (II)	IV (II)	IV (II)	II	II	IV (II)
Air Temperature (°C)	15	18	16	15	16	11	17	16
Water Temperature (°C)	11.39	12.62	10.91	9.16	11.72	11.65	12.28	10.51
pH	7.66	7.75	7.63	7.48	7.58	7.72	7.75	7.6
Transparency (cm)	-	-	135	-	-	-	-	-
Electrical Conductivity (mS)	0.082	0.099	0.061	0.027	0.054	0.078	0.084	0.049
Dissolved Oxygen (mg/L)	11.11	10.05	11.65	10.62	10.5	11.5	10.6	10.14
Dissolved Oxygen (%)	111.55	100.90	116.97	106.63	105.42	115.46	106.43	101.81
Total Nitrogen (ppm)	0.6139	0.4071	0.2992	0.2916	0.1105			
NH ₃ -N (ppm)	0.142	0.036	0.008	0.006	0.002			
NO ₂ -N (ppm)	0.007	0.008	0.008	0.009	0.006			
NO ₃ -N (ppm)	0.069	0.046	0.057	0.036	0.009			
Total Phosphorous (ppm)	0.0721	0.0641	0.0502	0.0486	0.0673			
Total Dissolved Solids TDS (gm/L)	0.054	0.064	0.04	0.025	0.035	0.051	0.055	0.032
Turbidity (NTU)								
Oxidative Redox Potential ORP (mV)	-96.8	-81.8	-60.9	-84.3	-90.5	-61.7	-70.8	-78.2
Salty	0.04	0.05	0.03	0.02	0.02	0.04	0.04	0.02

Weather		S	S	R	S	C	S	S	S
Water Clarity		CL	CL	CL	CL	CL	CL	CL	CL
Water Coloration		G	G	DG	G	G	DG	DG	G
River Width (m) (estimate)		100	150	40	10	40	100	50	50
Bank Condition	Left	Rc.	Rc.	Rc.	Rc.	Sd. & Rc.	Sd. & Rc.	Rc.	Rc.
	Right	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.	Rc.
Bank Height (m) (estimate)	Left	10	10	20	3	10	10	20	5
	Right	10	10	20	3	10	10	20	5
Bank Width (m) (estimate)	Left	0	0	0	0	10	10	10	0
	Right	0	0	0	0	0	10	0	0
Bank Gradient (°) (estimate)	Left	45	80	80	90	85	50	70	90
	Right	70	70	80	45	85	50	70	60
Bottom Condition		Gv.	Gv.	Gv.	Gv.	Sd. & Gv.	Rc.	Rc.	Rc.
Biological Condition in the Water		-	-	-	-	-	-	-	-
Biological Env. on the Banks	Left	-	-	-	-	Mos.	-	-	-
	Right	-	-	-	-	Mos.	-	-	-
Riparian Area Condition	Left	Sec.	Bam.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
	Right	Sec.	Bam.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.

6.1.5. Pisa

The measured water quality values are as shown in Table (6.1.5) and Fig (6.1.5.1 to 6.1.5.5). The temperature becomes high because of the season but is lower than Mali Hka. Oxygen is also well concentrated and flow is very fast in most part of the region. pH value is the lowest compared to the other dam environments. Colour of water is very clear and rocky and gravel bottoms are common. Bank gradient is steep and rocky banks are common along the river.

Most of the riparian areas are covered with untouched forest because of difficult accessibility. There is no gold mining along the region.

Table 6.1.5. Water quality and environmental conditions of Pisa Dam area.

Station	I	II	III	IV	V
GPS	N 26° 43' 54.2" E 98° 22' 34.6"	N 26° 44' 26.7" E 98° 22' 42.1"	N 26° 44' 22.4" E 98° 22' 36.7"	N 26° 41' 55.9" E 98° 23' 20.9"	N 26° 39' 44.4" E 98° 23' 08.0"
Elevation (m)	533	546	553	780	1006

Date		17/4/2009	18/4/2009	28/4/2009	20/4/2009	21/4/2009
Time		10:00	12:05	12:46	9:52	8:42
Parameter	Location	II	IV (II)	II	IV (II)	IV (II)
Air Temperature (°C)		24	19	19	16.5	17
Water Temperature (°C)		15.65	13.42	13.37	15.07	16.08
pH		7.6	6.77	6.89	6.95	7.01
Transparency (cm)		-	-	-	-	-
Electrical Conductivity (mS/cm)		0.032	0.013	0.014	0.013	0.021
Dissolved Oxygen (mg/L)		11.53	10.6	13.94	10.04	10.57
Dissolved Oxygen (%)		115.76	106.43	133.8	108	113.7
Total Nitrogen (ppm)		0.5443	0.2454	0.2809	0.2122	0.644
NH ₃ -N (ppm)		0.033	0.008	0.009	0.001	0.006
NO ₂ -N (ppm)		0.007	0.006	0.008	0.006	0.007
NO ₃ -N (ppm)		0.145	0.032	0.068	0.067	0.034
Total Phosphorous (ppm)		0.04964	0.0853	0.04916	0.02425	0.0916
Total Dissolved Solids TDS (gm/L)						
Turbidity (NTU)		-1.4	18.9	17.6	-1.9	-0.6
Oxidative Redox Potential ORP (mV)		152	-169	-162	-167	-167
Salty						
Weather		1/2 C	Sh	Sh	1/2C	C & Fg
Water Clarity		CL	TB	TB	CL	CL
Water Coloration		G	YB	YB	G	G
River Width (m) (estimate)		70	20	100	20	20
Bank Condition	Left	Rc	Rc	Rc & Gv	Rc & Gv	Rc
	Right	Rc	Rc	Rc	Rc	Rc
Bank Height (m) (estimate)	Left	10	5	10	10	1
	Right	10	5	10	10	1
Bank Width (m) (estimate)	Left	50	0	30	3	0
	Right	0	0	0	0	0
Bank Gradient (°) (estimate)	Left	40	60	50	80	60
	Right	80	80	70	80	90
Bottom Condition		Gv & Sd	Gr & Rc	Rc & Gv	Sd & Gv	Rc & Sd
Biological Condition in the Water		-	-	-	-	-
Biological Env. on the Banks	Left	-	Mos	Mos	Mos	Mos
	Right	-	Mos	Mos	Mos	Mos
Riparian Area Condition	Left	Sec	Sec	Sec	Bam	Sec
	Right	Sec	Sec	Sec	Bam	Sec

6.1.6. Wusok

The measured water quality values and environmental conditions are as shown in Table (6.1.6) and Fig. (6.1.6.1 to 6.1.6.5). Temperature is as low as other surveyed areas of May Hka River. Water color is very clear and oxygen is well concentrated because of high flow rate and rough bottom along the surveyed area.

Bank gradient is high and rocky banks are common along surveyed areas. Rocky and gravel bottoms are common along the region. Secondary forests are common except

near the village which is covered with terrace and shifting farms. There is no gold mining in the region.

Table 6.1.6. Water quality and environmental conditions of Wusok Dam area.

Station	I	II	III	IV	V	VI	VII
GPS	N 26° 24' 29.3" E 98° 17' 31.0"	N 26° 28' 22.1" E 98° 17' 21.1"	N 26° 25' 59.0" E 98° 17' 34.4"	N 26° 24' 44.6" E 98° 17' 27.1"	N 26° 19' 45.3" E 98° 19' 56.8"	N 26° 36' 27.5" E 98° 22' 23.8"	N 26° 33' 18.3" E 98° 20' 42.9"
Elevation (m)	392	451	492	399	923	636	678
Date	12/4/2009	12/4/2009	25/4/2009	26/4/2009	27/4/2009	21/4/2009	22/4/2009
Time	8:30	17:20	9:41	10:21	14:37	15:12	13:00
Location Parameter	II	II	IV (II)	II	IV (II)	IV (II)	IV (II)
Air Temperature (°C)	17	17	21	19	27	21	20
Water Temperature (°C)	14.4	14.3	16.1	15.3	16.82	15.56	15.95
pH	7.42	7.33	7.55	7.6	7.2	7.65	7.2
Transparency (cm)	-	-	-	-	-	-	-
Electrical Conductivity (mS/cm)	0.024	0.027	0.035	0.069	0.014	0.045	0.017
Dissolved Oxygen (mg/L)	10.2	9.7	9.92	9.5	11.18	10.57	10.17
	102.41	97.39	99.60	95.38	112.25	106.12	102.11
Total Nitrogen (ppm)	0.1635	1.0373	0.2952	0.5148	0.2133	1.42	0.442
NH ₃ -N (ppm)	0.011	0.079	0.015	0.014	0.002	0.232	0.045
NO ₂ -N (ppm)	0.008	0.007	0.006	0.006	0.009	0.006	0.007
NO ₃ -N (ppm)	0.008	0.66	0.054	0.36	0.009	0.78	0.096
Total Phosphorous (ppm)	0.04055	0.1707	0.03226	0.09153	0.0471	0.1192	0.03036
Total Dissolved Solids TDS (gm/L)							
Turbidity (NTU)	12.7	12	11	19.2	-1.8	10.5	-2
Oxidative Redox Potential ORP (mV)	-153	-29	-172	-98	-130	-130	-157
Salty							
Weather	S	S	S	S	S	C	Sh

Water Clarity		CL	CL	CL	TB	CL	TB	CL
Water Coloration		YG	LG	LG	G	G	YG	LG
River Width (m) (estimate)		50	70	30	100	50	70	25
Bank Condition	Left	Sd. & Rc.	Sd. & Rc.	Rc.	Sd. & Gv.	Bd.	Rc	Rc & Bd
	Right	Rc.	Rc.	Rc.	Rc.	Bd.	Bd	Rc & Bd
Bank Height (m) (estimate)	Left	10	10	10	10	10	3	3
	Right	10	10	10	10	10	3	3
Bank Width (m) (estimate)	Left	100	50	0	30	10	0	0
	Right	10	0	0	0	5	10	0
Bank Gradient (°) (estimate)	Left	20	80	80	45	45	80	90
	Right	80	80	80	80	70	90	90
Bottom Condition		Gv. & Sd.	Gr. & Sd.	Gv. & Bd.	Sd. & Gv.	Gv. & Sd.	Rc & Sd	Gv and Sd
Biological Condition in the Water		-	-	-	-	-		
Biological Env. on the Banks	Left	-	Mos.	Mos.	-	Mos.	Mos.	Mos.
	Right	-	Mos.	Mos.	-	Mos.	Mos.	Mos.
Riparian Area Condition	Left	Vil.	Sec.	Sec.	Vil.	Sec.	Bam.	Bam.
	Right	Sec.	Sec.	Sec.	Sec.	Sec.	Sec & Sft	Bam.

6.1.7. Chibwe

The measured water quality values and environmental conditions are as shown in Table (6.1.7) and Fig. (6.1.7.1 to 6.1.7.5). Temperature is low compared to Mali Hka. Oxygen is well concentrated in the surveyed areas. Colour of water is very clear except in Ngawchang Hka, the major tributary in Chibwe Dam area. The colour of water of Ngawchang Hka is very turbid caused by suspended silts in the water.

River width of most parts of the areas is wider and sandy bottoms can be found in those regions. Bank gradient is not steep compared to other Nmai Hka banks. Terrace

farms, shifting farms and secondary forests can be found proportionately along the riparian areas especially near the villages. Gold mining can be found in the downstream areas of the dam.

Table 6.1.7. Water quality and environmental conditions of Chibwe Dam area.

Station		I	II	III	IV	V
GPS		N 26° 16' 13.6" E 98° 18' 41.4"	N 26° 16' 12.4" E 98° 18' 37.9"	N 26° 02' 05.8" E 98° 10' 35.7"	N 25° 58' 48.5" E 98° 09' 43.1"	N 25° 53' 41.2" E 98° 07' 48.1"
Elevation (m)		504	500	277	242	229
Date		10/4/2009	29/4/2009	23/4/2009	24/4/2009	25/4/2009
Time		9:00	8:36			
Location		IV (II)	IV (II)	II	II	IV (II)
Parameter						
Air Temperature (°C)		20	21	22	26	28.5
Water Temperature (°C)		19	19.01	15.08	15.88	19.5
pH		7.39	7.65	7.7	7.2	7.4
Transparency (cm)		-	-	-	-	-
Electrical Conductivity (mS/cm)		0.046	0.089			
Dissolved Oxygen (mg/L)		11	8.36			
Dissolved Oxygen (%)		116.7	83.94			
Total Nitrogen (ppm)		0.4469	0.1241	1.0043	0.6405	0.5277
NH ₃ -N (ppm)		0.036	0.003	0.222	0.114	0.057
NO ₂ -N (ppm)		0.007	0.008	0.002	0.007	0.008
NO ₃ -N (ppm)		0.04	0.006	0.57	0.22	0.36
Total Phosphorous (ppm)		0.02959	0.055	0.07395	0.04721	0.1377
Total Dissolved Solids TDS (gm/L)						
Turbidity (NTU)		40.2	36			
Oxidative Redox Potential ORP (mV)		-196	362			
Salty						
Weather		S	S	C	S	S
Water Clarity		TB	TB	CL	CL	CL
Water Coloration		YB	YB	G	LG	LG
River Width (m) (estimate)		80	80	150	220	20
Bank Condition	Left	Rc.	Rc.	Rc.	Rc.	Rc.
	Right	Rc.	Rc.	Rc.	Rc.	Rc.
Bank Height (m) (estimate)	Left	5	5			
	Right	5	5			
Bank Width (m) (estimate)	Left	0	0	0	0	3
	Right	10	10	0	0	0
Bank Gradient (°) (estimate)	Left	70	70	80	85	70
	Right	60	60	70	80	80
Bottom Condition		Gv. & Sd.	Gv. & Sd.	Rc. & Sd.	Sd.	Sd. & Rc.
Biological Condition in the Water		-	-	-	-	-
Biological Env. on the Banks	Left	-	-	-	-	-
	Right	-	-	-	-	-
Riparian Area Condition	Left	Sec. & Ter.	Sec. & Ter.	Vil.	Vil.	Vil.
	Right	Vil.	Vil.	Sec.	Sec.	Agr.

Index:

I= Ayeyarwaddy	S= Sunny	G= Green	Sd= Sandy	Pri= Primary
II= May Hka	C= Cloudy	LG= Light Green	Rc= Rocky	Sec= Secondary
III= Mali Hka	R= Rainy	DG= Deep Green	Bd= Boulder	Bam= Bamboo forest
IV= Tributary	W= Windy	CL= Clear	Gv= Gravel	Sft= Shifting Farm
	Sh= Showering	TB= Turbid	Pb= Pebble	Ter= Terrace Farm
	Fg= Foggy	YG= Yellow Green	Md= Muddy	Agr= Agricultural Farm
		YB= Yellow Brown	St= Silty	Vil= Village
		Alg= Algae		GM= Gold Mining
		Bent= Benthos		Bus= Bush
		Mos= Mosses		Camp= Asia World Camp
		Pt= Phytoplankton		Org= Orange Farm
		Mc= Macrophyte		Is= Island
		Td= Toad larvae		

6.2. Aquatic organisms

6.2.1. Myitsone

Recorded lists of phytoplankton, zooplankton, periphyton, phytobenthos and zoobenthos for Myitsone Dam area are as shown in Tables.

6.2.1.1. Phytoplankton:

6.2.1.1.1. Qualitative analysis of Phytoplankton:

There are 64 genera and 205 species from 7 phylums are recorded from this survey. The genera and species compositions in each phylum are 34 genera and 158 species from phylum-Bacillariophyta, 14 genera and 20 species from phylum-Chlorophyta, 10 genera and 18 species from phylum-Cyanophyta, 2 genera and 3 species from phylum-Cryptophyta, 1 genera and 3 species from phylum-Chrysophyta, 2 genera and 2 species from phylum-Pyrrophyta and 1 genus and 1 species from phylum-Euglenophyta. The highest species composition is from phylum-Bacillariophyta and the percentage is about 77.1% (Table 6.2.1.1.1 & 6.2.1.1.2).

Table 6.2.1.1.1. Qualitative analysis of Phytoplankton in Myitsone Dam area.

Sr.	Scientific name	M 1	M 2	M 3	M 4	I	II	III	IV	V	VI
1	<i>Diatoma vulgaris</i>			*							
2	<i>Diatoma tenuis</i>				*						
3	<i>Diatoma mesodon</i>	*	*		*						*
4	<i>Diatoma elongatum</i>		*								
5	<i>Synedra ulna</i> var. <i>contracta</i>									*	*

6	<i>Synedra acus</i>	*	*	*							
7	<i>Rhizosolenia longiseta</i>										
8	<i>Cocconeis placentula</i>										
9	<i>Cocconeis placentula</i> var. <i>euglypta</i>	*	*		*	*		*			
10	<i>Cocconeis pediculus</i>										
11	<i>Fragilaria biceps</i>	*	*		*	*	*	*	*	*	
12	<i>Fragilaria bidens</i>										
13	<i>Fragilaria ulna</i>	*			*	*	*	*	*	*	*
14	<i>Fragilaria ulna</i> var. <i>acus</i>	*									
15	<i>Fragilaria capucina</i>										
16	<i>Fragilaria construens</i>									*	
17	<i>Fragilaria arcus</i>	*	*	*	*					*	*
18	<i>Cymbella</i> sp.	*	*	*		*	*	*		*	*
19	<i>Cymbella minuta</i>	*	*	*	*				*	*	*
20	<i>Cymbella neoleptoceros</i>										
21	<i>Cymbella affinis</i>				*	*					*
22	<i>Cymbella sinuata</i>	*							*		
23	<i>Cymbella cymbiformis</i> var. <i>nonpunctata</i>										
24	<i>Cymbella turgidula</i>					*				*	
25	<i>Cymbella helvetica</i>										
26	<i>Cymbella lanceolata</i>					*			*	*	*
27	<i>Cymbella caespitosa</i>	*									
28	<i>Cymbella perpusilla</i>	*									
29	<i>Cymbella tumida</i>										
30	<i>Achnanthes conspicus</i>	*		*	*						
31	<i>Achnanthes laterostrata</i>										
32	<i>Achnanthes pusilla</i>										
33	<i>Achnanthes biasoletiana</i> var. <i>subatomus</i>	*	*	*	*	*	*	*	*	*	*
34	<i>Achnanthes minutissima</i> var. <i>jackii</i>										
35	<i>Achnanthes lanceolata</i> ssp. <i>frequentissima</i>										
36	<i>Achnanthes crenulata</i>	*									
37	<i>Achnanthes biasoletiana</i>	*	*	*	*	*	*	*	*	*	*
38	<i>Achnanthes minutissima</i>					*					
39	<i>Achnanthes lanceolata</i> ssp. <i>miota</i>										
40	<i>Achnanthes exigua</i> var. <i>heterovalvata</i>				*						
41	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	*									
42	<i>Achnanthes lanceolata</i>			*							
43	<i>Achnanthes minutissima</i> var. <i>saprophila</i>										
44	<i>Achnanthes minutissima</i> var. <i>affinis</i>		*	*	*						
45	<i>Achnanthes hungarica</i>										
46	<i>Achnanthes delicatula</i>		*								
47	<i>Navicula</i> sp1.	*				*	*	*		*	
48	<i>Navicula</i> sp2.										
49	<i>Navicula radiosafallax</i>	*	*	*	*	*			*	*	*
50	<i>Navicula americana</i>										
51	<i>Navicula biasoletiana</i>										

52	<i>Navicula capitatoradiata</i>	*		*	*	*	*	*	*	*	*	*
53	<i>Navicula bacillum</i>			*								
54	<i>Navicula brockmanii</i>											
55	<i>Navicula salinarum</i>	*										
56	<i>Navicula delicatilineolata</i>				*							
57	<i>Navicula schroeteri</i> var. <i>symmetrica</i>											
58	<i>Navicula oligotrphenta</i>					*						
59	<i>Navicula menisculus</i>					*						
60	<i>Navicula mutica</i>											
61	<i>Navicula cryptocephala</i>											
62	<i>Navicula erifuga</i>											
63	<i>Navicula helensis</i>											
64	<i>Navicula pupula</i>											
65	<i>Navicula mutica</i>											
66	<i>Navicula lanceolata</i>	*				*						
67	<i>Navicula viridula</i> var. <i>rostellata</i>											
68	<i>Navicula viridula</i> var. <i>germainii</i>					*						
69	<i>Navicula laterostrata</i>				*				*			
70	<i>Gomphonema</i> sp.											
71	<i>Gomphonema augur</i>											
72	<i>Gomphonema lingulatiformis</i>		*	*		*	*			*	*	*
73	<i>Gomphonema minutum</i>	*	*		*	*	*	*	*	*	*	*
74	<i>Gomphonema pumilum</i>	*	*	*		*	*	*	*	*	*	*
75	<i>Gomphonema augur</i> var. <i>gautieri</i>											
76	<i>Gomphonema rhombicum</i>											
77	<i>Gomphonema bararicum</i>											
78	<i>Gomphonema montanum</i> var. <i>subclavatum</i>											
79	<i>Gomphonema olivaceum</i>	*										
80	<i>Gomphonema parvulum</i>					*			*			
81	<i>Gomphonema parvulum</i> var. <i>parvulus</i>											
82	<i>Gomphonema hebridense</i>											
83	<i>Gomphonema pseudoaugur</i>											
84	<i>Gomphonema truncatum</i>											
85	<i>Nitzschia palea</i>					*						
86	<i>Nitzschia fruticosa</i>											
87	<i>Nitzschia sinuata</i> var. <i>tabellaria</i>											
88	<i>Nitzschia acicularis</i>											
89	<i>Nitzschia</i> sp.	*		*		*		*	*	*	*	*
90	<i>Nitzschia kuetzingiana</i>											
91	<i>Nitzschia nana</i>											
92	<i>Nitzschia vermicularis</i> f. <i>minor</i>											
93	<i>Nitzschia recta</i>				*							
94	<i>Nitzschia reversa</i>											
95	<i>Nitzschia draveillensis</i>			*								
96	<i>Nitzschia frustulum</i>											
97	<i>Nitzschia sochabilis</i>				*							
98	<i>Nitzschia capitellata</i>		*									

99	<i>Nitzschia linearis</i> var. <i>subtilis</i>											
100	<i>Nitzschia sigma</i>					*						
101	<i>Nitzschia gessneri</i>											
102	<i>Nitzschia paleacea</i>			*								
103	<i>Nitzschia dissipata</i>					*			*	*	*	
104	<i>Nitzschia inconspicua</i>	*										
105	<i>Nitzschia amplexans</i>	*										
106	<i>Nitzschia lacuum</i>	*										
107	<i>Epithemia sorex</i>	*										
108	<i>Epithemia adnata</i>											
109	<i>Melosira granulata</i> var. <i>angustissima</i>	*		*	*	*	*	*				
110	<i>Melosira granulata</i> var. <i>angustissima</i> f. <i>spiralis</i>					*	*	*	*			
111	<i>Melosira varians</i>	*	*		*	*	*		*	*	*	
112	<i>Melosira ambigua</i>											
113	<i>Stauroneis</i> sp.					*			*		*	
114	<i>Stauroneis pygmaea</i>											
115	<i>Stauroneis anceps</i>											
116	<i>Stauroneis kriegeri</i>	*	*									
117	<i>Stauroneis anceps</i> var. <i>javanica</i>											
118	<i>Gyrosigma</i> sp.				*							
119	<i>Gyrosigma acuminatum</i>								*			
120	<i>Cyclotella</i> sp.				*				*			
121	<i>Cyclotella stelligera</i>				*							
122	<i>Cyclotella meneghiniana</i>			*								
123	<i>Coscinodiscus</i> sp.											
124	<i>Surirella</i> sp.											
125	<i>Surirella spiralis</i>											
126	<i>Surirella nervosa</i>											
127	<i>Surirella robusta</i>	*				*						
128	<i>Surirella linearis</i>					*						
129	<i>Surirella capronii</i>											
130	<i>Surirella robusta</i> var. <i>splendida</i>			*								
131	<i>Surirella terricola</i>											
132	<i>Surirella brebissonii</i>											
133	<i>Amphora inariensis</i>											
134	<i>Amphora pediculus</i>											
135	<i>Pinnularia braunii</i> var. <i>amphicephala</i>											
136	<i>Pinnularia divergen</i> var. <i>capitata</i>											
137	<i>Pinnularia</i> sp.		*									
138	<i>Pinnularia subgibba</i>											
139	<i>Caloneis molaris</i>											
140	<i>Caloneis silicula</i>											
141	<i>Diploneis ovalis</i>											
142	<i>Diploneis elliptica</i>											
143	<i>Amphipleura</i> sp.				*							
144	<i>Eunotia parallela</i>											
145	<i>Eunotia tridentula</i>											

146	<i>Anomoeoneis spaerophora</i>										
147	<i>Plantzschia amphioxys</i> var. <i>major</i>										
148	<i>Neidium apiculatum</i>										
149	<i>Neidium ampliatus</i>										
150	<i>Cymatopleura solea</i>										
151	<i>Frustulia vulgaris</i>										
152	<i>Frustulia rhomboides</i>										
153	<i>Amphora libyca</i>										
154	<i>Sellaphora bacillum</i>	*									
155	<i>Bacillaria paradoxa</i>	*									
156	<i>Didymosphenia geminata</i>		*								
157	<i>Craticula halophila</i>										
158	<i>Aulacoseira distans</i>			*							
159	<i>Synechocystis minuscula</i>										*
160	<i>Lyngbya semiplena</i>										
161	<i>Lyngbya birgei</i>										
162	<i>Oscillatoria</i> sp.				*						
163	<i>Oscillatoria chlorina</i>			*							*
164	<i>Oscillatoria animalis</i>										
165	<i>Oscillatoria princeps</i>						*	*			
166	<i>Oscillatoria subbrevis</i>	*									
167	<i>Oscillatoria fraga</i>										
168	<i>Anabaena oscillarioides</i>	*			*						
169	<i>Anabaena cylindrica</i>										
170	<i>Nostoc minutum</i>	*									
171	<i>Nostoc spongiaeforme</i>										
172	<i>Phormidium tenue</i>	*		*	*	*			*		
173	<i>Microcystis aeruginosa</i>	*									
174	<i>Merismopedia glauca</i>	*									
175	<i>Chroococcus minutus</i>										
176	<i>Chamaesiphon curvatus</i>										
177	<i>Chlamydomonas</i> sp.										
178	<i>Uronema confervicolum</i>		*								
179	<i>Spirogyra</i> sp.						*	*	*		
180	<i>Hormidium subtile</i>					*					
181	<i>Ulothrix</i> sp.				*						
182	<i>Ulothrix zonata</i>										
183	<i>Ulothrix variabilis</i>										
184	<i>Eudorina elegans</i>										
185	<i>Chlorella vulgaris</i>										
186	<i>Ankistrodesmus falcatus</i> var. <i>mirabilis</i>										
187	<i>Ankistrodesmus angustus</i>				*						
188	<i>Pediastrum tetras</i>			*							
189	<i>Pediastrum simplex</i>										
190	<i>Scenedesmus ellipticus</i>										
191	<i>Microspora stagnorum</i>										
192	<i>Microspora quadrata</i>										
193	<i>Draparnaldia</i> sp.					*		*			

194	<i>Cosmarium nastutum</i>										
195	<i>Staurastrum indentatum</i>										
196	<i>Staurastrum muticum</i>	*									
197	<i>Peridinium</i> sp.										
198	<i>Ceratium hirundinella</i>										
199	<i>Dinobryon seriularia</i>										
200	<i>Dinobryon cylindricum</i>										
201	<i>Dinobryon divergens</i>										
202	<i>Cryptomonas</i> sp.				*						
203	<i>Chroomonas acuta</i>										
204	<i>Cryptomonas ovata</i>					*			*		
205	<i>Euglena</i> sp.										

Solr.	Scientific name	VII	V III	IX	X	XI	XII	X III	X IV	XV
1	<i>Diatoma vulgaris</i>									
2	<i>Diatoma tenuis</i>									
3	<i>Diatoma mesodon</i>								*	
4	<i>Diatoma elongatum</i>					*				
5	<i>Synedra ulna</i> var. <i>contracta</i>									
6	<i>Synedra acus</i>				*					
7	<i>Rhizosolenia longiseta</i>					*				
8	<i>Cocconeis placentula</i>									
9	<i>Cocconeis placeniula</i> var. <i>euglypta</i>	*	*	*	*	*	*	*	*	*
10	<i>Cocconeis pediculus</i>			*	*					*
11	<i>Fragilaria biceps</i>	*	*	*	*	*	*	*	*	*
12	<i>Fragilaria bidens</i>		*			*	*	*	*	
13	<i>Fragilaria ulna</i>				*	*	*	*	*	
14	<i>Fragilaria ulna</i> var. <i>acus</i>									
15	<i>Fragilaria capucina</i>									
16	<i>Fragilaria construens</i>									
17	<i>Fragilaria arcus</i>	*	*			*	*	*	*	*
18	<i>Cymbella</i> sp.	*								
19	<i>Cymbella minuta</i>	*			*	*		*	*	
20	<i>Cymbella neoleptoceros</i>	*								
21	<i>Cymbella affinis</i>	*				*	*	*	*	*
22	<i>Cymbella sinuata</i>	*	*						*	
23	<i>Cymbella cymbiformis</i> var. <i>nonpunctata</i>									
24	<i>Cymbella turgidula</i>									
25	<i>Cymbella helvetica</i>					*				
26	<i>Cymbella lanceolata</i>									
27	<i>Cymbella caespitosa</i>									
28	<i>Cymbella perpusilla</i>									
29	<i>Cymbella tumida</i>									
30	<i>Achnanthes conspicus</i>									
31	<i>Achnanthes laterostrata</i>									
32	<i>Achnanthes pusilla</i>	*								

33	<i>Achnanthes biasoletiana</i> var. <i>subatomus</i>	*	*	*	*	*	*	*	*	*
34	<i>Achnanthes minutissima</i> var. <i>jackii</i>	*								
35	<i>Achnanthes lanceolata</i> ssp. <i>frequentissima</i>	*		*				*		
36	<i>Achnanthes crenulata</i>	*	*			*	*		*	
37	<i>Achnanthes biasoletiana</i>	*	*	*	*	*	*	*	*	*
38	<i>Achnanthes minutissima</i>	*	*	*	*	*	*		*	*
39	<i>Achnanthes lanceolata</i> ssp. <i>miota</i>		*							
40	<i>Achnanthes exigua</i> var. <i>heterovalvata</i>									
41	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	*	*	*	*		*	*	*	
42	<i>Achnanthes lanceolata</i>									
43	<i>Achnanthes minutissima</i> var. <i>saprophila</i>			*						
44	<i>Achnanthes minutissima</i> var. <i>affinis</i>						*	*	*	
45	<i>Achnanthes hungarica</i>								*	
46	<i>Achnanthes delicatula</i>									
47	<i>Navicula</i> sp1.		*		*					*
48	<i>Navicula</i> sp2.									
49	<i>Navicula radiosafallax</i>	*	*	*	*	*	*	*	*	
50	<i>Navicula americana</i>	*								
51	<i>Navicula biasoletiana</i>	*	*		*					
52	<i>Navicula capitatoradiata</i>	*	*	*		*	*	*	*	*
53	<i>Navicula bacillum</i>	*	*	*						
54	<i>Navicula brockmanii</i>		*							
55	<i>Navicula salinarum</i>									
56	<i>Navicula delicatilineolata</i>									
57	<i>Navicula schroeteri</i> var. <i>symmetrica</i>									*
58	<i>Navicula oligotraphenta</i>		*			*		*		
59	<i>Navicula menisculus</i>			*		*			*	
60	<i>Navicula mutica</i>			*						
61	<i>Navicula cryptocephala</i>					*	*			
62	<i>Navicula erifuga</i>					*		*		
63	<i>Navicula helensis</i>						*			
64	<i>Navicula pupula</i>			*						
65	<i>Navicula mutica</i>				*					
66	<i>Navicula lanceolata</i>					*				
67	<i>Navicula viridula</i> var. <i>rostellata</i>					*				
68	<i>Navicula viridula</i> var. <i>germainii</i>									
69	<i>Navicula laterostrata</i>			*		*				
70	<i>Gomphonema</i> sp.	*								
71	<i>Gomphonema augur</i>				*					
72	<i>Gomphonema lingulatifomis</i>	*			*					
73	<i>Gomphonema minutum</i>	*	*		*	*	*	*	*	*
74	<i>Gomphonema pumilum</i>	*	*	*		*	*	*	*	
75	<i>Gomphonema augur</i> var. <i>gautieri</i>	*								
76	<i>Gomphonema rhombicum</i>		*							
77	<i>Gomphonema bararicum</i>		*							
78	<i>Gomphonema montanum</i> var. <i>subclavatum</i>			*						
79	<i>Gomphonema olivaceum</i>			*					*	

80	<i>Gomphonema parvulum</i>	*			*	*		*		
81	<i>Gomphonema parvulum</i> var. <i>parvulus</i>							*		
82	<i>Gomphonema hebridense</i>					*	*			
83	<i>Gomphonema pseudoaugur</i>									
84	<i>Gomphonema truncatum</i>				*					
85	<i>Nitzschia palea</i>	*								
86	<i>Nitzschia fruticosa</i>	*								
87	<i>Nitzschia sinuata</i> var. <i>tabellaria</i>	*		*						
88	<i>Nitzschia acicularis</i>									*
89	<i>Nitzschia</i> sp.	*	*	*	*			*	*	
90	<i>Nitzschia kuetzingiana</i>									*
91	<i>Nitzschia nana</i>		*							
92	<i>Nitzschia vermicularis</i> f <i>minor</i>									*
93	<i>Nitzschia recta</i>						*	*	*	*
94	<i>Nitzschia reversa</i>			*						
95	<i>Nitzschia draveillensis</i>			*						
96	<i>Nitzschia frustulum</i>				*					
97	<i>Nitzschia sochabilis</i>					*				
98	<i>Nitzschia capitellata</i>				*	*		*	*	
99	<i>Nitzschia linearis</i> var. <i>subtilis</i>									*
100	<i>Nitzschia sigma</i>						*			
101	<i>Nitzschia gessneri</i>									
102	<i>Nitzschia paleacea</i>									
103	<i>Nitzschia dissipata</i>		*			*		*		
104	<i>Nitzschia inconspicua</i>									
105	<i>Nitzschia amplexans</i>									
106	<i>Nitzschia lacuum</i>									
107	<i>Epithemia sorex</i>			*	*				*	
108	<i>Epithemia adnata</i>			*						
109	<i>Melosira granulata</i> var. <i>angustissima</i>				*	*	*	*	*	
110	<i>Melosira granulata</i> var. <i>angustissima</i> f. <i>spiralis</i>				*					
111	<i>Melosira varians</i>	*		*	*	*	*	*	*	*
112	<i>Melosira ambigua</i>	*	*		*					*
113	<i>Stauroneis</i> sp.						*			
114	<i>Stauroneis pygmaea</i>		*	*						
115	<i>Stauroneis anceps</i>		*							
116	<i>Stauroneis kriegeri</i>			*	*					
117	<i>Stauroneis anceps</i> var. <i>javanica</i>									
118	<i>Gyrosigma</i> sp.		*							
119	<i>Gyrosigma acuminatum</i>									*
120	<i>Cyclotella</i> sp.				*	*	*	*		
121	<i>Cyclotella stelligera</i>	*			*					
122	<i>Cylotella meneghiniana</i>				*					
123	<i>Coscinodiscus</i> sp.									
124	<i>Surirella</i> sp.						*			
125	<i>Surirella spiralis</i>		*							
126	<i>Surirella nervosa</i>					*				

127	<i>Surirella robusta</i>					*	*	*		
128	<i>Surirella linearis</i>					*	*		*	
129	<i>Surirella capronii</i>						*			
130	<i>Surirella robusta</i> var.splendida									
131	<i>Suriralla terricola</i>									
132	<i>Surirella brebissonii</i>						*			
133	<i>Amphora inariensis</i>	*	*			*	*			
134	<i>Amphora pediculus</i>	*			*					
135	<i>Pinnularia braunii</i> var.amphicephala	*								
136	<i>Pinnularia divergen</i> var.capitata						*			
137	<i>Pinnularia</i> sp.			*			*			*
138	<i>Pinnularia subgibba</i>				*					
139	<i>Caloneis molaris</i>	*								
140	<i>Caloneis silicula</i>					*				
141	<i>Diploneis ovalis</i>	*			*					
142	<i>Diploneis elliptica</i>									
143	<i>Amphipleura</i> sp.									
144	<i>Eunotia parallela</i>		*							
145	<i>Eunotia tridentula</i>									
146	<i>Anomoeoneis spaerophora</i>			*						
147	<i>Plantzschia amphioxys</i> var.major			*			*			
148	<i>Neidium apiculatum</i>				*	*				
149	<i>Neidium ampliutum</i>									
150	<i>Cymatopleura solea</i>					*				
151	<i>Frustulia vulgaris</i>					*				
152	<i>Frustulia rhomboides</i>									
153	<i>Amphora libyca</i>						*			
154	<i>Sellaphora bacillum</i>									
155	<i>Bacillaria paradoxa</i>					*	*	*		*
156	<i>Didymosphenia geminata</i>									
157	<i>Craticula halophila</i>	*								
158	<i>Aulacoseira distans</i>									
159	<i>Synechocystis minuscula</i>			*						
160	<i>Lyngbya semiplena</i>	*								
161	<i>Lyngbya birgei</i>								*	
162	<i>Oscillatoria</i> sp.						*			
163	<i>Oscillatoria chlorina</i>									
164	<i>Oscillatoria animalis</i>			*				*		
165	<i>Oscillatoria princeps</i>									
166	<i>Oscillatoria subbrevis</i>									
167	<i>Oscillatoria fracca</i>									
168	<i>Anabaena oscillarioides</i>	*			*					
169	<i>Anabaena cylindrica</i>									
170	<i>Nostoc minutum</i>		*	*						
171	<i>Nostoc spongiaeforme</i>									
172	<i>Phormidium tenus</i>	*		*		*	*	*		
173	<i>Microcystis aeruginosa</i>									
174	<i>Merismopedia glauca</i>			*						

175	<i>Chroococens minutus</i>			*						
176	<i>Chamnesiphon curvatus</i>									
177	<i>Chlamydomonas</i> sp.				*					
178	<i>Uronema confervicolum</i>									
179	<i>Spirogyra</i> sp.				*	*	*	*	*	
180	<i>Hormidium subtile</i>									
181	<i>Ulothrix</i> sp.					*			*	
182	<i>Ulothrix zonata</i>		*		*		*			
183	<i>Ulothrix variabilis</i>									
184	<i>Eudorina elegans</i>					*				
185	<i>Chlorella vulgaris</i>	*								
186	<i>Ankistrodesmus falcatus</i> var.mirabilis				*					
187	<i>Ankistrodesmus angustus</i>									
188	<i>Pediastrum tetras</i>									
189	<i>Pediastrum simplex</i>								*	
190	<i>Scenedesmus ellipticus</i>									
191	<i>Microspora stagnorum</i>		*							
192	<i>Microspora quadrata</i>									
193	<i>Draparnaidia</i> sp.									
194	<i>Cosmarium nastutum</i>					*				
195	<i>Staurostrum indentatum</i>					*				
196	<i>Staurostrum muticum</i>									
197	<i>Peridinium</i> sp.				*					
198	<i>Ceratium hirundinella</i>									*
199	<i>Dinobryon seriularia</i>				*	*				
200	<i>Dinobryon cylindricum</i>						*			
201	<i>Dinobryon divergens</i>					*	*	*	*	
202	<i>Cryptomonas</i> sp.									
203	<i>Chroomonas acuta</i>				*					
204	<i>Cryptomonas ovata</i>				*	*				*
205	<i>Euglena</i> sp.				*					

Sr.	Scientific name	X VI	XV II	XV III	X IX	XX	XX I	XX II	XX III
1	<i>Diatoma vulgaris</i>								
2	<i>Diatoma tenuis</i>								
3	<i>Diatoma mesodon</i>	*	*			*	*		
4	<i>Diatoma elongatum</i>	*	*				*		
5	<i>Synedra ulna</i> var. <i>contracta</i>								
6	<i>Synedra acus</i>								
7	<i>Rhizosolenia longiseta</i>								
8	<i>Cocconeis placentula</i>		*		*				
9	<i>Cocconeis placeniula</i> var.euglypta	*	*	*	*		*	*	*
10	<i>Cocconeis pediculus</i>							*	*
11	<i>Fragilaria biceps</i>	*	*	*	*		*	*	*
12	<i>Fragilaria bidens</i>							*	
13	<i>Fragilaria ulna</i>		*			*	*	*	*

14	<i>Fragilaria ulna</i> var. <i>acus</i>								
15	<i>Fragilaria capucina</i>					*			
16	<i>Fragilaria construens</i>								
17	<i>Fragilaria arcus</i>	*	*			*	*	*	
18	<i>Cymbella</i> sp.								
19	<i>Cymbella minuta</i>	*	*		*	*	*	*	*
20	<i>Cymbella neoleptoceros</i>								
21	<i>Cymbella affinis</i>	*	*		*	*	*		
22	<i>Cymbella sinuata</i>	*			*	*	*		
23	<i>Cymbella cymbiformis</i> var. <i>nonpunctata</i>			*					
24	<i>Cymbella turgidula</i>		*			*	*		*
25	<i>Cymbella helvetica</i>		*	*					
26	<i>Cymbella lanceolata</i>								
27	<i>Cymbella caespitosa</i>								
28	<i>Cymbella perpusilla</i>								
29	<i>Cymbella tumida</i>				*	*			
30	<i>Achnanthes conspicus</i>								
31	<i>Achnanthes laterostrata</i>	*							
32	<i>Achnanthes pusilla</i>								
33	<i>Achnanthes biasoletiana</i> var. <i>subatomus</i>	*	*	*	*	*	*	*	*
34	<i>Achnanthes minutissima</i> var. <i>jackii</i>						*		
35	<i>Achnanthes lanceolata</i> ssp. <i>frequentissima</i>								
36	<i>Achnanthes crenulata</i>	*	*		*	*	*	*	*
37	<i>Achnanthes biasoletiana</i>	*	*	*	*	*	*	*	*
38	<i>Achnanthes minutissima</i>	*	*	*	*	*	*	*	*
39	<i>Achnanthes lanceolata</i> ssp. <i>miota</i>								
40	<i>Achnanthes exigua</i> var. <i>heterovalvata</i>								
41	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	*	*	*	*	*	*	*	*
42	<i>Achnanthes lanceolata</i>								
43	<i>Achnanthes minutissima</i> var. <i>saprophila</i>		*						*
44	<i>Achnanthes minutissima</i> var. <i>affinis</i>	*	*						
45	<i>Achnanthes hungarica</i>								
46	<i>Achnanthes delicatula</i>		*						
47	<i>Navicula</i> sp1.								*
48	<i>Navicula</i> sp2.								
49	<i>Navicula radiosafallax</i>	*	*	*	*	*	*	*	*
50	<i>Navicula americana</i>	*							
51	<i>Navicula biasoletiana</i>								
52	<i>Navicula capitatoradiata</i>	*	*		*	*	*	*	*
53	<i>Navicula bacillum</i>								
54	<i>Navicula brockmanii</i>								
55	<i>Navicula salinarum</i>				*				
56	<i>Navicula delicatilineolata</i>								
57	<i>Navicula schroeteri</i> var. <i>symmetrica</i>								
58	<i>Navicula oligotrphenta</i>			*	*	*	*		*
59	<i>Navicula menisculus</i>	*	*		*	*		*	*
60	<i>Navicula mutica</i>								
61	<i>Navicula cryptocephala</i>								

62	<i>Navicula erifuga</i>								
63	<i>Navicula helensis</i>								
64	<i>Navicula pupula</i>	*							
65	<i>Navicula mutica</i>								
66	<i>Navicula lanceolata</i>						*	*	
67	<i>Navicula viridula</i> var. <i>rostellata</i>								
68	<i>Navicula viridula</i> var. <i>germainii</i>								
69	<i>Navicula laterostrata</i>								*
70	<i>Gomphonema</i> sp.								
71	<i>Gomphonema augur</i>								
72	<i>Gomphonema lingulatiformis</i>	*	*		*	*			
73	<i>Gomphonema minutum</i>	*	*	*	*	*	*	*	*
74	<i>Gomphonema pumilum</i>	*	*	*	*	*	*	*	*
75	<i>Gomphonema augur</i> var. <i>gautieri</i>								
76	<i>Gomphonema rhombicum</i>								
77	<i>Gomphonema bararicum</i>								
78	<i>Gomphonema montanum</i> var. <i>subclavatum</i>								
79	<i>Gomphonema olivaceum</i>								
80	<i>Gomphonema parvulum</i>		*	*		*			
81	<i>Gomphonema parvulum</i> var. <i>parvulus</i>	*							
82	<i>Gomphonema hebridense</i>								
83	<i>Gomphonema pseudoaugur</i>							*	
84	<i>Gomphonema truncatum</i>								
85	<i>Nitzschia palea</i>								
86	<i>Nitzschia fruticosa</i>								
87	<i>Nitzschia sinuata</i> var. <i>tabellaria</i>								
88	<i>Nitzschia acicularis</i>								
89	<i>Nitzschia</i> sp.	*					*		*
90	<i>Nitzschia kuetzingiana</i>								
91	<i>Nitzschia nana</i>								
92	<i>Nitzschia vermicularis</i> f. <i>minor</i>								
93	<i>Nitzschia recta</i>		*		*	*	*		*
94	<i>Nitzschia reversa</i>								
95	<i>Nitzschia draveillensis</i>							*	
96	<i>Nitzschia frustulum</i>								
97	<i>Nitzschia soehabialis</i>				*	*			
98	<i>Nitzschia capitellata</i>	*							
99	<i>Nitzschia linearis</i> var. <i>subtilis</i>								
100	<i>Nitzschia sigma</i>				*				
101	<i>Nitzschia gessneri</i>			*					
102	<i>Nitzschia paleacea</i>				*				
103	<i>Nitzschia dissipata</i>					*	*	*	*
104	<i>Nitzschia inconspicua</i>								
105	<i>Nitzschia amplexans</i>								
106	<i>Nitzschia lacuum</i>								
107	<i>Epithemia sorex</i>							*	
108	<i>Epithemia adnata</i>							*	
109	<i>Melosira granulata</i> var. <i>angustissima</i>	*	*						

110	<i>Melosira granulata</i> var. <i>angustissima</i> f. <i>spiralis</i>								
111	<i>Melosira varians</i>	*	*			*	*	*	*
112	<i>Melosira ambigua</i>		*						
113	<i>Stauroneis</i> sp.					*			
114	<i>Stauroneis pygmaea</i>								
115	<i>Stauroneis anceps</i>								
116	<i>Stauroneis kriegeri</i>	*						*	*
117	<i>Stauroneis anceps</i> var. <i>javanica</i>	*	*						
118	<i>Gyrosigma</i> sp.								
119	<i>Gyrosigma acuminatum</i>	*							
120	<i>Cyclotella</i> sp.				*				
121	<i>Cyclotella stelligera</i>								
122	<i>Cylotella meneghiniana</i>								
123	<i>Coscinodiscus</i> sp.	*							
124	<i>Surirella</i> sp.								
125	<i>Surirella spiralis</i>								
126	<i>Surirella nervosa</i>								
127	<i>Surirella robusta</i>	*	*						
128	<i>Surirella linearis</i>	*							
129	<i>Surirella capronii</i>								
130	<i>Surirella robusta</i> var. <i>splendida</i>								
131	<i>Suriralla terricola</i>	*							
132	<i>Surirella brebissonii</i>								
133	<i>Amphora inariensis</i>				*		*	*	*
134	<i>Amphora pediculus</i>								
135	<i>Pinnularia braunii</i> var. <i>amphicephala</i>								
136	<i>Pinnularia divergen</i> var. <i>capitata</i>								
137	<i>Pinnularia</i> sp.				*			*	
138	<i>Pinnularia subgibba</i>								
139	<i>Caloneis molaris</i>								
140	<i>Caloneis silicula</i>								
141	<i>Diploneis ovalis</i>								
142	<i>Diploneis elliptica</i>								*
143	<i>Amphipleura</i> sp.								
144	<i>Eunotia parallela</i>								
145	<i>Eunotia tridentula</i>		*						
146	<i>Anomoeoneis spaerophora</i>								
147	<i>Plantzschia amphioxys</i> var. <i>major</i>								
148	<i>Neidium apiculatum</i>								
149	<i>Neidium ampliutum</i>		*						
150	<i>Cymatopleura solea</i>								
151	<i>Frustulia vulgaris</i>								
152	<i>Frustulia rhomboides</i>							*	
153	<i>Amphora libyca</i>								
154	<i>Sellaphora bacillum</i>								
155	<i>Bacillaria paradoxa</i>	*	*		*			*	
156	<i>Didymosphenia geminata</i>								
157	<i>Craticula halophila</i>				*	*			

158	<i>Aulacoseira distans</i>								
159	<i>Synechocystis minuscula</i>								
160	<i>Lyngbya semiplena</i>		*						
161	<i>Lyngbya birgei</i>	*							
162	<i>Oscillatoria</i> sp.								
163	<i>Oscillatoria chlorina</i>			*		*	*		
164	<i>Oscillatoria animalis</i>			*					
165	<i>Oscillatoria princeps</i>								
166	<i>Oscillatoria subbrevis</i>								
167	<i>Oscillatoria fraca</i>		*						
168	<i>Anabaena oscillarioides</i>								
169	<i>Anabaena cylindrica</i>							*	
170	<i>Nostoc minutum</i>			*				*	
171	<i>Nostoc spongiaeforme</i>						*		
172	<i>Phormidium tenue</i>	*	*						
173	<i>Microcystis aeruginosa</i>								
174	<i>Merismopedia glauca</i>								
175	<i>Chroococcus minutus</i>								
176	<i>Chamnesiphon curvatus</i>					*			
177	<i>Chlamydomonas</i> sp.								
178	<i>Uronema confervicolum</i>								
179	<i>Spirogyra</i> sp.								
180	<i>Hormidium subtile</i>								
181	<i>Ulothrix</i> sp.						*		
182	<i>Ulothrix zonata</i>	*	*	*		*	*		
183	<i>Ulothrix variabilis</i>			*					
184	<i>Eudorina elegans</i>								
185	<i>Chlorella vulgaris</i>			*					
186	<i>Ankistrodesmus falcatus</i> var. <i>mirabilis</i>								
187	<i>Ankistrodesmus angustus</i>								
188	<i>Pediastrum tetras</i>	*							
189	<i>Pediastrum simplex</i>								
190	<i>Scenedesmus ellipticus</i>								
191	<i>Microspora stagnorum</i>								
192	<i>Microspora quadrata</i>						*		
193	<i>Draparnaldia</i> sp.								
194	<i>Cosmarium nastutum</i>								
195	<i>Staurostrum indentatum</i>								
196	<i>Staurostrum muticum</i>								
197	<i>Peridinium</i> sp.								
198	<i>Ceratium hirundinella</i>								
199	<i>Dinobryon seriularia</i>								
200	<i>Dinobryon cylindricum</i>								
201	<i>Dinobryon divergens</i>								
202	<i>Cryptomonas</i> sp.								
203	<i>Chroomonas acuta</i>								
204	<i>Cryptomonas ovata</i>	*							
205	<i>Euglena</i> sp.								

Table 6.2.1.1.2.. Phytoplankton species composition and percentage.

Phylum	Cyano phyta	Chrypto phyta	Bacillario phyta	Chloro phyta	Pyrro phyta	Chryso phyta	Eugleno phyta	Total
Species	18	3	158	20	2	3	1	205
Percentage (%)	8.78	1.46	77.1	9.76	0.98	1.46	0.49	100

6.2.1.1.2. Quantitative analysis ofPhytoplankton:

The highest density was recorded about 32.4×10^5 cells/L in station XII (near Pampa village, Ayeyarwaddy River) and the lowest was about 0.12×10^5 cells/L in station XV (Pungre Hka Tributary). The mean concentration of Myitsone dam area is about 5.55×10^5 cells/L (Table 6.2.1.1.3).

Table 6.2.1.1.3. Phytoplankton density in each sampling stations.

Sampling station	M1	M2	M3	M4	I	II	III	IV	V	VI	VII	VIII	IX	X
Density (10^5 cells/L)	2.35	3.96	1.21	13.1 7	5.05	1.11	3.66	3.61	5.79	6.19	2.6	4.31	3.54	15.4 4
Sampling station	X I	X II	X III	X IV	X V	X VI	X VII	X VIII	X IX	XX	XX I	XX II	XX III	Mea n
Density (10^5 cells/L)	5.1	3.2 4	3.22	2.82	0.12	3.76	3.42	0.78	8.66	11.78	3.0 2	1.58	1.21	5.55

6.2.1.1.3. Common phytoplankton found in Myitsone Dam area.

Due to the surveyed data, the highest species composition was recorded from station XI (near Yekyi Village, Ayeyarwaddy River), 51 species and the lowest species composition was recorded from station I (infront of Asia World Camp, Ayeyarwaddy River) & II (Mali Hka River), 16 species. Common species found in the surveyes stations are *Achnanthes biasoletiana*, *Gomphonema minutum*, *Fragilaria biceps* and *Cymbella affinis*.

6.2.1.2. Zooplankton:

6.2.1.2.1. Qualitative analysis of Zooplankton.

There are 67 species from Protozoa, 32 species from Rotifera and 25 species from Crustacea recorded from Myitsone dam area. The highest species composition is Protozoa and the percentage is about 54.03% (Table 6.2.1.2.1 to 6.2.1.2.4).

Table 6.2.1.2.1. Qualitative analysis of Protozoa in Myitsone Dam area.

Sr.	Species	V II	V II I	I X	X	X I	X II	X II I	X I V	X V	X V I	X V II	X V II I	X I X	X X	X X I	X X II	X X II I	M I	M 2	M 3	M 4
1	<i>Amoeba</i> sp.	*																				
2	<i>Polychaos timidium</i>					*		*														
3	<i>Saccamoeba gongornia</i>		*																			*
4	<i>Arcella gibbosa</i>																				*	
5	<i>Arcella discoides</i>	*	*	*		*		*			*	*		*	*			*	*	*	*	
6	<i>Arcella hemisphaerica</i>	*			*		*				*	*	*	*	*	*	*		*	*		
7	<i>Arcella hemisphaerica undulate</i>			*										*							*	*
8	<i>Arcella rotundata</i>	*		*																		
9	<i>Arcella rotundata</i>																*					*
10	<i>Arcella vulgaris</i>					*	*															
11	<i>Nebela collaris</i>																			*		
12	<i>Quadrullella symmetrica</i>										*				*					*		
13	<i>Diffugia globulosa</i>				*	*	*	*	*	*	*	*	*		*			*	*		*	*
14	<i>Diffugia acuminata</i>			*			*	*														
15	<i>Diffugia oblonga</i>						*								*				*			
16	<i>Diffugia lucida</i>	*																				
17	<i>Diffugia avellana</i>						*															*
18	<i>Diffugia hydrostatica lithophila</i>							*														
19	<i>Diffugia gramen</i>							*														
20	<i>Diffugia mamillaris</i>									*												
21	<i>Diffugia</i> sp.									*												

22	<i>Centropyxis aerophila aerophila</i>																					*
23	<i>Centropyxis platystoma</i>						*	*		*	*		*	*				*	*	*	*	*
24	<i>Centropyxis platystoma armata</i>											*										
25	<i>Centropyxis constricta</i>		*				*			*			*					*	*	*		
26	<i>Centropyxis aculeata</i>	*	*	*		*	*	*	*				*		*	*	*	*	*			*
27	<i>Centropyxis aculeata grandis</i>	*								*												
28	<i>Centropyxis ecornis</i>					*	*	*	*	*			*									
29	<i>Centropyxis ecornis leidyi</i>																			*	*	
30	<i>Centropyxis discoides</i>																	*				
31	<i>Centropyxis minuta</i>																					*
32	<i>Cyclopyxis arcellodes</i>							*		*									*			*
33	<i>Cyclopyxis deflandrei</i>									*	*		*	*		*	*			*		
Sr.	Species	V II	V II I	I X	X	X I	X II	X II I	X I V	X V	X V I	X V II	X V II I	X I X	X X	X X I	X X II	X X II I	M 1	M 2	M 3	M 4
34	<i>Pontigulasia incisa</i>					*	*	*														
35	<i>Phryganella nidulus</i>																					*
36	<i>Wailesella</i> sp.			*			*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
37	<i>Euglypha filifera</i>	*		*		*											*					
38	<i>Euglypha rotunda</i>			*		*																
39	<i>Euglypha</i> sp.								*													
40	<i>Cyphoderia ampulla</i>						*	*										*	*			
41	<i>Pseudodifflugia gracilis</i>																					
42	<i>Pamphagus</i> sp.																					
43	<i>Plagiophrys scutiformis</i>																	*		*		
44	<i>Lieberkuhnia wagneri</i>				*																	
45	<i>Holophrya atra</i>																					*
46	<i>Coleps</i> sp.						*															
47	<i>Didinium balbianii nanum</i>				*																	
48	<i>Mesodinium pulex</i>				*				*													
49	<i>Lagynophrya conifera</i>				*																	
50	<i>Podophrya fixa</i>																	*				
51	<i>Sphaerophrya</i> sp.																				*	
52	<i>Hemiophrys</i> sp.				*	*																
53	<i>Litonotus</i> sp.							*														
54	<i>Vorticella</i> sp.			*			*															
55	<i>Epistylis rotans</i>													*								
56	<i>Cothurnia oblonga</i>																					
57	<i>Ophryolena</i> sp.				*																	*
58	<i>Malacophrys rotans</i>		*	*																		

24	<i>Ascomorpha</i> sp.		*															
25	<i>Synchaeta</i> sp.						*											
26	<i>Polyarthra vulgaris</i>			*		*												
27	<i>Trichocerca cylindrica</i>				*													
28	<i>Trichocerca pusilla</i>									*								
29	<i>Pompholyx sulcata</i>				*		*	*										
30	<i>Philodina</i> sp.	*		*	*				*		*		*	*				
31	<i>Habrotrocha</i> sp.			*														

Table 6.2.1.2.3. Qualitative analysis of Crustacea in Myitsone Dam area.

	Species	Station	V II	X	X I	X II	X III	X IV	X V	X VI	XX I	M 1	M 2
	Cladocera												
	Division Eucladocera												
	Superfamily Sidoidea												
	Family Sididae												
	<i>Diaphanosom</i>												
1	<i>Diaphanosoma leuchtenbergianum</i>			*									
	Superfamily Chydoroidea												
	Daphniidae												
	<i>Ceriodaphnia</i>												
2	<i>Ceriodaphnia cornuta</i>					*							
3	<i>Ceriodaphnia quadrangula</i>			*	*								
	Family Bosminidae												
	<i>Bosmina</i>												
4	<i>Bosmina longirostris</i>			*		*	*						
5	<i>Bosmina coregoni</i>			*			*						
6	<i>Bosmina fatalis</i>						*						
	Family Chydoridae												
	<i>Alona</i>												
7	<i>Alona guttata</i>			*									
	<i>Chydorus</i>												
8	<i>Chydorus sphaericus</i>			*									
	Copepoda												
	Harpacticoidae												
9	<i>Harpacticoida</i> sp.											*	
	Chirognatha												
	Canthocamptidae												
	<i>Mesochra</i>												

10	<i>Mesochra</i> sp.						*						
	Parastenocaridae												
	<i>Parastenocaris</i>												
11	<i>Parastenocaris brevipes</i>						*						
	Cyclopoida												
	Cyclopidae												
	<i>Eucyclops</i>												
12	<i>Eucyclops serrulatus</i>			*		*							
13	<i>Eucyclops macruioides denticulatus</i>			*									
	<i>Paracyclops</i>												
14	<i>Paracyclops fimbriatus</i>											*	
15	<i>Paracyclops</i> sp.						*	*					
	<i>Acanthocyclops</i>												
16	<i>Acanthocyclops viridis</i>						*						
	<i>Microcyclops</i>												
17	<i>Microcyclops varicans</i>		*		*		*						
	<i>Mesocyclops</i>												
18	<i>Mesocyclops leuckarti</i>		*	*		*							
19	<i>Mesocyclops pehpeiensis</i>		*										
	<i>Thermocyclops</i>												
20	<i>Thermocyclops mongolicus</i>					*							
21	<i>Thermocyclops vermifer</i>		*										
22	<i>Thermocyclops hyalinus</i>		*										
23	<i>Nauplius</i>	*	*	*		*	*		*	*	*	*	*
24	<i>Calanoida larva</i>		*										
25	<i>Cyclopida larva</i>		*	*		*	*						

Table 6.2.1.2.4. Zooplankton variety composition and percentage.

	Protozoa	Rotifera	Crustacea	Total
Species	67	32	25	124
Percentage (%)	54.03	25.81	20.16	100

6.2.1.2.2. Common Zooplankton found in Myitsone Dam area.

Due to the surveyed data, the highest species composition for Protozoa recorded from station M-4 (near Balamintin Bridge, Ayeyarwaddy River) was 18 and the lowest species composition recorded from station XVIII (Taunghepe Hka Tributary) was 3. Common species found in the surveyes stations are *Arcella discoides*, *Arcella hemisphaerica*, *Diffugia globulosa*, *Centropyxis platystoma*, *Centropyxis aculeate*, *Waillesella* sp..

The highest species composition of rotifera recorded from station XI (near Yekyi Village, Ayeyarwaddy River) was 9 and the lowest composition from station XX (May Hka River) and M-2 (May Hka River) was 1. *Colurella adriatica*, *Epiphanes* sp., *Cephalodella innesi*, *Philodina* sp. were found as common species in Myitsone dam area.

For crustacea, the highest species composition was recorded in station X (near Tarlawgyi Village, Ayeyarwaddy River), XI (near Yekyi Village, Ayeyarwaddy River) and XIV (near Waing Maw, Ayeyarwaddy River) was 10 and the lowest was in VII (Hpungin Hka Tributary, Mali Hka River), XII (near Pampa Village, Ayeyarwaddy River), XV (Pungre Hka Tributary), XVI (near N'Gen Village, Ayeyarwaddy River), XXI (near Khalone Island, May Hka River) and M-2 (May Hka River) and 1 species was recorded.

6.2.1.3. Periphyton:

6.2.1.3.1. Qualitative analysis of Periphyton:

There are 26 genera and 125 species of periphyton recorded from Myitsone Dam area. Among them, 31 species from genus-*Navicula*, 16 species from genus-*Achnanthes*, 13 species from genus-*Nitzschia* and 10 species from genus-*Cymbella* were recorded. The highest composition is genus *Navicula* and the percentage is about 24.8% (Table 6.2.1.3.1 & 6.2.1.3.2).

Table 6.2.1.3.1. Qualitative analysis of Periphyton in Myitsone Dam area.

Sr.	Genus	Species	Mali Hka Tributary of	Mali Hka	Nmai Hka Tributary of	Nmai Hka	Ayeyarwaddy Tributary of	Ayeyarwaddy
1	<i>Achnanthes</i>	<i>Achnanthes atomus</i>	*	*	*	*	*	*
2		<i>Achnanthes biasoletti</i>	*	*	*	*	*	*
3		<i>Achnanthes biasoletti</i> var. <i>subatomus</i>	*	*	*	*	*	*
4		<i>Achnanthes catenatum</i>	*			*	*	*
5		<i>Achnanthes conspicua</i>					*	
6		<i>Achnanthes crenulata</i>	*		*	*		
7		<i>Achnanthes exigua</i>	*	*	*		*	*
8		<i>Achnanthes hungarica</i>				*	*	
9		<i>Achnanthes lanceolata</i>	*			*	*	*
10		<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	*	*	*		*	*
11		<i>Achnanthes minutissima</i>	*	*	*	*	*	*
12		<i>Achnanthes minutissima</i> var. <i>affinis</i>	*	*	*	*	*	*
13		<i>Achnanthes minutissima</i> var. <i>gracillima</i>	*		*	*	*	*
14		<i>Achnanthes minutissima</i> var. <i>saprophila</i>			*	*	*	*
15		<i>Achnanthes rupestoides</i>			*			
16		<i>Achnanthes subhudsonis</i>	*	*	*	*	*	*
17	<i>Amphi</i>	<i>Amphipleura pellucida</i>			*			

	<i>pleura</i>							
18	<i>Amphora</i>	<i>Amphora fontinalis</i>	*		*			
19		<i>Amphora montana</i>			*	*	*	
20		<i>Amphora pediculus</i>	*		*		*	*
21	<i>Anomoeoneis</i>	<i>Anomoeoneis pseudotusculus</i>	*					
22	<i>Bacillaria</i>	<i>Bacillaria paradoxa</i>	*	*	*		*	*
23	<i>Cocconeis</i>	<i>Cocconeis pediculus</i>	*					
24		<i>Cocconeis placentula</i> var. <i>lineata</i>	*		*			*
25		<i>Cocconeis placentula</i>			*	*	*	*
26	<i>Crymatopleura</i>	<i>Crymatopleura solea</i>	*					
27	<i>Cymbella</i>	<i>Cymbella cymbiformis</i>					*	
28		<i>Cymbella cymbiformis</i> var. <i>nonpunctata</i>	*					
Sr.	Genus	Species	Mali Hka Tributary of	Mali Hka	Nmai Hka Tributary of	Nmai Hka	Ayeyarwaddy Tributary of	Ayeyarwaddy
29	<i>Denticula</i>	<i>Cymbella delicatula</i>				*	*	
30		<i>Cymbella lacustris</i>	*	*		*		*
31		<i>Cymbella microcephala</i>				*	*	*
32		<i>Cymbella minuta</i>		*	*	*	*	*
33		<i>Cymbella perpusilla</i>				*		
34		<i>Cymbella sinuata</i>			*			
35		<i>Cymbella tumida</i>		*	*	*	*	*
36		<i>Cymbella turgidula</i>	*	*	*	*	*	*
37		<i>Denticula tenuis</i>		*				
38	<i>Diadensis</i>	<i>Diadensis confervacea</i>					*	*
39		<i>Diadensis contenta</i>					*	
40	<i>Diatoma</i>	<i>Diatoma mesadon</i>				*		*
41		<i>Diatoma problematica</i>						*
42	<i>Diploneis</i>	<i>Diploneis elliptica</i>	*					
43		<i>Diploneis marginestriata</i>	*					
44		<i>Diploneis oblongella</i>			*			
45	<i>Epithemia</i>	<i>Epithemia adnata</i>	*		*			*
46		<i>Epithemia sores</i>	*		*			*

47	Fragilaria	<i>Fragilaria arcus</i>				*		*
48		<i>Fragilaria capucina</i>	*		*	*	*	*
49		<i>Fragilaria capucina</i> var. <i>vaucheriae</i>				*		*
50		<i>Fragilaria crotonensis</i>				*	*	
51		<i>Fragilaria fasciculata</i>			*			
52		<i>Fragilaria pinnata</i>						*
53		<i>Fragilaria pseudogaillonii</i>	*	*	*	*	*	*
54		<i>Fragilaria ulna</i>				*	*	*
55	Frustulum	<i>Frustulum</i> sp	*					
56		<i>Frustulum vulgaris</i>			*		*	
57	Gomphonema	<i>Gomphonema augur</i> var. <i>gautieri</i>					*	
58		<i>Gomphonema bicep</i>		*				
59		<i>Gomphonema clavatum</i>	*	*	*			
60		<i>Gomphonema clevei</i>	*	*	*	*	*	*
61		<i>Gomphonema minutum</i>	*	*	*	*	*	*
Sr.	Genus	Species	Mali Hka Tributary of	Mali Hka	Nmai Hka Tributary of	Nmai Hka	Ayeyarwaddy Tributary of	Ayeyarwaddy
62		<i>Gomphonema parvulum</i>	*	*	*	*		*
63		<i>Gomphonema parvulum</i> var. <i>exilissimum</i>					*	
64		<i>Gomphonema pumilum</i>	*		*	*		*
65		<i>Gomphonema rhombicum</i>	*		*	*	*	
66		<i>Gomphonema claratum</i>					*	
67		<i>Gomphonema sphnerophorum</i>			*			
68	Gyrosigma	<i>Gyrosigma acuminatum</i>					*	*
69		<i>Gyrosigma scalproides</i>		*				
70	Luticola	<i>Luticola mutica</i>			*		*	*
71	Melosira	<i>Melosira varians</i>		*	*	*	*	*
72	Navicula	<i>Navicula arvensis</i>		*	*			
73		<i>Navicula atomus</i>			*		*	*
74		<i>Navicula atomus</i> var. <i>permitis</i>	*		*		*	*
75		<i>Navicula bryophila</i>			*	*	*	*
76		<i>Navicula capitatoradiata</i>	*		*	*		*
77		<i>Navicula cincta</i>			*	*	*	*

78		<i>Navicula cryptocephala</i>		*	*	*		*
79		<i>Navicula cryptotenella</i>	*		*	*	*	*
80		<i>Navicula decussis</i>			*			*
81		<i>Navicula delicatilineolata</i>			*	*	*	*
82		<i>Navicula erifuga</i>				*		
83		<i>Navicula gregaria</i>			*			*
84		<i>Navicula heimansioides</i>			*	*		
85		<i>Navicula lanceolata</i>				*		
86		<i>Navicula minuma</i>	*	*	*	*	*	*
87		<i>Navicula minuscula</i>	*	*				
88		<i>Navicula minuscula</i> <i>var. grunowii</i>	*	*	*	*	*	*
89		<i>Navicula notha</i>			*		*	*
90		<i>Navicula novaesiberica</i>						*
91		<i>Navicula obtecta</i>	*					
92		<i>Navicula oligotraphenta</i>			*			
93		<i>Navicula perpusilla</i>				*		
94		<i>Navicula radiosafallax</i>	*	*	*			
Sr.	Genus	Species	Mali Hka Tributary of	Mali Hka	Nmai Hka Tributary of	Nmai Hka	Ayeyarwaddy Tributary of	Ayeyarwaddy
95		<i>Navicula reichardtiana</i>		*	*			*
96		<i>Navicula schroeteri</i> var. <i>symmetrica</i>		*		*	*	*
97		<i>Navicula seminulum</i>					*	
98		<i>Navicula</i> sp1						*
99		<i>Navicula subminuscula</i>					*	*
100		<i>Navicula thermaloides</i>					*	
101		<i>Navicula viridula</i>			*			
102		<i>Navicula viridula</i> <i>var. rostellata</i>					*	*
103	<i>Neidium</i>	<i>Neidium affine</i> var. <i>humerus</i>	*					
104		<i>Neidium dubium</i>	*					
105	<i>Nitzschia</i>	<i>Nitzschia amphibian</i>				*		
106		<i>Nitzschia angustatula</i>			*			
107		<i>Nitzschia clausii</i>		*	*		*	*
108		<i>Nitzschia dissipata</i>		*	*	*	*	*
109		<i>Nitzschia flexa</i>					*	

110		<i>Nitzschia frustulum</i>	*	*	*			*
111		<i>Nitzschia incospicua</i>	*		*		*	*
112		<i>Nitzschia linearis</i>						*
113		<i>Nitzschia palea</i>	*	*	*	*	*	*
114		<i>Nitzschia paleacea</i>			*		*	
115		<i>Nitzschia paleaeformis</i>					*	*
116		<i>Nitzschia recta</i>						*
117		<i>Nitzschia sinuata var. tabellaria</i>	*		*			
118	<i>Pinnularia</i>	<i>Pinnularia</i> sp			*		*	*
119	<i>Rhopalodia</i>	<i>Rhopalodia gibba</i>	*					
120		<i>Sellaphora bacillum</i>				*		
121	<i>Sellaphora</i>	<i>Sellaphora japonica</i>	*		*	*	*	
122		<i>Sellaphora pupula</i>	*			*	*	*
123		<i>Surirella angusta</i>			*	*	*	*
124	<i>Surirella</i>	<i>Surirella linearis</i>		*	*		*	*
125		<i>Surirella robusta</i>			*		*	

Table 6.2.1.3.2. Periphyton species composition and percentage.

Genus	<i>Achnanthes</i>	<i>Amphipleura</i>	<i>Amphora</i>	<i>Anomoeoneis</i>	<i>Bacillaria</i>	<i>Cocconeis</i>	<i>Cryptatopleura</i>	<i>Cymbella</i>	<i>Denticula</i>	<i>Diadesmids</i>	<i>Diatoma</i>	<i>Diplolepis</i>	<i>Epithemia</i>	<i>Fragilaria</i>
Species	16	1	3	1	1	3	1	10	1	2	2	3	2	8
Percentage (%)	12.8	0.8	2.4	0.8	0.8	2.4	0.8	8.0	0.8	1.6	1.6	2.4	1.6	6.4
Genus	<i>Frustulu</i>	<i>Gomphonema</i>	<i>Gyrosigma</i>	<i>Luticola</i>	<i>Melosira</i>	<i>Navicula</i>	<i>Neidium</i>	<i>Nitzschia</i>	<i>Pinnularia</i>	<i>Rhopalodia</i>	<i>Sellaphora</i>	<i>Surirella</i>	Total	
Species	2	11	2	1	1	31	2	13	1	1	3	3	125	
Percentage (%)	1.6	8.8	1.6	0.8	0.8	24.8	1.6	10.4	0.8	0.8	2.4	2.4	100	

6.2.1.3.2. Quantitative analysis of Periphyton:

The density of periphyton is higher in Tributaries of Ayeyarwaddy River and concentration is about 11.40×10^{10} ind./m². The lowest density, 0.28×10^{10} ind./m² was recorded from Mali Hka. Mean density of periphyton is about 5.12×10^{10} ind./m² in Myitsone area.

6.2.1.3.3. Common periphyton found in Myitsone Dam area.

Common species found in Myitsone dam area are *Achnanthes atomus*, *Achnanthes biasoletti*, *Ananthes biasoletti* var. *subatomus*, *Achnanthes minutissima*, *Achnanthes minutissima* var. *affinis*, *Achnanthes subhudsonis*, *Cymbella turgidula*, *Fragilaria pseudogaillonii*, *Gomphonema clevei*, *Gomphonema minutum* and *Navicula minuma* and *Nitzschia palea*.

The highest species composition is recorded from the tributary of May Hka and species list is about 71 species. The lowest species composition is from Mali Hka and species composition is about 35 species.

6.2.1.4. Benthos:

6.2.1.4.1. Qualitative analysis of Benthos:

There are 75 species from 3 phylums of benthos recorded from Myitsone Dam area. Among them, phylum-Arthropoda is dominant and 71 species found from this phylum. The composition of phylum-Arthropoda is about 94.67% (Table 6.2.1.4.1 & 6.2.1.4.2).

Table 6.2.1.4.1. Qualitative analysis of Benthos in Myitsone Dam area.

	Phylum	Arthropoda																			
	Class	Isecta																			
No	Order	Family	Genus	Species	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	
1	Odonata	Enphaeidae		Enphaeidae sp.												*				*	
2	Odonata	Gomphidae	<i>Stylogomphus</i>	<i>Stylogomphus</i> sp.		*															
3	Odonata	Gomphidae	<i>Leptogomphus</i>	<i>Leptogomphus</i> sp.										*							
4	Odonata	Gomphidae	<i>Megalogomphus</i>	<i>Megalogomphus</i> sp.										*							
5	Odonata	Gomphidae	<i>Phaenandrogomphus</i>	<i>Phaenandrogomphus</i> sp.		*	*									*					
6	Odonata	Gomphidae	<i>Lamelligomphus</i>	<i>Lamelligomphus</i> sp.												*		*			
7	Plecoptera	Perlidae		Perlidae sp.		*	*									*		*	*	*	
8	Plecoptera	Peltoperlidae		Peltoperlidae sp.												*					
9	Plecoptera	Nemouridae		Nemouridae sp.												*					
10	Ephemeroptera	Heptageniidae	<i>Rhithrogena</i>	<i>Rhithrogena</i> sp.			*									*					
11	Ephemeroptera	Heptageniidae	<i>Cinygmina</i>	<i>Cinygmina</i> sp.		*									*	*		*	*	*	
12	Ephemeroptera	Heptageniidae	<i>Heptagenia</i>	<i>Heptagenia</i> sp.												*					
13	Ephemeroptera	Heptageniidae		Heptageniidae sp.		*															
14	Ephemeroptera	Ephemerallidae	<i>Cincticostella</i>	<i>Cincticostella insolita</i>												*					
15	Ephemeroptera	Ephemerallidae	<i>Notacanthella</i>	<i>Notacanthella quadrata</i>												*		*			
16	Ephemeroptera	Ephemerallidae		Ephemerallidae sp.												*	*	*		*	

17	Ephemeroptera	Isonychiidae		Isonychiidae sp.												*	*	*		*
18	Ephemeroptera	Baetidae	<i>Baetis</i>	<i>Baetis</i> sp.	*	*	*	*	*	*						*	*	*	*	*
19	Ephemeroptera	Baetidae	<i>Pseudocloeon</i>	<i>Pseudocloeon</i> sp.	*	*										*	*	*	*	
20	Ephemeroptera	Leptophlebiidae		Leptophlebiidae sp.		*	*									*	*		*	*
21	Ephemeroptera	Teloganodidae		Teloganodidae sp.		*														
22	Ephemeroptera	Caenidae		Caenidae sp.					*	*							*	*		
23	Ephemeroptera	Ephemeridae		Ephemeridae sp.					*											*
24	Trichoptera	Glossosomatidae		Glossosomatidae sp.														*		
25	Trichoptera	Philopotamidae		Philopotamidae sp.														*		
26	Trichoptera	Hydropsychidae	<i>Macrostemum</i>	<i>Macrostemum</i> sp.												*				
27	Trichoptera	Hydropsychidae	<i>Ceratopsyche</i>	<i>Ceratopsyche</i> sp.												*	*	*	*	*
28	Trichoptera	Helicopsychidae	<i>Helicopsyche</i>	<i>Helicopsyche</i> sp.												*	*	*	*	
29	Trichoptera	Xiphocentronidae	<i>Melanotrichia</i>	<i>Melanotrichia</i> sp.												*	*		*	
30	Trichoptera	Leptoceridae		Leptoceridae sp.	*												*		*	
31	Trichoptera	Hydroptilidae		Hydroptilidae sp.					*							*				
32	Trichoptera	Ecnomidae	<i>Ecnomus</i>	<i>Ecnomus</i> sp.													*			
33	Trichoptera	Psychomyiidae		Psychomyiidae sp.													*			
34	Trichoptera	Stenopsychidae	<i>Stenopsyche</i>	<i>Stenopsyche</i> sp.												*	*	*	*	*
35	Coleoptera	Elmidae		Elmidae sp.		*											*		*	
36	Coleoptera	Psephenida		Psephenidae sp1.		*													*	*
37	Coleoptera	Psephenidae		Psephenidae sp2.															*	*
38	Coleoptera	Lepiceridae		Lepiceridae sp.		*												*		
39	Coleoptera	Gyrinidae		Gyrinidae sp.													*	*		
40	Coleoptera	Scirtidae		Scirtidae sp.													*			
41	Coleoptera	Micromalthidae		Micromalthidae sp.													*			
42	Coleoptera	Ptilodactylidae		Ptilodactylidae sp.		*														
43	Hemiptera	Gelastocoridae		Gelastocoridae sp.													*			*
44	Hemiptera	Gerridae	<i>Phyacobates</i>	<i>Phyacobates</i> sp.			*													
45	Hemiptera	Aphelocheiridae		Aphelocheiridae sp.		*	*									*				*
46	Hemiptera	Corixidae		Corixidae sp.					*	*										
47	Diptera	Tabanidae		Tabanidae sp.												*	*			
48	Diptera	Ceratopogonidae		Ceratopogonidae sp.												*				
49	Diptera	Athericidae		Athericidae sp.		*														
50	Diptera	Simuliidae		Simuliidae sp.													*	*	*	*
51	Diptera	Tipulidae	<i>Limoniinae</i>	<i>Limnophila</i> sp.		*	*										*	*	*	*
52	Diptera	Tipulidae	<i>Limoniinae</i>	<i>Limnophila</i> sp.		*														
53	Diptera	Tipulidae	<i>Antocha</i> sp	<i>Antocha</i> sp.												*	*	*	*	*
54	Diptera	Tipulidae	<i>Limoniinae</i>	<i>Limnophila</i> sp.													*			
55	Diptera	Chironomidae	<i>Polypedilum</i>	<i>Polypedilum</i> sp1													*			
56	Diptera	Chironomidae	<i>Polypedilum</i>	<i>Polypedilum</i> sp2	*				*	*						*	*	*	*	*

57	Diptera	Chironomidae	<i>Thienemannimyia</i>	<i>Thienemannimyia</i> sp.		*				*	*				*	*	*	*		
58	Diptera	Chironomidae	<i>Eukiefferiella</i>	<i>Eukiefferiella</i> sp.												*				
59	Diptera	Chironomidae	<i>Cryptochironomus</i>	<i>Cryptochironomus</i> sp.												*				
60	Diptera	Chironomidae	<i>Rheotanytarsus</i>	<i>Rheotanytarsus</i> sp.		*									*	*				
61	Diptera	Chironomidae	<i>Tanytarsus</i>	<i>Tanytarsus</i> sp.						*	*							*		
62	Diptera	Chironomidae	<i>Robackia</i>	<i>Robackia</i> sp.		*										*				
63	Diptera	Chironomidae	<i>Apedilum</i>	<i>Apedilum</i> sp.														*		
64	Diptera	Chironomidae	<i>Platysmittia</i>	<i>Platysmittia</i> sp.											*					
65	Diptera	Chironomidae	<i>Orthocladius</i>	<i>Orthocladius</i> sp.						*					*			*	*	
66	Diptera	Chironomidae	<i>Chironomus</i>	<i>Chironomus</i> sp.						*										
67	Diptera	Chironomidae	<i>Microtendipes</i>	<i>Microtendipes</i> sp.						*										
68	Diptera	Chironomidae	<i>Procladius</i>	<i>Procladius</i> sp.						*										
69	Diptera	Chironomidae	<i>Parachironomus</i>	<i>Parachironomus</i> sp.															*	
70	Diptera			pupae						*	*				*					
	Class	Crustacea																		
No	Order	Family	Genus	Species	V II	VII I	IX	X	X I	X I I	X III	XI V	XV	XV II	XV III	XI X	XX	XX I	XX II	XX III
71	Decapoda	Palaemonidae	<i>Macrobrachium</i>	<i>Macrobrachium</i> sp.			*													
	Phylum	Annelida																		
	Class	Oligochaeta																		
No	Order	Family	Genus	Species	V II	VII I	IX	X	X I	X I I	X III	XI V	XV	XV II	XV III	XI X	XX	XX I	XX II	XX III
72	Tubificida	Tubificidae	<i>Spirosperma</i>	<i>Spirosperma nikolskyi</i>				*										*		
73	Tubificida	Tubificidae	<i>Limnodrilus</i>	<i>Limnodrilus amblysetus</i>															*	
74	Tubificida	Tubificidae	<i>Limnodrilus</i>	<i>Limnodrilus hofmeisteri</i>						*										
	Phylum	Nematomorpha																		
	Class	Nematoda																		
No	Order	Family	Genus	Species	V II	VII I	IX	X	X I	X I I	X III	XI V	XV	XV II	XV III	XI X	XX	XX I	XX II	XX III
75				Nematoda sp.						*						*		*		

Table 6.2.1.4.2. Benthos species composition and percentage.

Phylum	Arthropoda	Annelida	Nematomorph a	Total
Species	71	3	1	75
Percentage (%)	94.67	4	1.33	100

6.2.1.4.2. Common Benthos found in Myitsone Dam area.

Common species found in Myitsone dam area is *Baetis* sp. from phylum-Arthropoda. The highest species composition is found in station XIX (Tum Pang Hka Tributary).

6.2.2. Ayeyarwaddy River

Phytoplankton, zooplankton, periphyton and phytobenthos recorded lists for Ayeyarwaddy River are as shown in Table (6.2.2.1 to 6.2.2.4). 54 species of phytoplankton, 105 species of zooplankton, 77 species of benthos and 88 species of periphyton are recorded from Ayeyarwaddy River. Among these records, 6 species of phytoplankton, 23 species of zooplankton and 2 species of periphyton cannot be identified into species level. For benthos, only 6 species out of 77 can be identified into species level.

Table 6.2.2.1. Qualitative analysis of Phytoplankton in Ayeyarwaddy River.

Sr.	Species
1	<i>Diatoma mesodon</i>
2	<i>Diatoma anceps</i>
3	<i>Synedra amphicephala</i> var. <i>intermedia</i>
4	<i>Synedra ulna</i> var. <i>contracta</i>
5	<i>Cocconeis placentula</i>
6	<i>Cocconeisplaceniula</i> var. <i>euglypta</i>
7	<i>Fragilaria vaucheriae</i> var. <i>capitellata</i>
8	<i>Fragilaria bidens</i>
9	<i>Fragilaria ulna</i>
10	<i>Fragilaria arcus</i>
11	<i>Cymbella</i> sp.
12	<i>Cymbella minuta</i>
13	<i>Cymbella sinuata</i>
14	<i>Achnanthes biasoletiana</i> var. <i>subatomus</i>
15	<i>Achnanthes lanceolata</i> ssp. <i>frequentissima</i>
16	<i>Achnanthes crenulata</i>
17	<i>Achnanthes biasoletiana</i>
18	<i>Achnanthes minutissima</i>
19	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>
20	<i>Achnanthes minutissima</i> var. <i>affinis</i>
21	<i>Achnanthes minutissima</i> var. <i>gracillima</i>
22	<i>Achnanthes ploenensis</i>

23	<i>Achnanthes petersenii</i>
24	<i>Achnanthes impexiformis</i>
25	<i>Achnanthes nitidiformis</i>
26	<i>Navicula radiosafallax</i>
27	<i>Navicula capitatoradiata</i>
28	<i>Navicula contenta</i> var. <i>biceps</i>
29	<i>Navicula oligotraphenta</i>
30	<i>Gomphonema minutum</i>
31	<i>Gomphonema pumilum</i>
32	<i>Gomphonema olivaceum</i> var. <i>olivaceoides</i>
33	<i>Gomphonema parvulum</i>
34	<i>Nitzschia dissipata</i>
35	<i>Nitzschia intermedia</i>
36	<i>Melosira varians</i>
37	<i>Melosira ambigua</i>
38	<i>Cyclotella</i> sp.
39	<i>Surirella</i> sp.
40	<i>Surirella linearis</i>
41	<i>Pinnularia</i> sp.
Sr.	Species
42	<i>Eunotia diodon</i>
43	<i>Eunotia sudetica</i>
44	<i>Craticula halophila</i>
45	<i>Luticola mutica</i>
46	<i>Lyngbya</i> sp.
47	<i>Oscillatoria chlorina</i>
48	<i>Oscillatoria animalis</i>
49	<i>Oscillatoria tenuis</i>
50	<i>Tychonema granulatum</i>
51	<i>Anabaena oscillarioides</i>
52	<i>Planktothrix cryptovaginata</i>
53	<i>Uronema confervicolum</i>
54	<i>Closterium</i> sp.

Table 6.2.2.2. Qualitative analysis of Zooplankton in Ayeyarwaddy River.

Sr.	Species
1	<i>Amoeba</i>
2	<i>Polychaos timidum</i>
3	<i>Saccamoeba gongornia</i>
4	<i>Arcella gibbosa</i>
5	<i>Arcella discoides</i>
6	<i>Arcella hemisphaerica</i>
7	<i>Arcella hemisphaerica undulata</i>

8	<i>Arcella rotundata</i>
9	<i>Arcella megastoma</i>
10	<i>Arcella vulgaris</i>
11	<i>Nebela collaris</i>
12	<i>Quadrullella symmetrica</i>
13	<i>Diffflugia globulosa</i>
14	<i>Diffflugia acuminata</i>
15	<i>Diffflugia oblonga</i>
16	<i>Diffflugia lucida</i>
17	<i>Diffflugia avellana</i>
18	<i>Diffflugia hydrostatica lithophila</i>
19	<i>Diffflugia gramen</i>
20	<i>Diffflugia mammillaris</i>
21	<i>Diffflugia sp.</i>
22	<i>Centropyxis aerophila aerophila</i>
Sr.	Species
23	<i>Centropyxis platystoma</i>
24	<i>Centropyxis platystoma armata</i>
25	<i>Centropyxis constricta</i>
26	<i>Centropyxis aculeata</i>
27	<i>Centropyxis aculeata grandis</i>
28	<i>Centropyxis ecornis</i>
29	<i>Centropyxis ecornis leidyi</i>
30	<i>Centropyxis discoides</i>
31	<i>Centropyxis minuta</i>
32	<i>Cyclopyxis arcellodes</i>
33	<i>Cyclopyxis deflandrei</i>
34	<i>Pontigulasia incisa</i>
35	<i>Phryganella nidulus</i>
36	<i>Wailesella sp.</i>
37	<i>Euglypha filifera</i>
38	<i>Euglypha rotunda</i>
39	<i>Euglypha sp.</i>
40	<i>Cyphoderia ampulla</i>
41	<i>Plagiophrys scutiformis</i>
42	<i>Lieberkuhnia wagneri</i>
43	<i>Holophrya atra</i>
44	<i>Coleps sp.</i>
45	<i>Didinium balbianii nanum</i>
46	<i>Mesodinium pulex</i>

47	<i>Lagynophrya conifera</i>
48	<i>Spathidium scalpriforme</i>
49	<i>Spathidium mucicola</i>
50	<i>Podophrya fixa</i>
51	<i>Sphaerophrya</i> sp.
52	<i>Hemiophrys</i> sp.
53	<i>Litonotus</i> sp.
54	<i>Chilodonella nana</i>
55	<i>Vorticella microstoma</i>
56	<i>Vorticella</i> sp.
57	<i>Carchesium polypinum</i>
58	<i>Epistylis rotans</i>
59	<i>Ophryolena</i> sp.
60	<i>Malacophrys rotans</i>
Sr.	Species
61	<i>Lembadion bullinum</i>
62	<i>Cyclidium muscicola</i>
63	<i>Cyclidium</i> sp.
64	<i>Strobilidium gyrans</i>
65	<i>Strobilidium velox</i>
66	<i>Holosticha kessleri</i>
67	<i>Uroleptus caudatus</i>
68	<i>Tintinnopsis wangi</i>
69	<i>Tintinnopsis conicus</i>
70	<i>Dicranoporus</i> sp.
71	<i>Colurella unicauda</i>
72	<i>Colurella</i> sp.
73	<i>Lepadella patella</i>
74	<i>Lepadella acuminata</i>
75	<i>Trichotria tetractis</i>
76	<i>Keratella cochleari</i>
77	<i>Keratella valga</i>
78	<i>Lecane closterocerca</i>
79	<i>Lecane hamata</i>
80	<i>Lecane thienemanni</i>
81	<i>Lecane bulla</i>
82	<i>Lecane stenroosi</i>
83	<i>Lecane</i> sp.
84	<i>Euchlanus .dilatata</i>
85	<i>Asplanchnopus</i> sp.

86	<i>Epiphanes</i> sp.
87	<i>Notommata</i> sp.
88	<i>Reticula</i> sp.
89	<i>Cephalodella catellina</i>
90	<i>Cephalodella innesi</i>
91	<i>Cephalodella gibba</i>
92	<i>Cephalodella</i> sp.
93	<i>Eosphora</i> sp.
94	<i>Proales daphnicola</i>
95	<i>Proales</i> sp.
96	<i>Scaridium longicaudum</i>
97	<i>Ascomorpha</i> sp.
98	<i>Synchaeta</i> sp.
Sr.	Species
99	<i>Polyarthra vulgaris</i>
100	<i>Trichocerca cylindrica</i>
101	<i>Trichocerca pusilla</i>
102	<i>Pompholyx sulcata</i>
103	小三肢轮虫
104	<i>Philodina</i> sp.
105	<i>Habrotrocha</i> sp.

Table 6.2.2.3. Analysis of Benthos in Ayeyarwaddy River.

Sr.	Species
1	Enphaeidae sp.
2	<i>Stylogomphus</i> sp.
3	<i>Leptogomphus</i> sp.
4	<i>Megalogomphus</i> sp.
5	<i>Phaenandrogomphus</i> sp.
6	<i>Lamelligomphus</i> sp.
7	Perlidae sp.
8	Peltoperlidae sp.
9	Nemouridae sp.
10	<i>Rhithrogena</i> sp.
11	<i>Cinygmina</i> sp.
12	<i>Heptagenia</i> sp.
13	<i>Thalerosphyrus</i> sp.
14	<i>Cincticostella insolita</i>
15	<i>Notacanthella quadrata</i>
16	Ephemerallidae sp
17	Isonychiidae sp.

18	<i>Baetis</i> sp.
19	<i>Pseudocloeon</i> sp.
20	Leptophlebiidae sp.
21	Teloganodidae sp.
22	Caenidae sp.
23	Ephemeridae sp.
24	Glossosomatidae sp.
25	Philopotamidae sp.
26	<i>Macrostemum</i> sp.
27	<i>Ceratopsyche</i> sp.
28	<i>Helicopsyche</i> sp.
29	<i>Melanotrichia</i> sp.
30	Leptoceridae sp.
Sr.	Species
31	Hydroptilidae sp.
32	<i>Ecnomus</i> sp.
33	Psychomyiidae sp.
34	<i>Stenopsyche</i> sp.
35	Elmidae sp.
36	Psephenidae sp1.
37	Psephenidae sp2.
38	Hydrochidae sp.
39	Hydraenidae sp.
40	Hydrophilidae sp.
41	Gyrinidae sp.
42	Scirtidae sp.
43	Micromalthidae sp.
44	Ptilodactylidae sp.
45	Gelastocoridae sp.
46	<i>Phyacobates</i> sp.
47	Aphelocheiridae sp.
48	Corixidae sp.
49	Tabanidae sp.
50	Ceratopogonidae sp.
51	Athericidae sp.
52	Simuliidae sp.
53	<i>Limnophila</i> sp.
54	<i>Thaumastoptera</i> sp.
55	<i>Antocha</i> sp.
56	<i>Polypedilum</i> sp1
57	<i>Polypedilum</i> sp2
58	<i>Thienemannimyia</i> sp.
59	<i>Eukiefferiella</i> sp.
60	<i>Cryptochironomus</i> sp.
61	<i>Rheotanytarsus</i> sp.
62	<i>Tanytarsus</i> sp.

63	<i>Robackia</i> sp.
64	<i>Apedilum</i> sp.
65	<i>Platysmittia</i> sp.
66	<i>Orthocladius</i> sp.
67	<i>Chironomus</i> sp.
68	<i>Microtendipes</i> sp.
69	<i>Procladius</i> sp.
70	<i>Parachironomus</i> sp.
71	双翅目 蛹
72	<i>Macrobrachium</i> sp.
73	<i>Spirosperma nikolskyi</i>
Sr.	Species
74	<i>Limnodrilus amblysetus</i>
75	<i>Limnodrilus hoffmeisteri</i>
76	Enchytraeidae sp.
77	Nematoda sp.

Table 6.2.2.4. Qualitative analysis of Periphyton in Ayeyarwaddy River.

Sr.	Species	伊江支流 Ayeyarwaddy	伊江干 流
1	<i>Achnanthes atomus</i>	+	+
2	<i>Achnanthes biasoletti</i>	+	+
3	<i>Achnanthes biasoletti</i> var. <i>subatomus</i>	+	+
4	<i>Achnanthes catenatum</i>	+	+
5	<i>Achnanthes conspicua</i>	+	
6	<i>Achnanthes exigua</i>	+	+
7	<i>Achnanthes hungarica</i>	+	
8	<i>Achnanthes lanceolata</i>	+	+
9	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	+	+
10	<i>Achnanthes minutissima</i>	+	+
11	<i>Achnanthes minutissima</i> var. <i>affinis</i>	+	+
12	<i>Achnanthes minutissima</i> var. <i>gracillima</i>	+	+
13	<i>Achnanthes minutissima</i> var. <i>saprophila</i>	+	+
14	<i>Achnanthes subhudsonis</i>	+	+
15	<i>Amphora montana</i>	+	
16	<i>Amphora pediculus</i>	+	+
17	<i>Bacillaria paradoxa</i>	+	+
18	<i>Cocconeis placentula</i> var. <i>lineata</i>		+
19	<i>Cocconeis placentula</i>	+	+
20	<i>Cymbella cymbiformis</i>	+	
21	<i>Cymbella delicatula</i>	+	

22	<i>Cymbella lacustris</i>		+
23	<i>Cymbella microcephala</i>	+	+
24	<i>Cymbella minuta</i>	+	+
25	<i>Cymbella tumida</i>	+	+
26	<i>Cymbella turgidula</i>	+	+
27	<i>Diadismus confervacea</i>	+	+
28	<i>Diadismus contenta</i>	+	
29	<i>diatoma mesadon</i>		+
30	<i>diatoma problematica</i>		+
Sr.	Species	伊江支流 Ayeyarwaddy	伊江干 流
31	<i>Epithemia adnata</i>		+
32	<i>Epithemia sorex</i>		+
33	<i>Fragilaria arcus</i>		+
34	<i>Fragilaria capucina</i>	+	+
35	<i>Fragilaria capucina</i> var. <i>vaucheriae</i>		+
36	<i>Fragilaria crotonensis</i>	+	
37	<i>Fragilaria pinnata</i>		+
38	<i>Fragilaria pseudogaillonii</i>	+	+
39	<i>Fragilaria ulna</i>	+	+
40	<i>Frustulum vulgare</i>	+	
41	<i>Gomphonema augur</i> var. <i>gautieri</i>	+	
42	<i>Gomphonema clevei</i>	+	+
43	<i>Gomphonema minutum</i>	+	+
44	<i>Gomphonema parvulum</i>		+
45	<i>Gomphonema parvulum</i> var. <i>exilissimum</i>	+	
46	<i>Gomphonema pumilum</i>		+
47	<i>Gomphonema rhombicum</i>	+	
48	<i>Gomphonema</i> sp1(与 <i>G.claratum</i> 相似)	+	
49	<i>Gyrosigma acuminatum</i>	+	+
50	<i>luticola mutica</i>	+	+
51	<i>Melosira varians</i>	+	+
52	<i>Navicula atomus</i>	+	+
53	<i>Navicula atomus</i> var. <i>permitis</i>	+	+
54	<i>Navicula bryophila</i>	+	+
55	<i>Navicula capitatoradiata</i>		+
56	<i>Navicula cincta</i>	+	+
57	<i>Navicula cryptocephala</i>		+
58	<i>Navicula cryptotenella</i>	+	+
59	<i>Navicula decussis</i>		+

60	<i>Navicula delicatilineolata</i>	+	+
61	<i>Navicula gregaria</i>		+
62	<i>Navicula minima</i>	+	+
63	<i>Navicula minuscula</i> var. <i>grunowii</i>	+	+
64	<i>Navicula notha</i>	+	+
65	<i>navicula novaesiberica</i>		+
66	<i>Navicula reichardtiana</i>		+
67	<i>Navicula schroeteri</i> var. <i>symmetrica</i>	+	+
Sr.	Species	伊江支流 Ayeyarwaddy	伊江干 流
68	<i>Navicula seminulum</i>	+	
69	<i>Navicula</i> sp1		+
70	<i>Navicula subminuscula</i>	+	+
71	<i>Navicula thermaloides</i>	+	
72	<i>Navicula viridula</i> var. <i>rostellata</i>	+	+
73	<i>Nitzschia clausii</i>	+	+
74	<i>Nitzschia dissipata</i>	+	+
75	<i>Nitzschia flexa</i>	+	
76	<i>Nitzschia frustulum</i>		+
77	<i>Nitzschia incospicua</i>	+	+
78	<i>Nitzschia linearis</i>		+
79	<i>Nitzschia palea</i>	+	+
80	<i>Nitzschia paleacea</i>	+	
81	<i>Nitzschia paleaeformis</i>	+	+
82	<i>Nitzschia recta</i>		+
83	<i>Pinnularia</i> sp	+	+
84	<i>Sellaphora japonica</i>	+	
85	<i>sellaphora pupula</i>	+	+
86	<i>Surirella angusta</i>	+	+
87	<i>Surirella linearis</i>	+	+
88	<i>Surirella robusta</i>	+	
Total		67	70

6.2.3. May Hka River

Phytoplankton, zooplankton, periphyton and phytobenthos recorded lists for May Hka River are as shown in Table (6.2.3.1 to 6.2.3.4). 76 species of phytoplankton, 114 species of zooplankton, 105 species of benthos and 90 species of are recorded from May Hka River. Among these records, 9 species of phytoplankton, 22 species of zooplankton and 1 species of periphyton cannot be identified into species level. For benthos, only 24 species out of 105 can be identified into species level.

Table 6.2.3.1. Qualitative analysis of Phytoplankton in May Hka River.

Sr.	Species	恩梅开 江上游 May Hka	恩梅开 江中游	恩梅开 江下游
1	<i>Diatoma vulgaris</i> var. <i>ovalis</i>		+	
2	<i>Diatoma mesodon</i>	+	+	+
3	<i>Diatoma moniliformis</i>		+	
4	<i>Diatoma anceps</i>	+	+	
5	<i>Synedra</i> sp.		+	
6	<i>Synedra amphicephala</i> var. <i>intermedia</i>	+		
7	<i>Synedra ulna</i> var. <i>contracta</i>	+		
8	<i>Cocconeis placentula</i>	+	+	
9	<i>Cocconeis placentula</i> var. <i>euglypta</i>	+	+	+
10	<i>Fragilaria vaucheriae</i> var. <i>capitellata</i>		+	
11	<i>Fragilaria bidens</i>	+		
12	<i>Fragilaria ulna</i>	+	+	
13	<i>Fragilaria capucina</i> var. <i>vaucheriae</i>		+	
14	<i>Fragilaria arcus</i>	+	+	+
15	<i>Fragilaria brevistriata</i>		+	
16	<i>Cymbella</i> sp.		+	
17	<i>Cymbella minuta</i>	+	+	+
18	<i>Cymbella affinis</i>	+	+	
19	<i>Cymbella sinuata</i>	+	+	
20	<i>Cymbella cymbiformis</i>		+	
21	<i>Cymbella turgidula</i>		+	
22	<i>Achnanthes biasoletiana</i> var. <i>subatomus</i>	+	+	+
23	<i>Achnanthes lanceolata</i> ssp. <i>frequentissima</i>	+	+	+
24	<i>Achnanthes crenulata</i>	+	+	
25	<i>Achnanthes biasoletiana</i>	+	+	+
26	<i>Achnanthes minutissima</i>	+	+	+
27	<i>Achnanthes exigua</i>	+	+	

28	<i>Achnanthes minutissima</i> var. <i>affinis</i>	+	+	+
29	<i>Achnanthes minutissima</i> var. <i>gracillima</i>	+	+	
30	<i>Achnanthes ploenensis</i>	+		
31	<i>Achnanthes impexiformis</i>		+	
32	<i>Achnanthes catenata</i>		+	
33	<i>Achnanthes montana</i>		+	
34	<i>Navicula</i> sp1.	+	+	+
Sr.	Species	恩梅开 江上游 May Hka	恩梅开 江中游	恩梅开 江下游
35	<i>Navicula radiosafallax</i>	+	+	+
36	<i>Navicula capitatoradiata</i>	+	+	+
37	<i>Navicula contenta</i> var. <i>biceps</i>	+		
38	<i>Navicula oligotrappenta</i>	+	+	
39	<i>Navicula minima</i>		+	
40	<i>Navicula capitata</i> var. <i>hungarica</i>		+	
41	<i>Gomphonema</i> sp.	+	+	
42	<i>Gomphonema minutum</i>	+	+	+
43	<i>Gomphonema pumilum</i>	+	+	+
44	<i>Gomphonema rhombicum</i>		+	
45	<i>Gomphonema olivaceum</i> var. <i>olivaceoides</i>	+	+	
46	<i>Gomphonema parvulum</i>		+	
47	<i>Gomphonema parvulum</i> var. <i>exilissimum</i>	+		
48	<i>Gomphonema angustum</i>		+	+
49	<i>Gomphonema ribrio</i>	+	+	
50	<i>Nitzschia palea</i>			
51	<i>Nitzschia recta</i>		+	
52	<i>Nitzschia dissipata</i>	+	+	
53	<i>Nitzschia intermedia</i>	+		
54	<i>Nitzschia brevissima</i>		+	
55	<i>Melosira granulata</i>			+
56	<i>Melosira varians</i>		+	
57	<i>Stauroneis anceps</i> var. <i>obtusa</i>		+	
58	<i>Cyclotella</i> sp.	+		
59	<i>Cylotella meneghiniana</i>		+	
60	<i>Surirella linearis</i>	+	+	
61	<i>Pinnularia subcapitata</i>		+	
62	<i>Amphipleura</i> sp.		+	
63	<i>Eunotia tridentula</i>	+		
64	<i>Eunotia diodon</i>	+		

65	<i>Eunotia exigua</i>	+	+	
66	<i>Luticola mutica</i>		+	
67	<i>Oscillatoria sp.</i>	+		
68	<i>Oscillatoria chlorina</i>		+	+
69	<i>Oscillatoria animalis</i>		+	
70	<i>Oscillatoria granulata</i>		+	+
Sr.	Species	恩梅开 江上游 May Hka	恩梅开 江中游	恩梅开 江下游
71	<i>Nostoc minutum</i>		+	
72	<i>Phormidium diguetii</i>			+
73	<i>Cylindrospermum sp.</i>		+	+
74	<i>Uronema confervicolum</i>			+
75	<i>Ulothrix tenerrima</i>		+	
76	<i>Bulbochaete sp.</i>		+	
Total		40	61	21

Table 6.2.3.2. Qualitative analysis of Zooplankton in May Hka River.

Sr.	Species	I	II	III	IV	V
1	<i>Amoeba verrucosa</i>		+			
2	<i>Trichamoeba villosa</i>				+	
3	<i>Mayorella sp.</i>					+
4	<i>Polychaos timidum</i>		+		+	
5	<i>Saccamoeba gongornia</i>	+		+	+	
6	<i>Microchlamys Patella</i>			+		
7	<i>Arcella discoides</i>	+	+	+	+	+
8	<i>Arcella hemisphaerica</i>		+		+	+
9	<i>Arcella hemisphaerica undulata</i>		+			+
10	<i>Arcella rotundata</i>					+
11	<i>Arcella megastoma</i>		+		+	+
12	<i>Arcella vulgaris</i>					+
13	<i>Arcella polypora</i>					+
14	<i>Arcella sp.</i>					+
15	<i>Hyalosphenia subflava</i>		+			
16	<i>Hyalosphenia sp.</i>					+
17	<i>Nebela collaris</i>		+	+		
18	<i>Nebela tinctoria</i>	+				
19	<i>Quadrullella symmetrica</i>	+	+	+	+	+
20	<i>Quadrullella irregularis</i>				+	

21	<i>Diffugia globulosa</i>	+	+	+	+	+
22	<i>Diffugia acuminata</i>					+
23	<i>Diffugia oblonga</i>	+	+	+		+
24	<i>Diffugia oblonga brevicolla</i>			+		
25	<i>Diffugia lucida</i>		+	+	+	
Sr.	Species	I	II	III	IV	V
26	<i>Diffugia ampura</i>	+				+
27	<i>Diffugia glans</i>	+	+			+
28	<i>Diffugia gramen</i>			+	+	
29	<i>Diffugia varians</i>		+			
30	<i>Diffugia lobstoma</i>				+	
31	<i>Diffugia sp.</i>	+	+			+
32	<i>Centropyxis aerophila aerophila</i>			+		
33	<i>Centropyxis platystoma</i>	+	+	+	+	+
34	<i>Centropyxis platystoma armata</i>	+				+
35	<i>Centropyxis constricta</i>	+	+	+	+	+
36	<i>Centropyxis aculeata</i>	+	+	+	+	+
37	<i>Centropyxis aculeata oblonga</i>	+			+	+
38	<i>Centropyxis aculeata grandis</i>	+	+			+
39	<i>Centropyxis ecornis</i>	+	+		+	+
40	<i>Centropyxis cassis compressa</i>			+		
41	<i>Centropyxis minuta</i>	+	+	+	+	+
42	<i>Centropyxis hemisphaerica</i>		+			
43	<i>Cyclopyxis arcellodes</i>	+	+	+	+	+
44	<i>Cyclopyxis arcellodes</i>	+				
45	<i>Cyclopyxis kahli cyclostoma</i>	+				
46	<i>Cyclopyxis deflandrei</i>	+	+	+	+	+
47	<i>Pontigulasia incisa</i>		+	+	+	+
48	<i>Pontigulasia sp.</i>	+				
49	<i>phryganella hemisphaerica</i>	+	+	+		
50	<i>Wailesella sp.</i>	+	+	+	+	+
51	<i>Euglypha filifera</i>		+	+	+	
52	<i>Euglypha tuberculata</i>	+				
53	<i>Euglypha acanthophora</i>					+
54	<i>Euglypha rotunda</i>		+		+	+
55	<i>Euglypha sp.</i>		+			
56	<i>Cyphoderia ampulla</i>	+	+	+	+	+
57	<i>Cyphoderia ampulla vittrara</i>			+		+
58	<i>Pseudodiffugia gracilis</i>	+			+	+
59	<i>Pamphagus granulatus</i>	+		+	+	+

60	<i>Pamphagus</i> sp.			+		+
61	<i>Acanthocystis pantopoda</i>	+	+			
62	<i>Urotricha ovata</i>		+			
63	<i>Coleps bicuspis</i>		+			
Sr.	Species	I	II	III	IV	V
64	<i>Askenasia volvox</i>	+				
65	<i>Lagynophrya conifera</i>					+
66	<i>Chaenea teres</i>					+
67	<i>Chilodonella nana</i>		+			
68	<i>Vorticella microstoma</i>					+
69	<i>Vorticella</i> sp.	+	+			+
70	<i>Epistylis rotans</i>		+			
71	<i>Malacophrys rotans</i>				+	
72	<i>Cyclidium muscicola</i>		+			
73	<i>Cyclidium centrale</i>		+			
74	<i>Cyclidium oblongum</i>		+			
75	<i>Cyclidium flagellatum</i>		+			
76	<i>Cyclidium</i> sp.		+	+		+
77	<i>Strobilidium velox</i>				+	
78	<i>Strombidium</i> sp.				+	
79	<i>Astylonychia</i> sp.		+			
80	未定纤毛虫					+
81	<i>Dicranoporus robustus</i>					+
82	<i>Dicranoporus edestes</i>					+
83	<i>Encentrum</i> sp.					+
84	<i>Colurella adriatica</i>	+		+		+
85	<i>Colurella unicauda</i>		+	+		+
86	<i>Colurella uncinata deflexa</i>	+				
87	<i>Colurella obtusa</i>		+			
88	<i>Colurella</i> sp.		+	+		
89	<i>Lepadella patella</i>	+	+		+	+
90	<i>Lepadella acuminata</i>					+
91	<i>Lophocharis salpina</i>	+				
92	<i>Keratella valga</i>	+				
93	<i>Keratella testudo</i>					+
94	<i>Lecane closterocerca</i>		+			+
95	<i>Lecane crenata</i>		+			
96	<i>Lecane bulla</i>					+
97	<i>Lecane doryssa</i>					+
98	<i>Euchlanus calpidia</i>		+			

99	<i>Epiphanes brechionus</i>		+			
100	<i>Epiphanes</i> sp.	+	+	+		
101	<i>Resticula</i> sp.		+			
Sr.	Species	I	II	III	IV	V
102	<i>Resticula</i> sp.		+			
103	<i>Cephalodella catellina</i>			+	+	+
104	<i>Cephalodella innesi</i>	+			+	+
105	<i>Cephalodella gibba</i>	+	+			+
106	<i>Cephalodella sterea</i>		+			
107	<i>Cephalodella</i> sp.					+
108	<i>Proales daphnicola</i>		+			
109	<i>Ascomorpha</i> sp.		+			
110	田奈异尾轮虫				+	
111	<i>Trichocerca</i> sp.					+
112	<i>Philodina</i> sp.	+	+	+	+	+
113	<i>Rotaria tardigrada</i>		+		+	+
114	<i>Habrotrocha</i> sp.		+		+	+
Total		40	61	33	37	61

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I	Yenam
II	Kaunglangphu
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V	Chibwe

Table 6.2.4.1. Qualitative analysis of Phytoplankton in Mali Hka River.

Sr.	Species	I	II	III & IV	V
1	Enphaeidae sp.			+	
2	<i>Leptogomphus</i> sp.				
3	<i>Phaenandrogomphus</i> sp.				
4	<i>Protohermes</i> sp.				
5	Perlidae sp.			+	
6	Perlodidae sp.			+	
7	Nemouridae sp.				
8	Capniidae sp.			+	
9	Leuctridae sp.			+	
10	Nemouridae sp.			+	
11	<i>Rhithrogena</i> sp.			+	
12	<i>Epeorus</i> sp.			+	
13	<i>Cinygma</i> sp.			+	
14	<i>Cinygmina</i> sp.			+	
15	<i>Notacanthurus maculosus</i>			+	
16	Prosopistomatidae sp.			+	
17	<i>Cincticostella insolta</i>				
18	<i>Cincticostella boja</i>			+	
19	<i>Cincticostella Gosei</i>			+	
20	<i>Cincticostella</i> sp.			+	
21	<i>Drunella Cryptomeria</i>			+	
22	<i>Drunella bella</i>				
23	<i>Uracanthella rufa</i>				
24	<i>Uracanthella</i> sp.				
25	<i>Torleya</i> sp.				
26	<i>Serratella Jianghongen.</i>			+	
27	Ephemerallidae sp				
28	Isonychiidae sp.				

29	<i>Baetis</i> sp.	+	+	+	+
30	<i>Pseudocloeon</i> sp.		+	+	+
Sr.	Species	I	II	III & IV	V
31	<i>Choroterpides</i> sp1.				+
32	<i>Choroterpides</i> sp2.		+		+
33	<i>Habrophlebiodes</i> sp.			+	+
34	<i>Choroterpes yunnanensis</i>		+		
35	<i>Choroterpes</i> sp.		+		
36	<i>Thraulius Semicastanea</i>	+	+		
37	<i>Clypeocaenis flava</i>				+
38	<i>Glabrocaenis Petersi</i>				+
39	<i>Caenis nigropunctata</i>		+		+
40	<i>Caenis</i> sp.			+	
41	Caenidae sp.			+	+
42	Potamanthidae sp.				+
43	Ephemeridae sp.	+		+	+
44	蜉蝣目成虫		+		
45	Glossosomatidae sp.			+	+
46	Hydrobiosidae sp.			+	
47	Philopotamidae sp.		+		
48	<i>Macrostemum</i> sp.		+		
49	<i>Ceratopsyche</i> sp.	+	+	+	+
50	<i>Helicopsyche</i> sp.				+
51	Leptoceridae sp.		+		+
52	Hydroptilidae sp.				+
53	<i>Brachycentrus</i> sp.		+		+
64	<i>Micrasema</i> sp.	+	+	+	
55	Rhyacophilidae sp.			+	+
56	<i>Stenopsyche</i> sp.	+		+	+
57	Polycentropodidae sp.	+			
58	毛翅目蛹				+
59	Elmidae sp.	+	+	+	+
60	Psephenidae sp1.				

61	Psephenidae sp2.			+	
Sr.	Species	I	II	III & IV	V
62	Amphizoidae sp.				+
63	Lampyridae sp.		+		
64	Hydrophilidae sp.			+	
65	Gyrinidae sp.			+	
66	Scirtidae sp.	+	+	+	
67	鞘翅目一种				+
68	多食亚目一种	+		+	
69	Aphelocheiridae sp.				+
70	Tabanidae sp.	+	+	+	
71	Ceratopogonidae sp.			+	
72	Empididae sp.		+		
73	<i>Rhaphium</i> sp.		+		
74	Athericidae sp.	+	+	+	
75	Pelecorhynchidae sp.	+		+	
76	Tanyderidae sp.		+		
77	Simuliidae sp.	+	+	+	+
78	<i>Limnophila</i> sp.	+	+	+	+
79	<i>Dicranota</i> sp.	+			
80	<i>Hexatoma</i> sp.				+
81	<i>Antocha</i> sp.		+	+	+
82	<i>Polypedilum</i> sp2	+	+	+	+
83	<i>Thienemannimyia</i> sp.	+	+	+	+
84	<i>Einfeldia</i> sp.	+			
85	<i>Cryptochironomus</i> sp.		+		
86	Chironominae sp2.				+
87	摇蚊科一种			+	
88	<i>Hydrobaenus</i> sp.		+		
89	<i>Dicrotendipes</i> sp.		+		
90	<i>Cardiocladius</i> sp.	+	+		+
91	<i>Rheotanytarsus</i> sp.		+		
92	<i>Tanytarsus</i> sp.		+		+

Sr.	Species	I	II	III & IV	V
93	<i>Platysmittia</i> sp.	+			
94	<i>Orthocladius</i> sp.	+	+		
95	<i>Chironomus</i> sp.				
96	<i>Microtendipes</i> sp.	+	+	+	+
97	<i>Procladius</i> sp.				+
98	双翅目蛹	+	+		
99	<i>Spirosperma nikolskyi</i>		+		
100	巨毛水丝蚓	+			
101	<i>Limnodrilus</i> sp.	+			
102	Enchytraeidae sp.			+	
103	寡毛纲一种		+		
104	咽蛭			+	
105	涡虫		+		
Total		32	49	48	45

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I	Yenam
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Table 6.2.3.4. Qualitative analysis of Periphyton in May Hka River.

Sr.	Species	恩江支流 May Hka	恩江干流
1	<i>Achnanthes atomus</i>	+	+
2	<i>Achnanthes biasoletti</i>	+	+
3	<i>Achnanthes biasoletti</i> var. <i>subatomus</i>	+	+
4	<i>Achnanthes catenatum</i>		+
5	<i>Achnanthes crenulata</i>	+	+
6	<i>Achnanthes exigua</i>	+	
7	<i>Achnanthes hungarica</i>		+
8	<i>Achnanthes lanceolata</i>		+
9	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	+	
10	<i>Achnanthes minutissima</i>	+	+
11	<i>Achnanthes minutissima</i> var. <i>affinis</i>	+	+
12	<i>Achnanthes minutissima</i> var. <i>gracillima</i>	+	+
13	<i>Achnanthes minutissima</i> var. <i>saprophila</i>	+	+
14	<i>Achnanthes rupestroides</i>	+	
15	<i>Achnanthes subhudsonis</i>	+	+
16	<i>Amphipleura pellucida</i>	+	
17	<i>Amphora fontinalis</i>	+	
18	<i>Amphora montana</i>	+	+
19	<i>Amphora pediculus</i>	+	
20	<i>Bacillaria paradoxa</i>	+	
21	<i>Cocconeis placentula</i> var. <i>lineata</i>	+	
22	<i>Cocconeis placentula</i>	+	+
23	<i>Cymbella delicatula</i>		+
24	<i>Cymbella lacustris</i>		+
25	<i>Cymbella microcephala</i>		+
26	<i>Cymbella minuta</i>	+	+
27	<i>Cymbella perpusilla</i>		+
28	<i>Cymbella sinuata</i>	+	
29	<i>Cymbella tumida</i>	+	+
30	<i>Cymbella turgidula</i>	+	+
31	<i>diatoma mesadon</i>		+
32	<i>Diploneis oblongella</i>	+	
33	<i>Epithemia adnata</i>	+	
34	<i>Epithemia sorex</i>	+	
35	<i>Fragilaria arcus</i>		+

Sr.	Species	恩江支流 May Hka	恩江干流
36	<i>Fragilaria capucina</i>	+	+
37	<i>Fragilaria capucina</i> var. <i>vaucheriae</i>		+
38	<i>Fragilaria crotonensis</i>		+
39	<i>Fragilaria fasciculata</i>	+	
40	<i>Fragilaria pseudogaillonii</i>	+	+
41	<i>Fragilaria ulna</i>		+
42	<i>Frustulum vulgare</i>	+	
43	<i>Gomphonema clavatum</i>	+	
44	<i>Gomphonema clevei</i>	+	+
45	<i>Gomphonema minutum</i>	+	+
46	<i>Gomphonema parvulum</i>	+	+
47	<i>Gomphonema pumilum</i>	+	+
48	<i>Gomphonema rhombicum</i>	+	+
49	<i>Gomphonema sphnerophorum</i>	+	
50	<i>luticola mutica</i>	+	
51	<i>Melosira varians</i>	+	+
52	<i>Navicula arvensis</i>	+	
53	<i>Navicula atomus</i>	+	
54	<i>Navicula atomus</i> var. <i>permitis</i>	+	
55	<i>Navicula bryophila</i>	+	+
56	<i>Navicula capitatoradiata</i>	+	+
57	<i>Navicula cincta</i>	+	+
58	<i>Navicula cryptocephala</i>	+	+
59	<i>Navicula cryptotenella</i>	+	+
60	<i>Navicula decussis</i>	+	
61	<i>Navicula delicatilineolata</i>	+	+
62	<i>Navicula erifuga</i>		+
63	<i>Navicula gregaria</i>	+	
64	<i>Navicula heimansioides</i>	+	+
65	<i>Navicula lanceolata</i>		+
66	<i>Navicula minuma</i>	+	+
67	<i>Navicula minuscula</i> var. <i>grunowii</i>	+	+
68	<i>Navicula notha</i>	+	
69	<i>Navicula oligotrappenta</i>	+	
70	<i>Navicula perpusilla</i>		+
71	<i>Navicula radiosafallax</i>	+	

Sr.	Species	恩江支流 May Hka	恩江干流
72	<i>Navicula reichardtiana</i>	+	
73	<i>Navicula schroeteri</i> var. <i>symmetrica</i>		+
74	<i>Navicula viridula</i>	+	
75	<i>Nitzschia amphibia</i>		+
76	<i>Nitzschia angustatula</i>	+	
77	<i>Nitzschia clausii</i>	+	
78	<i>Nitzschia dissipata</i>	+	+
79	<i>Nitzschia frustulum</i>	+	
80	<i>Nitzschia inconspicua</i>	+	
81	<i>Nitzschia palea</i>	+	+
82	<i>Nitzschia paleacea</i>	+	
83	<i>Nitzschia sinuata</i> var. <i>tabellaria</i>	+	
84	<i>Pinnularia</i> sp	+	
85	<i>Sellaphora bacillum</i>		+
86	<i>Sellaphora japonica</i>	+	+
87	<i>Sellaphora pupula</i>		+
88	<i>Surirella angusta</i>	+	+
89	<i>Surirella linearis</i>	+	
90	<i>Surirella robusta</i>	+	
Total		71	54

6.2.4. Mali Hka River

Phytoplankton, zooplankton, periphyton and phytobenthos recorded lists for Mali Hka River are as shown in Table (6.2.4.1 to 6.2.4.4). 69 species of phytoplankton, 62 species of zooplankton, 26 species of benthos and 65 species of periphyton are recorded from Ayeyarwaddy River. Among these records, 11 species of phytoplankton, 10 species of zooplankton and 1 species of periphyton cannot be identified into species level. For benthos, only 2 species out of 26 can be identified into species level.

Table 6.2.4.1. Qualitative analysis of Phytoplankton in Mali Hka River.

Sr.	Species	迈立开江 中下游 Mali Hka
1	<i>Diatoma vulgaris</i>	+
2	<i>Diatoma mesodon</i>	+
3	<i>Diatoma moniliformis</i>	+
4	<i>Synedra acus</i>	+
5	<i>Cocconeis placentula</i>	+
6	<i>Cocconeis placeniula var.euglypta</i>	+
7	<i>Fragilaria bidens</i>	+
8	<i>Fragilaria ulna</i>	+
9	<i>Fragilaria arcus</i>	+
10	<i>Fragilaria brevistriata</i>	+
11	<i>Cymbella sp.</i>	+
12	<i>Cymbella minuta</i>	+
13	<i>Cymbella affinis</i>	+
14	<i>Cymbella sinuata</i>	+
15	<i>Cymbella turgidula</i>	+
16	<i>Achnanthes biasoletiana var. subatomus</i>	+
17	<i>Achnanthes lanceolata ssp. frequentissima</i>	+
18	<i>Achnanthes crenulata</i>	+
19	<i>Achnanthes biasoletiana</i>	+
20	<i>Achnanthes minutissima</i>	+
21	<i>Achnanthes minutissima var.affinis</i>	+
22	<i>Achnanthes minutissima var.gracillima</i>	+
23	<i>Achnanthes ploenensis</i>	+
24	<i>Achnanthes helvetica</i>	+
25	<i>Navicula spl.</i>	+
26	<i>Navicula radiosafallax</i>	+
27	<i>Navicula capitatoradiata</i>	+
28	<i>Navicula oligotraphenta</i>	+
29	<i>Navicula menisculus</i>	+
30	<i>Navicula capitata var.hungarica</i>	+
31	<i>Gomphonema minutum</i>	+
32	<i>Gomphonema pumilum</i>	+
33	<i>Gomphonema parvulum</i>	+
34	<i>Gomphonema truncatum</i>	+
35	<i>Gomphonema angustum</i>	+

Sr.	Species	迈立开江 中下游 Mali Hka
36	<i>Nitzschia palea</i>	+
37	<i>Nitzschia recta</i>	+
38	<i>Nitzschia dissipata</i>	+
39	<i>Nitzschia tubicola</i>	+
40	<i>Nitzschia intermedia</i>	+
41	<i>Melosira granulata</i>	+
42	<i>Melosira varians</i>	+
43	<i>Melosira ambigua</i>	+
44	<i>Stauroneis sp.</i>	+
45	<i>Cyclotella sp.</i>	+
46	<i>Surirella linearis</i>	+
47	<i>Surirella brebissonii</i>	+
48	<i>Pinnularia sp.</i>	+
49	<i>Eunotia sp.</i>	+
50	<i>Eunotia tridentula</i>	+
51	<i>Eunotia exigua</i>	+
52	<i>Eunotia minor</i>	+
53	<i>Eunotia bilunaris</i>	+
54	<i>Frustulia saxonica</i>	+
55	<i>Didymosphenia geminata</i>	+
56	<i>Craticula halophila</i>	+
57	<i>Luticola acidoclinata</i>	+
58	<i>Lyngbya sp.</i>	+
59	<i>Oscillatoria chlorina</i>	+
60	<i>Oscillatoria granulata</i>	+
61	<i>Oscillatoria willei</i>	+
62	<i>Phormidium diguetii</i>	+
63	<i>Chroococens minutus</i>	+
64	<i>Cylindrospermum sp.</i>	+
65	<i>Cylindrospermum stagnale</i>	+
66	<i>Uronema confervicolum</i>	+
67	<i>Microspora sp.</i>	+
68	<i>Draparnaidia sp.</i>	+
69	<i>Bulbochaete sp.</i>	+

Table 6.2.4.1. Qualitative analysis of Phytoplankton in Mali Hka River.

Sr.	Species	LASA
1	<i>Amoeba verrucosa</i>	+
2	<i>Vannella platypodia</i>	+
3	<i>Saccamoeba gongornia</i>	+
4	<i>Microchlamys Patella</i>	+
5	<i>Arcella discoides</i>	+
6	<i>Arcella hemisphaerica</i>	+
7	<i>Arcella megastoma</i>	+
8	<i>Arcella vulgaris</i>	+
9	<i>Arcella catinus</i>	+
10	<i>Nebela lageniformis</i>	+
11	<i>Quadrullella symmetrica</i>	+
12	<i>Diffflugia globulosa</i>	+
13	<i>Diffflugia acuminata</i>	+
14	<i>Diffflugia lucida</i>	+
15	<i>Diffflugia glans</i>	+
16	<i>Diffflugia gramen</i>	+
17	<i>Diffflugia bidens</i>	+
18	<i>Diffflugia sp.</i>	+
19	<i>Centropyxis platystoma</i>	+
20	<i>Centropyxis platystoma armata</i>	+
21	<i>Centropyxis aculeata</i>	+
22	<i>Centropyxis aculeata oblonga</i>	+
23	<i>Centropyxis aculeata grandis</i>	+
24	<i>Centropyxis ecornis</i>	+
25	<i>Centropyxis minuta</i>	+
26	<i>Cyclopyxis arcellodes</i>	+
27	<i>Cyclopyxis deflandrei</i>	+
28	<i>Pontigulasia incisa</i>	+
29	<i>Wailesella sp.</i>	+
30	<i>Euglypha filifera</i>	+
31	<i>Euglypha acabthophora</i>	+
32	<i>Euglypha rotunda</i>	+
33	<i>Cyphoderia ampulla</i>	+
34	<i>Pamphagus granulatus</i>	+
35	<i>Raphidiophrys viridis</i>	+
36	<i>Urotricha sp.</i>	+
Sr.	Species	LASA

37	<i>Didinium balbianii nanum</i>	+
38	<i>Lagynophrya</i> sp.	+
39	<i>Vorticella microstoma</i>	+
40	<i>Cothurnia annulata</i>	+
41	<i>Cyclidium muscicola</i>	+
42	<i>Cyclidium</i> sp.	+
43	<i>Strobilidium gyrans</i>	+
44	<i>Holosticha kessleri</i>	+
45	<i>Tintinnidium fluviatile</i>	+
46	<i>Colurella adriatica</i>	+
47	<i>Colurella unicauda</i>	+
48	<i>Colurella</i> sp.	+
49	<i>Lepadella patella</i>	+
50	<i>Lepadella triptera</i>	+
51	<i>Trichotria tetractis</i>	+
52	<i>Lecane closterocerca</i>	+
53	<i>Lecane crenata</i>	+
54	<i>Lecane bulla</i>	+
55	<i>Lecane glypta</i>	+
56	<i>Euchlanus pellucida</i>	+
57	<i>Epiphanes</i> sp.	+
58	<i>Cephalodella innesi</i>	+
59	<i>Ascomorpha</i> sp.	+
60	<i>Philodina</i> sp.	+
61	<i>Rotaria rotatoria</i>	+
62	<i>Habrotrocha</i> sp.	+

Table 6.2.4.3. Qualitative analysis of Benthos in Mali Hka River.

Sr.

Species

1	Perlidae sp.
2	<i>Cinygmmina</i> sp.
3	<i>Notacanthurus</i> sp.
4	Ephemerallidae sp
5	<i>Baetis</i> sp.
6	Leptophlebiidae sp.
7	<i>Ceratopsyche</i> sp.
8	<i>Arctopsyche</i> sp.
9	<i>Helicopsyche</i> sp.
10	Leptoceridae sp.
11	<i>Stenopsyche</i> sp.
12	Elmidae sp.
13	Psephenidae sp1.
14	Psephenidae sp2.
15	Aphelocheiridae sp.
16	<i>Limnophila</i> sp.
17	<i>Hexatoma</i> sp.
18	<i>Antocha</i> sp.
19	<i>Thienemannimyia</i> sp.
20	Chironominae sp1.
21	<i>Cardiocladius</i> sp.
22	<i>Rheotanytarsus</i> sp.
23	<i>Orthocladius</i> sp.
24	<i>Procladius</i> sp.
25	双翅目蛹
26	奥特开水丝蚓

Table 6.2.4.4. Qualitative analysis of Periphyton in Mali Hka River.

Sr.	Species	迈江支流 Mali Hka	迈江干流
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1	<i>Achnanthes atomus</i>	+	+
2	<i>Achnanthes biasoletti</i>	+	+
3	<i>Achnanthes biasoletti</i> var. <i>subatomus</i>	+	+
4	<i>Achnanthes catenatum</i>	+	
5	<i>Achnanthes crenulata</i>	+	
6	<i>Achnanthes exigua</i>	+	+
7	<i>Achnanthes lanceolata</i>	+	
8	<i>Achnanthes lanceolata</i> var. <i>rostrata</i>	+	+
9	<i>Achnanthes minutissima</i>	+	+
10	<i>Achnanthes minutissima</i> var. <i>affinis</i>	+	+
11	<i>Achnanthes minutissima</i> var. <i>gracillima</i>	+	
12	<i>Achnanthes subhudsonis</i>	+	+
13	<i>Amphora fontinalis</i>	+	
14	<i>Amphora pediculus</i>	+	
15	<i>Anomoeoneis pseudotusculus</i>	+	
16	<i>Bacillaria paradoxa</i>	+	+
17	<i>Cocconeis pediculus</i>	+	
18	<i>Cocconeis placentula</i> var. <i>lineata</i>	+	
19	<i>Crymatopleura solea</i>	+	
20	<i>Cymbella cymbiformis</i> var. <i>nonpunctata</i>	+	
21	<i>Cymbella lacustris</i>	+	+
22	<i>Cymbella minuta</i>		+
23	<i>Cymbella tumida</i>		+
24	<i>Cymbella turgidula</i>	+	+
25	<i>Denticula tenuis</i>		+
26	<i>Diploneis elliptica</i>	+	
27	<i>Diploneis marginestriata</i>	+	
28	<i>Epithemia adnata</i>	+	
29	<i>Epithemia sorex</i>	+	
30	<i>Fragilaria capucina</i>	+	
31	<i>Fragilaria pseudogaillonii</i>	+	+
32	<i>Frustulum</i> sp	+	
33	<i>Gomphonema bicep</i>		+
34	<i>Gomphonema clavatum</i>	+	+
35	<i>Gomphonema clevei</i>	+	+
Sr.	Species	迈江支流 Mali Hka	迈江干流
36	<i>Gomphonema minutum</i>	+	+
37	<i>Gomphonema parvulum</i>	+	+
38	<i>Gomphonema pumilum</i>	+	

39	<i>Gomphonema rhombicum</i>		
40	<i>Gyrosigma scalproides</i>		
41	<i>Melosira varians</i>		
42	<i>Navicula arvensis</i>		
43	<i>Navicula atomus</i> var. <i>permitis</i>		
44	<i>Navicula capitatoradiata</i>		
45	<i>Navicula cryptocephala</i>		
46	<i>Navicula cryptotenella</i>		
47	<i>Navicula minuma</i>		
48	<i>Navicula minuscula</i>		
49	<i>Navicula minuscula</i> var. <i>grunowii</i>		
50	<i>Navicula obtecta</i>		
51	<i>Navicula radiosafallax</i>		
52	<i>Navicula reichardtiana</i>		
53	<i>Navicula schroeteri</i> var. <i>symmetrica</i>		
54	<i>Neidium affine</i> var. <i>humerus</i>		
55	<i>Neidium dubium</i>		
56	<i>Nitzschia clausii</i>		
57	<i>Nitzschia dissipata</i>		
58	<i>Nitzschia frustulum</i>		
59	<i>Nitzschia incospicua</i>		
60	<i>Nitzschia palea</i>		
61	<i>Nitzschia sinuata</i> var. <i>tabellaria</i>		
62	<i>Rhopalodia gibba</i>		
63	<i>Sellaphora</i> + <i>aponica</i>		
64	<i>sellaphora pupula</i>		
65	<i>Surirella linearis</i>		
Total		52	35

6.3. Fish

96 species from 21 families were recorded from this survey. The highest species composition was recorded from Myitsone Dam area and recorded list is about 72 species. The lowest species composition was recorded from May Hka River. The identified fish list from May Hka River is about 30 species. About 31 species were recorded from Mali Hka River. 4 species cannot be identified into species level.

Surveyed areas along May Hka River were dominant with cold water genus of *Schizothorax* (Snow Trout) especially in the upstream areas (Table: 6.3.1). Unidentified species have to be studied in detail in the future. There may be endemic species present in these regions and this is an important field to be studied for reduction of impact on them. *Schizothorax* species may be endemic species but detailed study is required.

1 endangered species of *Schizothorax grahami* (Kunming Snout Trout) was recorded from May Hka River from Chibwe Dam area to upstream along May Hka River (Fig. 48). 1 data deficient species of *Macrogathus aral* (One-stripe Spiny Eel) was recorded from downstream of Myitsone Dam area (Fig. 49).

40 fish eggs were collected from Lasa Dam area. 1 berried female of *Schizothorax* sp. was caught from Wusok Dam area in April (Fig. 50).

Long migrants of genus *Anguilla nebulosa*, *Anguilla bengalensis* and *Tor putitora* were recorded from Myitkyina to Putao in Mali Hka River and from Myitkyina to Kaunglanhpu in May Hka River (Fig. 51).

Among the recorded lists, *Bangana devdevi*, *Eutropiichthys vacha*, *Neolissochilus hexagonolepis*, *Pangasius pangasius*, *Garra* species, *Labeo* specie, *Schizothorax* species and *Tor* species are the economically important species along the surveyed areas and need protection (Fig. 52). Records of length-weight relationship of economically important species are shown in table (6.3.2).

1 kind of cray fish was recorded as a possible species for aquaculture in the surveyed areas (Fig. 53). This species is reared in pond successfully in China for human consumption.

Schizothorax spp. are dominant among the cold water fish in all sampling stations along May Hka River. They are caught by set drift nets which are set on the bank of the river in the evening and harvested in the morning. Other common fish species are *Tor* sp., *Bangana* sp, *Garra* sp, *Neolissocheilus* sp. and *Glyptothorax* sp, and are caught by the same fishing method along the river.

Set drift nets of various mesh sizes are common fishing apparatus along the region. The length and the depth of drift nets depend on fishing area. Common length is about 10 meters and depth is about 1 meter. Cast nets are used in still water areas. Long lines and hooks are also used in Chibwe Dam area. Fishermen from Myitsone Dam area and downstream of Lasa and Chibwe Dam areas own small fishing boats. The major threat to environmental conservation along the surveyed areas is dynamite fishing which cause destruction not only to target species but also to other organisms.

Aquaculture is not developed in the study areas. The records of fisheries production of Kachin State for 2007-2008 (March) to 2008-2009 (August) are shown in Table (6.3.3) to (6.3.16).

Table 6.3.1. Distribution of fish species in EIA survey areas of Kachin State.

Family		Genus		Species		Author	Common Name	Local Name	Localities			IUCN status
Sr.		Sr.		Sr.					I	II	III	
I	Ambassidae	1	<i>Chanda</i>	1	<i>nama</i>	Hamilton, 1822	Elongate Glass-Perchlet	Nga zin zat	*			NE
		2	<i>Parambassis</i>	2	<i>ranga</i>	Hamilton, 1822	Indian Glassy Fish	Nga zin zat	*			NE
II	Anabantidae	3	<i>Anabas</i>	3	<i>testudineus</i>	Bloch, 1792	Climbing	Nga bye ma	*			NE

							Perch				
III	Anguillidae	4	Anguilla	4	bengalensis	Gray, 1831	Indian Mottled Eel	Nga lin bun			NE
				5	nebulosa	McClelland, 1844	Mottled Eel	Nga mee toung/ Nga lin ban			NE
IV	Badidae	5	Badis	6	ruber	Schreitmüller, 1923	Nga Thein Net	Nga mee laung			NE
V	Bagridae	6	Batasio	7	blythii	Blyth, 1860					NE
		7	Hemibagrus (Mystus)	8	microphthalmus	Day, 1877	Irrawaddy Mystus	Nga aik/ Nga ngaik			NE
		8	Mystus	9	carvasius	Hamilton, 1822	Gangetic Mystus	Nga zin yine kywe			NE
				10	pulcher	Chaudhuri, 1911	Pulcher Mystus	Nga zin yine			NE
		9	Sperata	11	acicularis	Ferraris & Runge, 1999		Nga Gyaung			NE
VI	Balitoridae	10	Acanthocobitis	12	botia	Hamilton, 1822	Mottled Loach	Nga tha le doe			NE
				13	rubidipinnis	Blyth, 1860		Nga tha le doe			NE
VII	Belonidae	12	Xenentodon	15	cancila	Hamilton, 1822	Freshwater Garfish	Nga phaung yoe			NE
VIII	Channidae	13	Channa	16	aurolineata	Hamilton, 1822	Great Snakehead	Nga yant die			NE
				17	harcourtbutele	Annandale, 1918	Burmese Snakehead	Nga yant			NE
				18	punctata	Bloch, 1793	Spotted Snakehead	Nga yant pa naw			NE
				19	sp.						
IX	Clariidae	14	Clarias	20	batrachus	Linnaeus, 1758	Walking Catfish/ Magor	Nga khu			NE
		17	Syncrossus	25	berdmorei	Blyth, 1860	Blyth's loach				NE
XI	Cyprinidae	18	Amblypharyngodon	26	atkinsonii	Blyth, 1860	Burmese Carplet	Nga byet			NE
		19	Bangana	27	devdevi	Hora, 1936	Labeo Devdevi	Kyauk nga lu			NE
		20	Barilius	28	barila	Hamilton, 1822	Barred Baril	Nga kyee gyun			NE
				29	barnoides	Vinciguerra, 1890					NE
		21	Cabdio (Cyprinus)	30	morar	Hamilton, 1822	Carplet	Yin baung zar			NE
		22	Chagunius	31	baileyi	Rainboth, 1986		Nga ga lone			NE
		23	Crossocheilus	32	burmanicus	Hora, 1936		Nga din lone			NE
		24	Garra	33	lamta	Hamilton, 1822	Lamta Garra	Nga kyauk kat			NE
				34	nasuta	McClelland, 1838	Khasi Garra	Nga kyauk kat			NE
				35	notata	Blyth, 1860	Tenasse rim Garra	Nga kyauk kat			NE
				36	qiaojiensis	Wu & Yao, 1977		Nga kyauk kat			NE
		25	Labeo	37	angra	Hamilton, 1822	Angra Labeo	Nga lu myi kwet			NE
				38	boga	Hamilton, 1822	Boga Labeo	Nga lone			NE
				39	dyocheilus	McClelland, 1839		Kyauk nga lu			NE
				40	gonius	Hamilton, 1822	Kuria Labeo	Nga daine			NE
				41	pierrei	Sauvage, 1880					NE
				42	yunnanensis	Chaudhuri, 1911					NE
		26	Mekongina	43	latius	Hamilton, 1822					NE
		27	Morulius	44	calbasu	Hamilton, 1822	Orange fin Labeo	Nga net pyar/ Nga poke net			NE
				45	chrysopheka dion	Bleeker, 1850	Black Sharkminnow				NE
		28	Mystacoleucus	46	marginatus	Valenciennes, 1842					NE

		29	<i>Neolissochilus</i>	47	<i>hexagonolepis</i>	McClelland, 1839	Copper Mahseer	Nga ni				NE
		30	<i>Osteobrama</i>	48	<i>belangeri</i>	Valenciennes, 1844	Manipur Osteobrama	Nga phant ma				NE
				49	<i>feae</i>	Vinciguerra, 1890		Nga phant ma				NE
		31	<i>Puntius</i>	50	<i>chola</i>	Hamilton, 1822	Swamp Barb	Nga khone ma				NE
				51	<i>orphoides</i>	Valenciennes, 1842	Javaen Barb	Nga khone ma				NE
				52	<i>stoliczkaenus</i>	Day, 1971		Nga khone ma				NE
				53	<i>sp.</i>							NE
		32	<i>Raiamus</i>	54	<i>guttatus</i>	Day, 1970	Burmese Trout	Nga la war				NE
		33	<i>Rasbora</i>	55	<i>rasbora</i>	Hamilton, 1822	Gangetic Scissortail Rasbora	Nga daung zin / Nga lu bay sin				NE
		34	<i>Salmostoma</i>	56	<i>sardinella</i>	Valenciennes, 1844	Sardinella Razorbelly Minnow	Nga phyin dauk/ Yin baung zar				NE
		35	<i>Scaphiodonichthys</i>	57	<i>sp./burmanicus</i>	Vinciguerra, 1890						NE
		36	<i>Schizothorax (Schizothorax)</i>	58	<i>chongi</i>	Fang, 1936		Ye khe nga				NE
				59	<i>grahami</i>	Regan, 1904	Kunming Snout Trout	Ye khe nga				CR, {B 1ab(i,ii,iii,iv,v)+ 2ab(I,ii,iii,iv,v)}
				60	<i>meridionalis</i>	Tsao, 1964		Ye khe nga				NE
				61	<i>myzostomus</i>	Tsao, 1964		Ye khe nga				NE
				62	<i>richardsonii</i>	Gray, 1832	Snow Trout	Ye khe nga				NE
				63	<i>wangchiachii</i>	Fang, 1936		Ye khe nga				NE
		37	<i>Systemus</i>	64	<i>orphoides</i>	Valenciennes, 1842		Nga khone ma				NE
		38	<i>Tor</i>	65	<i>brevifilis</i>	Peters, 1881		Nga dauk				NE
				66	<i>putitora</i>	Hamilton, 1822	Golden Mahseer	Nga dauk				NE
				67	<i>qiaojiensis</i>	Wu, 1977		Nga dauk				NE
				68	<i>tor</i>	Hamilton, 1822	Tor Mahseer	Nga dauk				NE
XII	Gobiidae	39	<i>Glossogobius</i>	69	<i>giuris</i>	Hamilton, 1822	Bar Eyed Goby/Tank Goby	Ka tha boe				NE
XIII	Heteropneustidae	40	<i>Heteropneustes</i>	70	<i>fossilis</i>	Bloch, 1794	Scorpion Fish/ Stinging Catfish	Nga gyee				NE
XIV	Mastacembelidae	41	<i>Macrognathus</i>	71	<i>aral</i>	Bloch & Schneider, 1801	One-stripe Spiny Eel	Nga la mwae				DD
		42	<i>Mastacembelus</i>	72	<i>armatus</i>	Lacepede, 1800	Zig-zag Eel	Nga la mwae				NE
				73	<i>manipurensis</i>	Hora, 1921						
				74	<i>unicolor</i>	Cuvier, 1832						NE
XV	Notopteriidae	43	<i>Notopterus</i>	75	<i>notopterus</i>	Pallas, 1769	Bronze Feather-back	Nga phe				NE
XVI	Osphronemidae	44	<i>Colisa</i>	76	<i>labiosa</i>	Day, 1877	Thick lipped Gourami	Nga phyin tha let				NE
XVII	Pangasiidae	45	<i>Pangasius</i>	77	<i>pangasius</i>	Hamilton, 1822	Yellow-tail Catfish	Nga dan				NE
XVIII	Pristigasteridae	46	<i>Ilisha</i>	78	<i>megaloptera</i>	Swainson, 1839	Bigeye Ilisha					NE

XIX	Schilbeidae	47	<i>Clupisoma</i>	79	<i>prateri</i>	Hora, 1937	Burmese Garua	Nga myin oak phar				NE
				80	<i>sp.</i>							NE
		48	<i>Eutropiichthys</i>	81	<i>vacha</i>	Hamilton, 1822	Batchwa vacha/ River Catfish	Nga myin kun ban				NE
		49	<i>Silonia</i>	82	<i>silondia</i>	Hamilton, 1822	Silond Catfish	NgaMyin/ Nga myin yin				NE
XX	Siluridae	50	<i>Ompok</i>	83	<i>pabo</i>	Hamilton, 1822	Pabo Catfish	Nga nu than				NE

				84	<i>sp. /bimaculatus</i>	Bloch, 1794	Butter Catfish	Nga nu than				NE
		51	<i>Wallago</i>	85	<i>attu</i>	Bloch : Schneider , 1801	Wallago/ Boal/ Freshwater Shark	Nga but				NE
XXI	Sisoridae	52	<i>Bagarius</i>	86	<i>bagarius</i>	Hamilton, 1822	Dwarf Goonch	Nga maung ma				NE
				87	<i>yarrelli</i>	Sykes, 1839	Goonch	Nga maung ma				NE
		53	<i>Gagata</i>	88	<i>gasawyuh</i>	Roberts : Ferraris, 1998		Nga nan kyaung				NE
		54	<i>Glyptothorax</i>	89	<i>cavia</i>	Hamilton, 1822	Cat fish	Nga maung ma				NE
				90	<i>dorsalis</i>	Vinciguerra, 1890		Nga maung ma				NE
				91	<i>longicauda</i>	Li, 1984						NE
				92	<i>minimaculatus</i>	Li, 1984						NE
				93	<i>trilineatus</i>	Blyth, 1860	Three-lined Catfish	Nga maung ma				NE
				94	<i>sp.</i>							NE
		55	<i>Pseudecheneis</i>	95	<i>sulcata</i>	McClelland, 1842	Sucker Throat Catfish	Lay yin pyan nga				NE
		56	<i>Pseudexostoma</i>	96	<i>yunanensis</i>	Tchang, 1935						NE
Total									72	30	31	

Index:

I	Ayeyarwaddy River	CR	Critically Endangered
II	May Hka River	DD	Data Deficient
III	Mali Hka River		

Table 6.3.2. Length-weight relationship of economically important fish species.

Sr.	species	Standard length (mm)	Total weight (g)
1	<i>Neolissochilus hexagonolepis</i>	100—550	12.7—4000
2	<i>Bangana devdevi</i>	180—405	104—1284
3	<i>Schizothorax meridionalis</i>	72—218	5.5—158.4
4	<i>Labeo boga</i>	160—283	103—452
5	<i>Tor putitora</i>	58—320	5—525
6	<i>Eutriplichthys vacha</i>	210—315	94.3—293.4
7	<i>Pangasius pangasius</i>	215—263	120—250

Table 6.3.3. Production of Fish from the Kachin State (2007-2008/ June).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	147.8	-	-	147.8
1.	Myitkyina	53.5	-	-	53.5

2.	Waing-maw	88.0	-	-	88.0
3.	Tanaing	6.3	-	-	6.3
4.	Chibwe	-	-	-	-
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	-	-
7.	Sin-Bo	-	-	-	-
B.	Moe-Nyin District	97.0	-	-	97.0
1.	Moe-Nyin	40.0	-	-	40.0
2.	Moe-Kaung	48.0	-	-	48.0
4.	Phar-Kant	9.0	-	-	9.0
C.	Bamaw District	182.5	-	-	182.5
1.	Bamaw	71.0	-	-	71.0
2.	Shwe-Ku	20.0	-	-	20.0
3.	Moe-Mauk	84.0	-	-	84.0
4.	Man-Si	7.5	-	-	7.5
D.	Putao Distirct	-	-	-	-
1.	Putao	-	-	-	-
2.	Machanbaw	-	-	-	-
3.	Sumpraboom	-	-	-	-
4.	Khaung-lan-phu	-	-	-	-
5.	Naung-Moon	-	-	-	-
	Total	427.3	-	-	427.3

Table 6.3.4. Production of Fish from the Kachin State (2007-2008/ July).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	165.0	73.0	71.98	309.98
1.	Myitkyina	59.0	11.0	2.03	72.03

2.	Waing-maw	99.0	13.0	2.45	114.45
3.	Tanaing	7.0	34.0	58.0	99.0
4.	Chibwe	-	-	0.34	0.34
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.16	0.16
7.	Sin-Bo	-	15.0	9.0	24.0
B.	Moe-Nyin District	107.4	71.0	370.0	548.4
1.	Moe-Nyin	44.5	16.0	350.0	410.5
2.	Moe-Kaung	53.0	28.0	11.0	92.0
4.	Phar-Kant	9.9	27.0	9.0	45.9
C.	Bamaw District	202.7	351.0	208.0	761.7
1.	Bamaw	78.5	130.0	60.0	268.5
2.	Shwe-Ku	22.0	210.0	135.0	367.0
3.	Moe-Mauk	94.0	11.0	8.0	113.0
4.	Man-Si	8.2	-	5.0	13.2
D.	Putao Distirct	-	-	7.5	7.5
1.	Putao	-	-	5.0	5.0
2.	Machanbaw	-	-	1.65	1.65
3.	Sumpraboom	-	-	0.35	0.35
4.	Khaung-lan-phu	-	-	0.33	0.33
5.	Naung-Moon	-	-	0.17	0,17
	Total	475.1	495.0	657.48	1627.58

Table 6.3.5. Production of Fish from the Kachin State (2007-2008/September).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	198.7	227.0	240.0	665.7
1.	Myitkyina	70.5	34.0	7.13	111.63

2.	Waing-maw	119.5	40.0	7.97	167.47
3.	Tanaing	8.7	105.0	194.2	307.9
4.	Chibwe	-	-	1.11	1.11
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.52	0.52
7.	Sin-Bo	-	48.0	29.07	77.07
B.	Moe-Nyin District	133.0	229.0	1247.9	1609.9
1.	Moe-Nyin	55.0	60.0	1180.64	1295.64
2.	Moe-Kaung	66.0	88.0	36.25	190.25
4.	Phar-Kant	12.0	81.0	31.01	124.0
C.	Bamaw District	244.5	1101.0	722.1	2067.6
1.	Bamaw	94.0	405.0	209.46	708.46
2.	Shwe-Ku	26.5	660.0	467.05	1153.55
3.	Moe-Mauk	114.0	36.0	29.06	179.06
4.	Man-Si	10.0	-	16.53	26.53
D.	Putao Distirct	-	-	24.0	24.0
1.	Putao	-	-	15.8	15.8
2.	Machanbaw	-	-	5.3	5.3
3.	Sumpraboom	-	-	1.0	1.0
4.	Khaung-lan-phu	-	-	1.01	1.01
5.	Naung-Moon	-	-	0.89	0.89
	Total	576.2	1557.0	2234.0	4367.2

Table 6.3.6. Production of Fish from the Kachin State (2007-2008/ October).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	233.2	382.0	320.89	936.09
1.	Myitkyina	81.5	56.0	9.63	147.13

2.	Waing-maw	141.5	69.0	10.47	220.97
3.	Tanaing	10.2	178.0	260.57	448.77
4.	Chibwe	-	-	1.46	1.46
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.69	0.69
7.	Sin-Bo	-	79.0	38.07	117.07
B.	Moe-Nyin District	153.8	335.0	1668.0	2156.8
1.	Moe-Nyin	64.0	88.0	1580.64	1732.64
2.	Moe-Kaung	76.0	130.0	46.35	252.35
4.	Phar-Kant	13.8	117.0	41.01	171.81
C.	Bamaw District	284.55	1599.0	955.5	2839.05
1.	Bamaw	110.0	600.0	279.46	989.46
2.	Shwe-Ku	31.0	950.0	615.45	1596.45
3.	Moe-Mauk	132.0	49.0	39.06	220.06
4.	Man-Si	11.55	-	21.53	33.08
D.	Putao Distirct	-	-	35.5	35.5
1.	Putao	-	-	22.8	22.8
2.	Machanbaw	-	-	7.8	7.8
3.	Sumpraboom	-	-	1.53	1.53
4.	Khaung-lan-phu	-	-	1.54	1.54
5.	Naung-Moon	-	-	1.83	1.83
	Total	671.35	2316.0	2979.89	5967.44

Table 6.3.7. Roduction of Fish from the Kachin State (2007-2008/ November).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	269.7	542.0	683.39	1495.09
1.	Myitkyina	93.5	80.0	42.36	215.86

2.	Waing-maw	164.5	99.0	114.67	378.17
3.	Tanaing	11.7	252.0	409.47	673.17
4.	Chibwe	-	-	7.98	7.98
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	4.63	4.63
7.	Sin-Bo	-	111.0	99.3	210.3
B.	Moe-Nyin District	176.0	448.0	2753.23	3377.23
1.	Moe-Nyin	73.5	118.0	2386.53	2578.03
2.	Moe-Kaung	87.0	175.0	218.23	480.23
4.	Phar-Kant	15.5	155.0	148.47	318.97
C.	Bamaw District	326.65	2124.0	1530.19	3980.84
1.	Bamaw	126.0	800.0	434.28	1360.28
2.	Shwe-Ku	35.5	1260.0	877.49	2172.99
3.	Moe-Mauk	152.0	64.0	124.73	340.73
4.	Man-Si	13.15	-	93.69	106.84
D.	Putao Distirct	-	-	117.14	117.14
1.	Putao	-	-	79.09	79.09
2.	Machanbaw	-	-	22.46	22.46
3.	Sumpraboom	-	-	3.73	3.73
4.	Khaung-lan-phu	-	-	5.07	5.07
5.	Naung-Moon	-	-	6.79	6.79
	Total	772.35	3114.0	5083.95	8970.3

Table 6.3.8. Production of Fish from the Kachin State (2007-2008/ December).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	306.36	706.00	788.14	1800.50
1.	Myitkyina	105.5	105.00	45.86	256.36

2.	Waing-maw	187.5	129.00	118.67	435.17
3.	Tanaing	13.36	327.00	491.47	831.83
4.	Chibwe	-	-	8.98	8.98
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	4.88	4.88
7.	Sin-Bo	-	145.00	113.30	258.30
B.	Moe-Nyin District	201.00	562.00	3299.23	4062.23
1.	Moe-Nyin	83.00	148.00	2906.53	3137.53
2.	Moe-Kaung	100.00	220.00	231.23	551.23
4.	Phar-Kant	18.00	194.00	161.47	373.47
C.	Bamaw District	372.00	2666.00	1860.19	4898.19
1.	Bamaw	144.00	1010.00	544.28	1698.28
2.	Shwe-Ku	41.00	1575.00	1077.49	2693.49
3.	Moe-Mauk	172.00	81.00	136.73	389.73
4.	Man-Si	15.00	-	101.69	116.69
D.	Putao Distirct	3.90	-	129.64	133.54
1.	Putao	3.90	-	86.59	90.49
2.	Machanbaw	-	-	25.46	25.46
3.	Sumpraboom	-	-	4.73	4.73
4.	Khaung-lan-phu	-	-	5.57	5.57
5.	Naung-Moon	-	-	7.29	7.29
	Total	883.26	3934.00	6077.20	10894.46

Table 6.3.9. Production of Fish from the Kachin State (2007-2008/ January).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	333.61	767.50	884.61	1985.72
1.	Myitkyina	115.50	115.00	48.91	279.41

2.	Waing-maw	203.50	139.50	122.31	465.31
3.	Tanaing	14.61	356.00	567.52	938.13
4.	Chibwe	-	-	9.48	9.48
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	5.11	5.11
7.	Sin-Bo	-	157.00	126.30	283.30
B.	Moe-Nyin District	218.80	614.00	3628.23	4461.03
1.	Moe-Nyin	90.70	161.00	3206.53	3458.23
2.	Moe-Kaung	108.50	241.00	249.23	598.73
4.	Phar-Kant	19.60	212.00	172.47	404.07
C.	Bamaw District	406.40	2912.00	2029.19	5347.59
1.	Bamaw	157.50	1104.00	589.28	1850.78
2.	Shwe-Ku	44.70	1720.00	1182.49	2947.19
3.	Moe-Mauk	188.00	88.00	146.73	422.73
4.	Man-Si	16.20	-	110.69	126.89
D.	Putao Distirct	4.6	-	140.64	145.24
1.	Putao	4.6	-	93.59	98.19
2.	Machanbaw	-	-	27.96	27.96
3.	Sumpraboom	-	-	5.08	5.08
4.	Khaung-lan-phu	-	-	6.10	6.10
5.	Naung-Moon	-	-	7.91	7.91
	Total	963.41	4293.70	6682.67	11939.58

Table 6.3.10. Production of Fish from the Kachin State (2007-2008/ March).

Sr.	District Township	2007-2008			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	381.0	870.0	1025.62	2277.42
1.	Myitkyina	131.73	130.0	54.06	315.79

2.	Waing-maw	232.57	158.0	129.89	520.46
3.	Tanaing	16.70	405.55	677.34	1099.59
4.	Chibwe	-	-	10.10	10.10
5.	Sawt-law	-	-	4.98	4.98
6.	Injaryan	-	-	5.58	5.58
7.	Sin-Bo	-	177.25	143.67	320.92
B.	Moe-Nyin District	250.29	700.37	4117.63	5068.29
1.	Moe-Nyin	103.61	184.13	3640.07	3927.81
2.	Moe-Kaung	124.19	273.92	284.20	682.31
4.	Phar-Kant	22.49	242.32	193.36	458.17
C.	Bamaw District	463.88	3325.90	2308.98	6098.76
1.	Bamaw	179.97	1260.63	683.09	2123.69
2.	Shwe-Ku	51.03	1964.34	1335.70	3351.07
3.	Moe-Mauk	214.52	100.93	163.83	479.28
4.	Man-Si	18.36	-	126.36	144.72
D.	Putao Distirct	4.85	-	160.29	165.14
1.	Putao	4.85	-	107.50	112.35
2.	Machanbaw	-	-	31.91	31.91
3.	Sumpraboom	-	-	5.89	5.89
4.	Khaung-lan-phu	-	-	6.99	6.99
5.	Naung-Moon	-	-	8.00	8.00
	Total	1100.02	4897.07	7612.52	13609.61

Table 6.3.11. Production of Fish from the Kachin State (2008-2009/ June).

Sr.	District Township	2008-2009			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	194.3	-	-	194.3
1.	Myitkyina	56.0	-	-	56.0

2.	Waing-maw	131.9	-	-	131.9
3.	Tanaing	6.4	-	-	6.4
4.	Chibwe	-	-	-	-
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	-	-
7.	Sin-Bo	-	-	-	-
B.	Moe-Nyin District	119.1	-	-	119.1
1.	Moe-Nyin	53.25	-	-	53.25
2.	Moe-Kaung	53.5	-	-	53.5
4.	Phar-Kant	12.35	-	-	12.35
C.	Bamaw District	207.92	-	-	207.92
1.	Bamaw	95.6	-	-	95.6
2.	Shwe-Ku	27.82	-	-	27.82
3.	Moe-Mauk	74.0	-	-	74.0
4.	Man-Si	10.5	-	-	10.5
D.	Putao Distirct	-	-	-	-
1.	Putao	-	-	-	-
2.	Machanbaw	-	-	-	-
3.	Sumpraboom	-	-	-	-
4.	Khaung-lan-phu	-	-	-	-
5.	Naung-Moon	-	-	-	-
	Total	521.32	-	-	521.32

Table 6.3.12. Production of Fish from the Kachin State (2008-2009/ July).

Sr.	District Township	2008-2009			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	220.3	96.0	73.9	390.2
1.	Myitkyina	61.5	15.0	2.5	79.0

2.	Waing-maw	151.9	18.0	2.0	171.9
3.	Tanaing	6.9	45.0	65.0	116.9
4.	Chibwe	-	-	0.3	0.3
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.1	0.1
7.	Sin-Bo	-	18.0	4.0	22.0
B.	Moe-Nyin District	132.1	78.0	393.0	603.1
1.	Moe-Nyin	59.75	18.0	370.0	447.75
2.	Moe-Kaung	59.5	30.0	13.0	102.5
4.	Phar-Kant	12.85	30.0	10.0	52.85
C.	Bamaw District	231.42	412.0	302.0	945.42
1.	Bamaw	103.6	150.0	85.0	338.6
2.	Shwe-Ku	30.82	250.0	195.0	475.82
3.	Moe-Mauk	86.0	12.0	16.0	114.0
4.	Man-Si	11.0	-	6.0	17.0
			-		
D.	Putao Distirct	-	-	8.5	8.5
1.	Putao	-	-	6.0	6.0
2.	Machanbaw	-	-	1.95	1.95
3.	Sumpraboom	-	-	0.3	0.3
4.	Khaung-lan-phu	-	-	0.1	0.1
5.	Naung-Moon	-	-	0.15	0.15
	Total	583.82	586.0	777.4	1947.22

Table 6.3.13. Production of Fish from the Kachin State (2008-2009/ August).

Sr.	District Township	2008-2009			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	246.3	194.0	153.1	593.4
1.	Myitkyina	67.0	30.0	5.0	102.0

2.	Waing-maw	171.9	36.0	4.3	212.2
3.	Tanaing	7.4	90.0	135.0	232.4
4.	Chibwe	-	-	0.6	0.6
5.	Sawt-law	-	-	-	-
6.	Injaryan	-	-	0.2	0.2
7.	Sin-Bo	-	38.0	8.0	46.0
B.	Moe-Nyin District	145.1	160.0	793.0	1098.1
1.	Moe-Nyin	66.25	40.0	740.0	846.25
2.	Moe-Kaung	65.5	62.0	28.0	155.5
4.	Phar-Kant	13.35	58.0	25.0	96.35
C.	Bamaw District	254.92	851.0	621.5	1727.42
1.	Bamaw	111.6	305.0	170.0	586.6
2.	Shwe-Ku	33.82	520.0	405.0	958.82
3.	Moe-Mauk	98.0	26.0	34.0	158.0
4.	Man-Si	11.5	-	12.5	24.0
D.	Putao Distirct	-	-	18.26	18.26
1.	Putao	-	-	12.0	12.0
2.	Machanbaw	-	-	3.9	3.9
3.	Sumpraboom	-	-	0.65	0.65
4.	Khaung-lan-phu	-	-	0.82	0.82
5.	Naung-Moon	-	-	0.89	0.89
	Total	646.32	1205.0	1585.86	3437.18

Table 6.3.14. Production of Fish from the Kachin State (2008-2009/ December).

Sr.	District Township	2008-2009			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	350.48	844.87	896.68	2029.03
1.	Myitkyina	88.40	136.08	46.40	270.88

2.	Waing-maw	252.00	145.15	119.05	516.20
3.	Tanaing	10.08	397.32	627.61	1035.01
4.	Chibwe	-	-	9.24	9.24
5.	Sawt-law	-	-	5.77	5.77
6.	Injaryan	-	-	4.62	4.62
7.	Sin-Bo	-	166.32	83.99	250.31
B.	Moe-Nyin District	225.86	617.71	3478.41	4321.98
1.	Moe-Nyin	94.70	155.92	3024.45	3275.07
2.	Moe-Kaung	111.84	244.27	252.18	608.29
4.	Phar-Kant	19.32	217.52	201.78	438.62
C.	Bamaw District	435.17	3062.74	2522.09	6020.00
1.	Bamaw	168.06	1160.00	721.46	2049.52
2.	Shwe-Ku	51.18	1812.62	1500.32	3364.12
3.	Moe-Mauk	199.30	90.12	190.17	479.59
4.	Man-Si	16.63	-	110.14	126.5
D.	Putao Distirct	5.00	-	139.21	144.21
1.	Putao	5.00	-	93.75	98.75
2.	Machanbaw	-	-	27.81	27.81
3.	Sumpraboom	-	-	5.14	5.14
4.	Khaung-lan-phu	-	-	5.54	5.54
5.	Naung-Moon	-	-	6.97	6.97
	Total	1016.51	4525.32	7036.39	12578.22

Table 6.3.15. Production of Fish from the Kachin State (2008-2009/ January).

Sr.	District Township	2008-2009			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	382.37	907.57	974.37	2264.31
1.	Myitkyina	96.40	146.60	49.77	292.77

2.	Waing-maw	275.00	157.15	129.05	561.20
3.	Tanaing	10.97	427.32	685.13	1123.42
4.	Chibwe	-	-	9.97	9.97
5.	Sawt-law	-	-	5.77	5.77
6.	Injaryan	-	-	4.94	4.94
7.	Sin-Bo	-	176.50	89.74	266.24
B.	Moe-Nyin District	245.28	659.53	3783.33	4688.14
1.	Moe-Nyin	102.50	166.16	3291.54	3560.20
2.	Moe-Kaung	121.84	260.07	272.18	654.09
4.	Phar-Kant	20.94	233.30	219.61	473.85
C.	Bamaw District	469.78	3308.74	2708.01	6486.53
1.	Bamaw	179.58	1260.00	781.73	2221.31
2.	Shwe-Ku	55.78	1951.62	1600.32	3607.72
3.	Moe-Mauk	216.67	97.12	205.82	519.61
4.	Man-Si	17.75	-	120.14	137.89
D.	Putao Distirct	5.79	-	150.25	156.04
1.	Putao	5.79	-	100.91	106.70
2.	Machanbaw	-	-	30.02	30.02
3.	Sumpraboom	-	-	5.64	5.64-
4.	Khaung-lan-phu	-	-	6.06	6.06
5.	Naung-Moon	-	-	7.62	7.62
	Total	1103.22	4875.84	7615.96	13595.02

Table 6.3.16. Production of Fish from the Kachin State (2008-2009/ February).

Sr.	District Township	2008-2009			
		Aquaculture	Inn	Open	Total
A	Myitkyina District	416.20	1003.29	1063.51	2483.00
1.	Myitkyina	104.98	161.60	54.77	321.15

2.	Waing-maw	299.25	172.37	141.65	613.27
3.	Tanaing	11.97	471.82	745.13	1228.92
4.	Chibwe	-	-	10.97	10.97
5.	Sawt-law	-	-	5.77	5.77
6.	Injaryan	-	-	5.48	5.48
7.	Sin-Bo	-	197.50	99.74	297.24
B.	Moe-Nyin District	268.25	733.53	4130.61	5132.39
1.	Moe-Nyin	112.50	185.16	3591.54	3889.20
2.	Moe-Kaung	132.81	290.07	299.46	722.34
4.	Phar-Kant	22.94	258.30	239.61	520.85
C.	Bamaw District	516.78	3637.00	2994.97	7148.75
1.	Bamaw	199.58	1377.50	856.73	2433.81
2.	Shwe-Ku	60.78	2152.48	1781.64	3994.90
3.	Moe-Mauk	236.67	107.02	225.82	569.51
4.	Man-Si	19.75	-	130.78	150.53
D.	Putao Distirct	6.09	-	164.92	171.01
1.	Putao	6.09	-	110.91	117.00
2.	Machanbaw	-	-	33.02	33.02
3.	Sumpraboom	-	-	6.14	6.14
4.	Khaung-lan-phu	-	-	6.58	6.58
5.	Naung-Moon	-	-	8.27	8.27
	Total	1207.32	5373.82	8354.01	14935.15

7. DISCUSSIONS

7.1. Water quality

The riverine ecosystem of study areas is typical lotic ecosystem. The controlling factors of lotic ecosystem are weather, soil characteristics, vegetation and land use of riparian area of the rivers. These will affect the ecological parameters of temperature, flow rate, water depth, water transparency, light penetration, chemical composition, pH and dissolved oxygen concentration in the water. These are important parameters of water

quality for the aquatic organisms. Any changes of these parameters will lead to create new species composition and distribution of aquatic organisms in specific area. According to the studies, most of the parameters of water quality are still in good conditions, except the high turbidity of water in Mali Hka River and Ngawchang Hka Tributary.

According to the records along Myitsone Dam environment, temperature of May Hka River is distinctly lower than Mali Hka and Ayeyarwaddy Rivers. In May Hka, the temperature of Yenam Dam environment is the lowest and gradually increases to Myitsone confluence. This is dependent on the source of the rivers and environmental conditions. The sources of the rivers are originated from snow capped mountains of northern Myanmar. In the low flow season, the source of water comes especially from melting of snow and ice of the mountains. In the high flow season, the water comes especially from the rain. Water can be heated or cooled through radiation on the surface and conduction to or from the air and surrounding environment. The amount of shading caused by the valley shaped mountains, climate of the region and elevation of the surveyed areas influence temperature distribution.

Most lotic species are poikilotherms whose internal temperature varies with their environment. Therefore temperature is a key abiotic factor for them. Species composition and distribution will differ between the rivers because of temperature difference. Cold water species are common in May Hka than Mali Hka River because of low water temperature in May Hka.

After damming, the water temperature in the reservoir will rise and become thermally stratified. This will depend on the water retention time, the depth of the reservoir and lack of circulation between water layers. The reservoir will undergo eutrophication because of favourable conditions such as warm temperature, good light intensity and higher nutrient concentration for blooming of phototrophic organisms.

Fast moving turbulent water is the typical feature of surveyed areas and contains greater concentration of dissolved oxygen, which supports greater biodiversity than the slow moving or stagnant water. Running water dissolves more oxygen than still water especially in a reservoir behind a dam. Oxygen is limited in the specific environment where circulation between the surface and deeper layers is poor, the activity of animals is very high and there is a large amount of the occurrence of organic decay. The amount of dissolved oxygen in the water is frequently the key substance in determining the extents and kinds of organic life in the water body. Fish and aquatic organisms need dissolved oxygen to survive and conversely, it is fatal to many kinds of anaerobic pathogenic bacteria. Dissolved oxygen concentration of the surveyed areas is nearly saturated and this condition is favourable to aquatic organisms in those areas. After damming, dissolved oxygen concentration in the reservoir will be changed very distinctly from the preimpoundment condition. Dissolved oxygen concentration within water layers will also differ because of low circulation in the water columns. Some aquatic organisms those which can not adapt to the new environment will disappear and resistant species will survive continuously.

Some fish species are favourable to the fast flowing water and gravel bottom for spawning. Running water is important for fertilization and completion of larval stages for these species. The change in flow rate and submergence of the spawning grounds will severely affect those species.

Water flow is the key factor in lotic ecosystems. The velocity of water flow varies along the river. It is typically based on variability of friction within the bottom or sides of the river and incline gradient. In addition, the amount of water input into the system from direct precipitation or rainfall affect flow rate. Flowing waters can alter the shape of the

bank and river bottom through erosion and deposition, creating a variety of habitats along the river. The flow rate in May Hka River is the highest and several rapids were observed along the river. V-shaped to U-shaped rocky banks are dominant along May Hka River because of the fast flowing water. The banks on Mali Hka River around Lasa dam environment are not steep compared to May Hka River. Because of low flow speed along Ayeyarwaddy River, bank width is wider and gradient is gradual especially downstream of Myitsone Dam site.

The inorganic substrate of lotic systems is composed of material present in the catchment that is eroded, transported, and deposited by the current. Inorganic substrates are classified by size on the Wentworth scale, which ranges from boulders, to pebbles, to gravel, to sand, and to silt (Giller and Malmqvist, 1998). Typically, particle size of larger boulders and stones in more mountainous areas decrease downstream to sandy bottoms in lowland rivers. This is because the higher gradients of mountain streams create a faster flow, moving smaller substrate materials further downstream for deposition. Various substrate types such as rocky, gravel, pebble to sandy are composed of fine particles, leaves, submerged wood and plants of river banks and beds were observed along the rivers. Rocky and gravel banks and beds are more common in May Hka and Mali Hka rivers than Ayeyarwaddy River. Sandy bottom and banks can be found downstream of Myitsone confluence.

Light penetration or water transparency is also important to aquatic ecosystem, because it provides the energy necessary to drive primary production via photosynthesis, and can also provide refuge for prey species in shadows. The amount of light that a system receives can be related to a combination of internal and external river variables. Most of the surveyed areas along May Hka are covered with valley walls and light might be shaded by those walls. In Mali Hka River, light penetration will be reduced caused by turbid water coloration. Because of various forms of gold mining along Mayli Hka and Myitsone dam area, colour of water is turbid caused by high concentration of suspended silt in the water. These are limiting factors for light penetration into the water. The composition and distribution of phototrophic organisms depend on light penetration into the water. After damming, the deposition of sediments carried along the river and the higher water transparency will cause for blooming of phototrophic organisms in addition with other conditions.

According to the study, pH values are lower in May Hka and Mali Hka rivers compared to downstream of Ayeyarwaddy River. In May Hka, pH value from Pisa is the lowest and less than 7 in some sampling sites. This may be caused by the discharge into the river from the forests of the catchment areas along the rivers. The conditions of riparian forests along the downstream of Kaunglanghpu Dam to the upstream of Chibwe Dam are better than the other areas.

Electrical conductivity is the measurement of the ability of water to conduct an electric current. The greater the content of ions in the water, the more current can carry and the higher the value. This is used to estimate the total ion concentration of the water and is often used as an alternative measure of dissolved solids. Higher values of electrical conductivity in some tributaries depend on the ion concentration of the source or catchment areas. The higher concentration of electrical conductivity in Lasa Dam area may be caused by the high turbidity and high concentration of certain ions in the water from gold mining.

Various concentrations of nutrients along the river are depending on the different environmental conditions along the rivers. Water chemistry varies tremendously along the river. The chemical composition is determined by inputs from the geology of its watershed, or catchment area, but can also be influenced by precipitation and addition

of human sources pollution. Large differences in water chemistry do not usually exist within small lotic systems, however, the concentrations of most nutrients, dissolved salts, and pH decrease as distance increases from the river's source. Upper reaches of the surveyed areas are not affected as much as the original riverine conditions because of low population and no industry along the river. Agriculture is not developed and there is no chemical pollution caused by agricultural run off. Riverine water quality of Mali Hka is worse compared to May Hka and downstream of Myitsone Dam areas because of gold mining processes. During the dam construction period, these will be reduced because of rising water level along the river. After completion of the dams, these may be totally submerged under the water and water quality will become better than the previous conditions.

The other problem of gold mining is mercury usage in gold purification process. A lot of mercury used in gold processing is disposed into the river water every day. Mercury is a very dangerous chemical for every kind of organisms including human beings. Mercury deposit on the river bed will severely affect bottom feeders such as *Schizothorax* spp., *Tor* spp. and *Neolissochileus* spp. Autotrophic organisms such as algae absorb every kind of chemical constituents from the surrounding medium for their photosynthesis process. At the same time, mercury will be absorbed into their cell body. The bottom feeders that feed on the algae will be severely affected by mercury poison. These fishes are not suitable for human consumption. Therefore, dam construction is good for environmental degradation caused by mercury poisoning of gold mining. Systematic gold mining technology has to be introduced into the region for reducing mercury and any kinds of chemical poisoning to the environment.

Turbidity of water in Ngawchang Hka Tributary is caused by the effluent of factory in the upstream of the tributary. This problem has to be considered seriously for Chibwe Dam area. The suspended silts in the water will deposit in Chibwe Dam and in the long term process this will cause a serious problem not only to the aquatic organisms but also to the people in this region. Negotiations to maintain water quality in Chibwe Dam is urgently required with the factory personnels before the dam construction.

Submergence of some plants in the riparian region along the dams and leaves falling into the dams will cause the change of chemical composition in the storage dams initially and then releasing of hydrogen sulphide and ammonia in the long term will lead to unfavourable water quality condition to the aquatic organisms in the dams. The chemical composition and concentration of nutrients will be higher than preimpoundment condition because of sedimentation along the barriers. Because of the higher concentration of nutrients and other preferable factors, aquatic phototrophic organisms will bloom rapidly. This blooming will lead to eutrophication in the dams. In the eutrophication, diurnal variation of pH and oxygen will be higher and this is an unfavourable condition for the aquatic organisms. All water parameter changes before and after dam construction will result in the changes of aquatic organisms including fish species composition and distribution in the study areas.

The ecosystem after damming will change from lotic to lentic ecosystem. Water flow rate will be reduced, water volume will be increased and water layers will be stratified. Thermal stratification will occur in the water layers because of stagnant condition as there is not enough mixing process in water layers. Oxygen concentration will also drop especially in the deep water layer. pH will be higher than the preimpoundment condition because of phototrophic organisms blooming in the water. Diurnal variation of dissolved oxygen and pH will occur in the dams. All of these effect cumulatively to the aquatic organisms in the long term. These changing effects are very important for the aquatic ecosystem. All changes will lead to new ecosystem for the aquatic organism.

As the water uptake for turbines is usually in the hypolimnion, cold water will be discharged downstream during the operation of the power station. The hypolimnion may become cold and deoxygenated, and discharge of such water downstream may have negative impact on the aquatic fauna in the river below the dam. Downstream flow rate in the river will depend on the amount of the compensated discharge from the dam. Water volume is considerably reduced during the dry season. As a result, the downstream may change to pools alternating with dry stretches in summer season. Due to decreased water discharges, water temperature will rise in the daytime and decline sharply at night in the downstream of the dams.

Flood rhythm in the downstream and upstream will be changed very prominently after damming. Water quality will deteriorate after storage of water in the reservoir. Release of good quality water is required for maintaining well-functioning downstream aquatic habitats. Artificial destratification is one of the effective mitigation measures for maintaining a good quality of water in a reservoir which undergoes stratification. It requires a process to lift cooler bottom water to the surface of a stratified impoundment. This helps to mix water and to maintain uniform temperature and vertical distribution of dissolved oxygen. From the above facts, maintaining aquatic ecological conditions is extremely essential to maintain water quality after each dam constructions.

Saltwater intrusion is a big problem if the dams construct near the river mouth region. But there is not a severe problem of saltwater intrusion in the rivermouth region after dam construction in the origin of Ayeyarwaddy River. Ayeyarwaddy River is one of the longest rivers in the world and the length is about 2170 kilometers. Main branch river naming Chindwin River and many minor rivers join Ayeyarwaddy River until rivermouth region. The volume of flow waters from those joining rivers will compensate the reduce flow of water volume at the starting point of Ayeyarwaddy River. The other favourable condition for this problem is the dams will not be finished at the same time and the flow volume will not be blocked suddenly. This problem has to study in detail in the future especially in the low flow season.

Cold water from May Hka will be blocked by series of dams on May Hka River. Damming on Ayeyarwaddy River in the downstream of Myitsone confluence will block also the inflow of coldwater into Ayeyarwaddy River from May Hka River. This will be a problem for inflow water quality into Ayeyarwaddy River and successive problem is distribution of aquatic organisms in the upstream of Ayeyarwaddy River. The distribution pattern of aquatic organisms especially fish species will be effected. Separate dams should be considered upstream of Myitsone confluence on May Hka and Mali Hka Rivers instead of Myitsone Dam for reducing this problem.

7.2 Aquatic organisms

The food base of streams within riparian forests is mostly derived from the trees, but wider streams and those that lack a canopy derive the majority of their food base from algae. In the aquatic food web, algae are the fundamental part of the system.

Algae, consisting of phytoplankton and periphyton, are the most significant sources of primary production in most streams and rivers. Phytoplankton floats freely in the water column and it is unable to maintain population in fast flowing streams. They can, however, develop sizable populations in slow moving rivers and backwaters. Periphytons are typically filamentous and tufted algae. They can attach themselves to objects to avoid being washed away by fast current. In places where flow rates are negligible or absent, periphyton may form a gelatinous, unanchored floating mat. Because of fast flowing water along surveyed areas, periphyton is more abundant than phytoplankton. But phytoplankton species composition is as high as periphyton species

composition. This means good quality of water and no pollution in those areas. Surviving in unpolluted flow water can be beneficial to plants and algae because the current is usually well aerated and it provides a continuous supply of nutrients. Phytoplankton and periphyton composition and distribution are limited by flow, light intensity, water chemistry, substrate, and grazing pressure. These organisms exhibit limited adaptations to fast flow and are most successful in reduced currents such in Tarlawgyi on Ayeyarwaddy River.

Species density and composition of phytoplankton in Myitsone Dam area is the highest in Ayeyarwaddy River and the lowest in Mali Hka River. Warmer temperature and slow flow of Ayeyarwaddy River are favour to phytoplankton species richness in the water. Lowest species richness in Mali Hka River is caused by the high turbidity of water along the river and this is the controlling factor for phototrophic organisms blooming in the water. Phytoplankton species composition in May Hka River is lower compared to Ayeyarwaddy River but higher than Mali Hka River.

Highest periphyton species density in Ayeyarwaddy River and lowest in Mali Hka River is dependent on flow rate, light intensity and other environmental conditions of the rivers. Periphyton species richness is the highest in May Hka depending on the undamaged condition of the natural water beds.

Zooplankton species composition is the highest in downstream of Myitsone Dam and the lowest in May Hka River depending on the phytoplankton richness and environmental conditions. Because of the fast flow water along May Hka River, organisms that suspend in the water column such as zooplankton cannot maintain in high density.

The comparison of species composition of aquatic organisms between the rivers is the highest in May Hka River and the lowest in Mali Hka River. This means better quality of water of May Hka River than the other rivers. Benthos and periphyton from Mali Hka River is significantly lower than the other rivers. This means the worst condition of river bed condition in Mali Hka River caused by gold mining and decomposed chemical such as mercury. Low composition of wandering organisms in the water column such as phytoplankton and zooplankton in Mali Hka River means the nuisance condition of turbid water to the aquatic organisms.

More primitive plants, such as mosses attach themselves to solid objects. This typically occurs in colder headwaters where rocky substrate offers attachment sites. Mosses are common along May Hka River upstream of Pisa dam site. Algae and mosses are important to lotic systems as a source of energy for forming microhabitats that shelter other fauna from predators and also from the current, and as a food resource.

Dams alter flow, temperature, and sediment regime of lotic systems. Additionally, damming at multiple locations along the river will amplify the impact. Dams can cause enhanced clarity and reduced variability in stream flow, and these will lead to an increase in periphyton abundance. Invertebrates immediately below a dam can show reductions in species richness due to an overall reduction in habitat heterogeneity.

Insects are the dominant invertebrates in lotic systems. These species exhibit tremendous diversity and can be found occupying almost every available habitat, including the surfaces of stones, deep below the substratum, adrift in the current, and in the surface film. Insects have developed several strategies for living in the adverse flows of lotic systems. Some avoid high current areas, inhabiting in the substratum or the sheltered side of rocks. Like most of the primary producers, lotic invertebrates often rely heavily on the current to bring them food and oxygen. Invertebrates, especially insects, are important as both consumers and prey items in lotic system.

Benthos species composition from Phylum-Arthropoda is the highest in Tungpang Hka Tributary along May Hka River depending on the better environmental condition of riparian areas along the River. The other favourable factors of May Hka River environment for the aquatic organisms is good oxygen concentration and untouchable condition of the river banks along most parts of the river.

Due to the surveyed results, May Hka River environment is better than Mayli Hka and Ayeyarwaddy Rivers for the aquatic organisms. These conditions will be altered after damming and some species that can adapt to the new environment will survive continuously and some species will be lost.

Unidentified species of aquatic organisms is required to study into special level. Some species may be typical species of coldwater especially Himalayan region. International study programme have to conduct for maintaining biodiversity of this region.

7.3. Fish

7.3.1. Fish in general

Fish are the best known inhabitants of lotic systems. The ability of fish species to live in flowing waters depends upon the swimming speed and the duration it can stay in the running water. This ability can vary greatly between species and is tied to the habitat in which it can survive. Continuous swimming expends a tremendous amount of energy and, therefore, fishes spend only short periods in full current. In fast flowing water, individuals remain close to the bottom or the banks, behind obstacles, and sheltered from the current and swim in the current only to feed or change locations. Some species have adapted to living only on the bottom, never venturing into the open water flow. These fishes are dorso-ventrally flattened species such as *Pseudexostoma* sp., to reduce flow resistance and often have eyes on top of their heads to observe what is happening above them. Some also have sensory barbels such as *Tor* sp., *Schizothorax* sp. and *Neolissochilus* sp., positioned under the head to assist in the testing of substratum.

Lacustrine conditions of the reservoir will differ from those of the continuously flowing river and this will also have an impact on the original fish fauna. Some species live in flow current do not like lacustrine conditions and can not survive well in the dams. Swar (1992) discussed that *Garra lamta*, *Glyptosternum*, *Coraglanis*, *Puntius* sp, *Glyptothorax pectinopterus*, *G. cavia*, *Psilorhynchus* and *Pseudecheneis* do not like lacustrine conditions. Carp minnow (*Barilius bendelensis*), stone loach (*Nemacheilus beavani*) and stone roller (*Garra gotyla*) find reservoir conditions favorable, and reservoir conditions are ideal for rapid colonization by hardy fish such as murels and catfish (*Heteropneustes fossilis*). *Garra* spp., *Glyptothorax* spp. and *Pseudecheneis* spp. will get a problem after damming and these spp. have to find out new suitable habitats.

Shoreline erosion and rapid and intensive drawdown are other problems faced by fish as they affect spawning and egg incubation. Swar (2002) pointed out that soil erosion affects the river ecology, resulting in the loss of breeding and nursing grounds of the riverine fish species. Physical injury or blocking of gills from silt or other suspended material has also affected the river fish fauna. High suspended silt concentration in the water of Ngawchang Hka Tributary and Mali Hka River are not good for fish living in those rivers and also for the spawning beds in the rivers.

Some economically important species of family-cyprinidae such as *Schizothorax* spp. inhabit in flow water and prefer fast flow speed on the gravel bottom for spawning. This helps fertilization and completion of larval life span of those species. In stagnant water, the eggs will sink to the bottom and larvae cannot swim to the surface layer for the completion of larval life span. The larvae will die on the bottom and population of these

species will climb down gradually after damming. Fish eggs those collected from Lasa Dam environment in April sampling have to study in detail in the future for specific species.

1 ovary matured *Schizothorax* species specimen collected from Wusok Dam area in April sampling will be related to higher temperature in that season. Spawning season of most fish species is related to higher water temperature and enough food availability. Recorded temperature from specimen collected site is about 15.3°C and this temperature is well enough for ovary maturation of cold water species. After dam construction, temperature changes will lead to changes of spawning area along the river.

Some fish species may disappear, others will adjust by changing from stenophagous to euryphagous. Omnivorous or planktivorous fish may adapt to the reservoir conditions. Fish are affected indirectly when their food organisms are destroyed caused by any changes in their riverine ecosystem. Fish food organisms will be highly affected by reduced flow rates and new species that prefer slow current will invade into the areas. Fish species that prefer the speedy current will be affected directly by the changes in their food and habitat after damming. This leads to stunted growth because of change of food, diseases and parasite infestation from malnutrition and increased mortality.

The problem in this area is extensive plantation method of shifting cultivation along the riverine catchment areas. This will cause land sliding along the catchment areas. Petr (2003) pointed out that poor agricultural practices lead to soil erosion and an increase in water turbidity, with spawning beds of valuable cold water fish species such as *Tor* sp., *Schizothorax* sp. and trout silted over. Not only are the natural habitats damaged or destroyed, but hatcheries constructed along streams may be damaged and made inoperative by the increased flow rates from deforested catchments, and the associated increase in transport of sediments, including stones and boulders, in fast running streams.

A dam will fragment and isolate upstream fish from downstream and affect significantly on migratory fish. Some migratory species may decline abruptly in reservoirs because of dam barriers. Migration is done to find suitable spawning and feeding grounds. A dam will obstruct the route of the long and mid-distance migratory fish. Upstream migrants will arrive at the dam site during the flow phase. Long distant migrants are most affected by a dam. These species will abandon the original pool and colonize deep pool regions downstream or upstream. Gubhaju (2002) discussed that short and mid-distance migratory fish *Schizothorax* and *Schizothoracichthys* move upstream in response to high turbidity, higher water temperature, and due to the scarcity of food during the rainy season in the lower reaches. Snow trout, once abundant in the Kulekhani River, became rare after the river was dammed. The same happened to mahseer after the impoundment of Phewa and Begnas lakes in Pokhara Valley. *Neolissocheilus hexagonolepis*, on the other hand, is a common fish in reservoir conditions (Swar, 1992). Populations of snow trouts are less affected, as they make a small-scale migration to tributaries to breed in clear and cool water during the monsoon and return to the main stream during the low flow period. Finally, dams fragment river systems, isolating previously continuous populations, and preventing the migrations of anadromous and catadromous species. Rai (2008) drew conclusion that migratory fish species are vulnerable during their life cycle due to river damming, and about 20% of the world's fresh water fishes are estimated near extinction or in urgent need of conservation. Therefore, to sustain biodiversity and fisheries in rivers requires sustainable management both of habitats and systems of exploitation.

One favourable condition for cold water mid-migrant species is open channels that remain along the dams such as Taron Wang Tributary in Yenam Dam, Ahkyang Ti

Tributary in Kaunglanhpu Dam, Mekh Rame Tributary in Pisa Dam, Maw (Ma) Kyaung Tributary in Wusok Dam, Ngawchang Hka Tributary in Chibwe Dam. Hkrang Hka and Shang Hka (Nam Tisang) Tributaries remain as open channels in Lasa Dam, Mali Hka. Those channels are important habitats for cold water species such as snow trouts. Maintaining the environmental conditions of those tributaries are extremely essential to maintain cold water species along the rivers. Maintaining these areas will help to reduce dam impact on cold water species after damming.

Lotic systems typically connect to each other, forming a path from spring, stream, river to ocean, and many fishes have life cycles that require stages in both fresh and seawater. *Anguilla* spp. are catadromous and are born and develop in the ocean and then move into freshwater as adults. *Anguilla* spp. will be lost in some parts such as upstreams of Mali Hka and May Hka Rivers because of dam barriers. *Anguilla bengalensis* and *Schizothorax richardsonii* have been also known to decline abruptly in reservoirs (Swar, 1992). But the whole population of *Anguilla* spp. will not disappear from Ayeyarwaddy River because they migrate from the river mouth to upstream along the river.

For the conservation of migratory fish, trapping and hauling is one kind of mitigation measures. It involves trapping of fish below the dam and transporting them to the reservoir or further upstream to maintain fish diversity and gene pool. But it is labor intensive and stressful to fish which increases their mortality. It also needs an appropriate location and facilities have to be designed at the earliest possible stage. But this is one of the effective mitigation measures for conservation of the migratory fish.

Maintenance of flow level is one of the important factors to maintain the situation of downstream fisheries situation. There may be decrease water depth in the downstream during the dry season due to the flow diversion and damming of the river. The effect is local and can be overcome to some extent by releasing compensation flow downstream. Compensation flow for the conservation of microflora, aquatic insects and fish in the downstream zone do need maintaining of downstream population. Regular releases of flushing flows will maintain quality of downstream spawning gravel bottoms from fine sediments covering.

Bottom feeders such as *Schizothorax* spp. and *Tor* spp. may be pulled and get killed due to the intake of the hydropower turbines. Even riverine fish that can adapt to fast current may be lost because of this problem. This problem is unavoidable because of the turbines in the dams.

Entrapment of fish is a critical problem after damming and some provision should be made to protect the fish against entrapment. Installation of appropriate screen devices at the intake will divert the fish from entering water intakes. Therefore, ideal fish bypass facilities should be installed along the dams.

Fish lift, fish passes and fish passages can be also considered as mitigation measures for migratory species. Fish passes play an important role in the conservation of the native fish resource. For the conservation of native species such as snow trouts, the maintenance of spawning grounds and fish hatcheries should be established as a means of enhancing the fish stocks affected by dams. Some resident fish utilise gravel bed areas for spawning. Considerable loss of spawning grounds of these species will take place immediately below dams. Therefore, adequate attention must be given to the protection of the spawning and nursery gravel beds and additional measures such as depositing gravel to increase the spawning habitat. Placing triangle and large boulders on the bottom to create pools in the downstream of the dam for spawning have to be considered.

Fish passes or passages are typically used to mitigate the effect of dams. Fish passes are one of the most important remedies for assisting fish migration. According to the fish records, hydropower projects of the Ayeyarwaddy River basin above Myitkyina are generally established in areas of fish migration and fish passes are recommended to mitigate the barrier effect of the dam. Gubhaju (2002) pointed out that a fish pass should meet the following criteria:

- it should be adapted to the requirements of the species concerned;
- it should be of a pool type, rocky ramp type, or a vertical slot;
- flow velocities must not exceed the swimming capacity of fish;
- it should provide passage for all fish sizes - large and small;
- it should be provided with proper fencing, with total ban on fishing.

Gubhaju (2002) also discussed that the more natural types of passes, e.g. rocky ramps or artificial rivers (bypass channels), can even enhance the beauty of the landscape. There are hundreds of good examples of well-designed and effective fish passes in the world. A fish pass needs to be tested for the known fish species migratory behaviour. The pass has to be monitored by fishery specialists. If the monitoring finds that fish do not use the fish pass, the pass has to be improved.

The problem in this area is using small mesh size fishing net. Fishermen along the surveyed areas also use dynamite extensively. Swar and Shrestha (1997) pointed out that several types of fishing gears, e.g. cast nets, small mesh size seine nets, gill nets and trammel nets are used in different rivers of Nepal. Gill nets, especially those with small mesh size, tend to be nonselective in their catch. Thus large quantity of fish fry, fingerlings smaller than the legal size limit and non-targeted species such as juvenile Gangetic Dolphin, crocodiles and turtles are captured and killed as by-catch by fishermen. Mortalities of these non-target organisms may have an unwanted impact on the riverine ecosystem and the aquatic biodiversity. The ever-increasing human population has become the main cause of high, illegal and irrational fishing pressure on the aquatic ecosystems. Fishing effort has been intensified without considering the size and species of fish. Such activities not only degrade the target fish population by changing the population size and structure, but also affect other species linked to it in the food chain. Non-target species may also be injured or killed by the use of unsuitable fishing gear and practices. The explosives, extensively used illegally in Nepal, are often misused in killing fish in large numbers. They are killed together with other aquatic animals, and this is accompanied by damage to the habitat of which recovery is slow. The knowledge transfer to the local people on importance of environmental conservation is urgently required.

Reservoir associated hatchery has to be considered to produce seed of important native fish such as mahseer, snow trout and labeo species. Stocking the reservoir and tail water will replenish the losses resulting from the disappearance of the natural spawning grounds and from secession of migrations. The fishermen should be provided seed from the hatchery to grow fish in ponds to marketable size. Culture fisheries such as cage or pond culture have to be developed in the region. This provides alternative means of subsistence and income, thus reducing the pressure of the capture fishery on native stocks. Therefore, regular fish stocking after damming is one way of enhancing reservoir fish stocks, reservoir-based aquaculture. In Nepal, a successful cage culture is being practiced in Trishuli and Kulekhani reservoirs where it provides income to the local fishery communities (Gubhaju, 2002). Dams can enhance some riverine fisheries, particularly tail-water fisheries immediately below dams that benefit from discharge of nutrients from the upstream reservoir.

Dam construction will change not only the riverine ecosystem but also fish distribution patterns in the region. To recover from the changes, mitigation or compensation measures have to be applied to reduce the impacts after damming. Compensation measures consist of fish hatcheries and stocking programs designed to reproduce the productivity of the fishery. Electrical power generation supports the development of the region, but the river ecosystems suffers adversely, especially the maintenance of fish species, which were not considered in earliest hydropower projects. The ecosystem will change and both feeding grounds and breeding grounds will be destroyed, leading to loss of fish species. Loss of fish species will lead to impact biodiversity in specific environment.

Due to the records, cold water species do not migrate downstream of Chibwe Dam environment in May Hka River and Lasa Dam environment in Mali Hka River. Warm water species, except long migrants, do not migrate upstream of those dams. This means Chibwe and Lasa Dam environments are the transition areas for cold and warm water species. We can conclude that dam constructions should start in those areas first to reduce impact on cold water species because cold water species are more important than warm water species in those regions.

7.3.2. Migratory fish

Migratory fish can be divided into 3 categories such as potamodromous, oceanodromous and diadromous species. Potamodromous and diadromous species found in this study. Potamodromous fish migrate within fresh water only such as *Labeo dyocheilus* (McClelland) and *Raiamas guttatus* (Day). Diadromous fish travel between salt and fresh water. Diadromous fish can be divided into 3 groups such as anadromous, catadromous and amphidromous fish. Catadromous and amphidromous species are recorded from this survey. Catadromous fish live in fresh water, and breed in the ocean such as *Anguilla bengalensis* (Gray) and *Anguilla nebulosa* (McClelland). Amphidromous fish move between fresh and salt water during their life cycle, but not to breed such as *Mystus carvasius* (Hamilton) and *Xenentodon cancilla* (Hamilton).

Long distant and mid or short distant migrants found in this area. Long distant migrants such as *Anguilla bengalensis* (Gray, 1831), *Anguilla nebulosa* (McClelland) and *Tor putitora* (Hamilton) will be affected severely after dam construction. These long distant migrants will be lost upstream of Myitsone Dam but will remain downstream of Myitsone Dam. The route of mid or short distant migrants of cold water fish such as Snow Trout will be affected after dam construction. But the favourable condition for cold water migrants is open tributaries remain above each dam. The headwaters of these tributaries originate in the snow capped mountains of Himalayas mountain range and the water in the tributaries is cold. This cold water environment is suitable for cold water species.

Important migratory species found in this area are *Anguilla nebulosa*, *Anguilla bengalensis*, *Tor putitora*, *Neolissochilus hexagonolepis*, *Bagarius yarrelli*, *Pangasius pangasius*, *Wallago attu*, *Labeo* species and *Schizothorax* species. These migratory species have to protect scientifically from impact after dam construction.

7.3.3. IUCN status of fishes recorded

Only one species is recorded as critically endangered species in IUCN (International Union for Conservation of Nature and Natural Resources) red list of threatened species in surveyed areas. Kunming Snout Trout, *Schizothorax grahami* (Regan), distinctly found in Nmai Hka upstream, has been recorded as endangered species list in IUCN, 2009. This fish is found as distinct cold water species in study areas. Kunming Snout

Trout prefers riffle habitats and cold water. It hides under big stones or caves under water in winter. In summer, it feeds in fast flowing water over sand and cobbles. It feeds and grows in lakes or rivers, but during the breeding season it will migrate to the rivers or any other kind of stream inlet to Lake Dianchi where it spawns in riffles (Chen and Cao, 2000). These scientists pointed out that major threats to this species loss from the lake are likely due to introduced fish species, water pollution, over-fishing, and breeding sites lost due to siltation and blocked access.

This species was found in Yenam, Kaunglanhpu and Chibwe dam area. Adults were found in Yenam and Kaunglanhpu dam areas and juveniles were found in Chibwe dam area in May. This means Kunming Snout Trout migrate downstream until Chibwe Dam area in May for spawning and remigrate to upstream areas. After damming, many open channels will remain in each dam and these will reduce blockage effect on migration route of this species along the rivers. Maintaining environmental conditions of dams and their tributaries are important for conservation of this species from extinction. More researches have to pay attention on the maintenance of this species in this area which is essential from the biodiversity point of view. Collaborative researches have to be undertaken within international organizations and national organizations supported by the construction company.

1 data deficient species of *Macrogathus aral* (One-stripe Spiny Eel) (Bloch & Schneider) was also recorded in downstream of Myitsone dam area. According to fishbase record, this species is regionally extinct in Sri Lanka. They occur in running and stagnant waters with silt or mud substrate. This species can be found in fresh and brackish waters and deltas of large rivers, common in ponds and slow flowing rivers with vegetation in plains. This species is common in rice paddy fields and they are nocturnal feeder, on insects and worms. This species can be found in tropical Asian countries such as Pakistan, India, Sri Lanka, Bangladesh, Nepal and Myanmar and is distributed between latitude 4°N to 10°N. To be protected from extinction, it is essential for further researches to be carried out on this species. This species will not be affected by dam construction because this species is found only downstream of Myitsone Dam.

Other species have not been evaluated yet in IUCN red list of threatened species. These fish species have to study in detail.

7.3.4. Economically important species

In May Hka and Mali Hka Rivers, *Schizothorax* spp., *Bangana devdevi* (Hora), *Neolissochilus hexagonolepis* (McClelland), *Tor* spp. and *Garra* spp. were recorded as economically important fish species. *Bangana devdevi*, *Neolissochilus hexagonolepis* (McClelland), *Garra lamta* (Hamilton), *Eutropiichthys vacha* (Hamilton), *Pangasius pangasius* (Hamilton), *Tor* spp. and *Labeo* spp. were recorded as important species list in Ayeyarwaddy River.

In those species, *Schizothorax* spp. inhabit distinctly to cold water and can be found only upstream of Chibwe and Lasa Dams. Warm water spp. such as *Eutropiichthys vacha*, *Pangasius pangasius* and *Labeo* spp. can be found only downstream of Lasa and Chibwe dams. *Bangana devdevi* can be found from Myitsone to upstream of Lasa and Wutsok dams but cannot be found in cold water environment.

Attentions have to directed for the development of artificial spawning for larval production for those species. Hatcheries have to be established in the region for producing fingerlings and restocking into the rivers. Technology for cold water aquaculture has to be introduced into the region and transferred to the local people. Collaborative works within local authorized groups, local peoples and researchers do need further developments.

7.3.5. Potential for aquaculture in the reservoir

Lacustrine condition and extensive surface area in the reservoirs will create reservoir fisheries in the region. The reservoirs will collect rich nutrients from depositions that, in turn, will promote plankton growth and create the potential for development of planktivorous fish culture. As this occurs, new job opportunities will be created for local people living around the reservoir. At the same time, regional fish production will also be increased. Poverty can be reduced and food security improved when subsistence fishermen achieve higher levels of sustainable productivity.

However, a fish hatchery is necessary near the dam site to breed and produce enough fingerlings for aquaculture activities as well as for economically important high value local fish species to be stocked into the river for conservation. Fishing pressure is an increasing factor with increasing human populations. Meanwhile, fish populations are decreasing due to over fishing and other environmental problems all over the world. The storage type reservoirs can accommodate commercial aquaculture.

The other kinds of cold water species such as cray fish those occur naturally in the region can be cultured in the ponds. Systematic techniques of pond culture for cold water species into the region are essential. Investment for the aquaculture development in the region is a must.

8. BRIEF SUMMARY

Aquatic ecological conditions, aquatic organisms and fish species list were surveyed in Hydropower Development of Ayeyarwaddy River Basin above Myitkyina project.

1. Temperature in May Hka River is found distinctly lower than Mali Hka and Ayeyarwaddy Rivers.
2. Water quality in Mali Hka is worsened because of various levels of gold minings along the river.
3. Serious turbidity of water recorded in Ngawchang Hka Tributary caused by factory effluent was found distinctly.
4. Dissolved oxygen concentrations along the rivers are nearly saturated to saturated values.
5. Riparian areas of May Hka is better than Mali Hka and Ayeyarwaddy Rivers because of low population and difficult to access there.
6. Phytoplankton species composition is the highest in May Hka River and the lowest in Ayeyarwaddy River.
7. Zooplankton species composition is the highest in May Hka River and the lowest in Mali Hka River.
8. Benthos species composition is the highest in May Hka River and the lowest in Mali Hka River.
9. Periphyton species composition is the highest in May Hka River and the lowest in Mali Hka River.
10. 5 economically important fish genera from May Hka and Mali Hka and 7 genera from Ayeyarwaddy River are recorded.
- 11.3 species of long distant migrants such as *Anguilla bengalensis*, *Anguilla nebulosa* and *Tor putitora* found in the surveyed areas.
12. Short or mid-distant migrants of cold water species such as *Schizothorax* species were found in upstreams of May Hka and Mali Hka Rivers.

13. 1 endangered fish species, *Schizothorax grahami* (Regan, 1904) is recorded from upstream of Chibwe Dam site in May Hka River.
14. 1 data deficient species, *Macrognathus aral* (Bloch & Schneider 1801) was recorded from downstream of Myitsone Dam site.
15. Dam construction should start in Chibwe Dam in May Hka River and Lasa Dam in Mali Hka River for reducing impact on cold water species.
16. To maintain the incoming cold water from May Hka in the originating of Ayeyarwaddy River, separate dams should be constructed in suitable sites upstream of Myitsone confluence on May Hka and Mali Hka Rivers instead of downstream for reducing impact on aquatic organisms distribution.

9. MITIGATION MEASURES

Due to the requirement of dam constructions for development of the region, the following mitigation measures have to be undertaken before and after dam construction period led by the government participating with local authorities and supported by Construction Company.

1. plan eco-friendly techniques for construction and employ maintenance in the areas of the dam projects for reducing the biodiversity impact;
2. encourage the small scale and medium scale instead of mechanized scale gold mining in the dam construction period for reducing severe damage to the riverine ecosystem caused by high turbidity;
3. encourage the river bank gold mining instead of river bed mining in the dam construction period for reducing direct impact on the benthos;
4. restrict fishing near the dam construction areas during construction period for reducing high fish catch on the fish aggregation near the barriers;
5. construct fish bypass system and collector channel at work site in the construction period for collecting the fish aggregates;
6. implement of fish trapping and hauling program before and after dam construction for collecting the fish;
7. construct suitable fish migration devices along with the dam for important migratory fish such as ladders or passages, including silt passage;
8. plan the regular draining for reducing irregular flooding rhythm and allowances for downstream water requirements of the aquatic organisms in the river;
9. establish conservation and protected zones or areas along the main rivers and tributaries for biodiversity conservation;
10. establish the hatcheries in the suitable areas for restocking economically important indigenous fish species; (eg. *Schizothorax* sp./Snow Trout, *Tor* sp./Nga Dauk, *Neolissochilus* sp./Nga Ni)
11. establish grow out farms, reservoir fishery and cage cultures on cold water fish species in the surveyed areas;
12. establish regular environmental monitoring and scientific research plans for the dams;
13. encourage the researchers and research projects for important fields in the dam areas;

14. establish education plans to upgrade the environmental knowledge for the local people; (eg. importance of riparian forest, dangerous of dynamite fishing, importance of banned season for fishery, etc.)
15. encourage the local people for long term plantation plan on the aquatic macrophytes or terrestrial plants in the riparian areas along the dams for suitable new habitats and shades for aquatic organisms;
16. plan to reduce shifting cultivation practice to reduce land erosion and develop suitable agricultural technique in mountainous regions not only for rice and edible plants but also for valuable Himalayan herbs for traditional medicine.

10. RECOMMENDATIONS

For successfully implementing the mitigation measures, the followings should be undertaken along with dam construction in the region led by the government participating with local authorities and supported by Construction Company.

1. establish suitable fund for short term and long term aquatic biodiversity conservation;
2. establish research center collaboratively within regional University or Institute and International Organizations;
3. establish suitable linkage between local and international organizations and conservationists for implementing Himalayan biodiversity conservation;
4. establish active NGO teams for aquatic ecological conservation;
5. negotiate between government sector, construction company and nature conservationists for eco-friendly technique urgently and establish task force group for follow up procedures;
6. establish monitoring group including government authorities, local representatives and nature conservationists for gold mining;
7. establish the regional fisheries team comprising government staff, local representatives and NGO members for development of fisheries conservation sector;
8. establish scientific research team for undertaking aquatic ecological conditions along the project areas in the construction period for drawing long term conservation plan in the region;
9. establish scientific research team for feasible fish passage design for migratory fish in the project dams;
10. find out suitable professions or jobs for the local people not only in fisheries but also in animal farming and valuable Himalayan herb and other plantations in the region;
11. initiate investigations on stocking of suitable fish in the rivers for enhancement of fish production;
12. initiate investigations into the possibilities of aquaculture in rivers and tributaries utilizing indigenous species;
13. initiate activities for further development of manpower in the field of fisheries production and conservation;
14. draw work plan within fisheries conservationists and other conservationists for working collaboratively in the region;

15. establish research linkage between the countries of Trans-Himalayan region for conservation and development of cold water fishery;
16. pay adequate attention to the conservation of cold water fish to maintain their gene pool in collaboration with international Institutions;
17. make provisions in the laws to oblige power companies to pay for the most efficient mitigation measures and to prove its efficiency;

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Fig. 3.1. Myanmar and Chinese team members working collaboratively.



Fig. 5.1. YSI (Yellow Spring Instrument) multipurpose model no. 6600 and TROLL multi-parameter series no. 9500.



Fig. 5.2. INDEX model pH, TDS and conductivity test kits.



Fig. 5.3. GARMIN GPS models GPSmap 60CSx and etrex-Legend Cx.



Fig. 5.4. Nikon COOLPIX L18 digital cameras and SONY Cyber-shot DSC-S730 digital camera.



Fig. 5.5 Phytoplankton and Zooplankton sampling using 25# mesh Phytoplankton net and 13# mesh Zooplankton net.

Fig 5.6. Benthos sampling using D-shape kick-net.



Fig. 5.7. Sampling the Periphyton.



Fig. 5.9. Fish markets in Myitkyina and Putao.

MYITSONE:

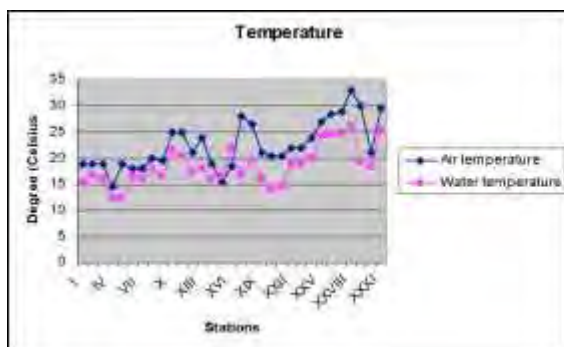


Fig. 6.1.1.1 Temperature distribution along Myitsone Dam environment..

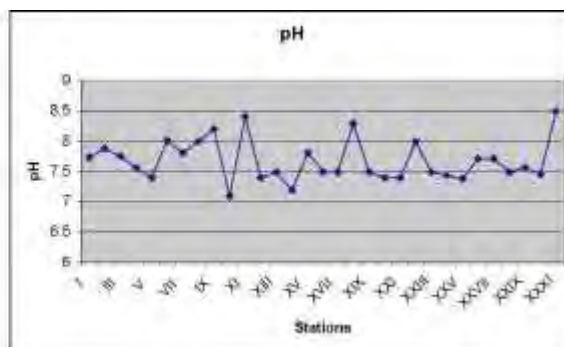


Fig. 6.1.1.2 pH distribution along Myitsone Dam environment.

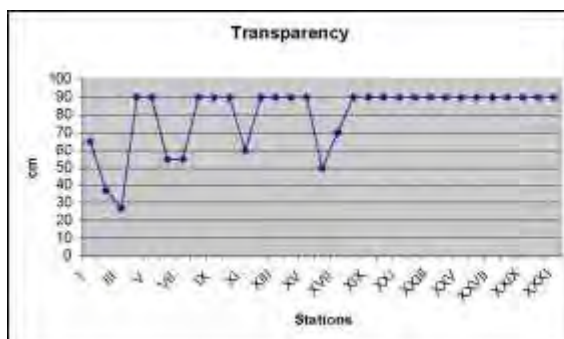


Fig. 6.1.1.3. Transparency distribution along Myitsone Dam environment.

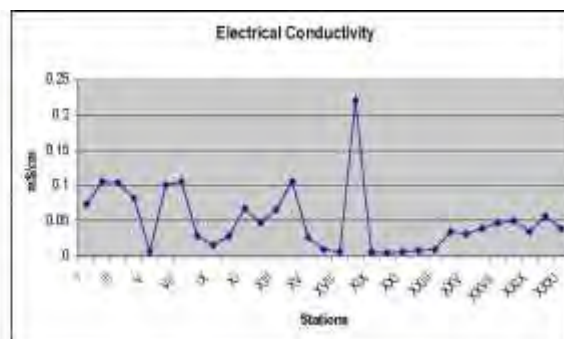


Fig. 6.1.1.4. Electrical conductivity distribution along Myitsone Dam environment.

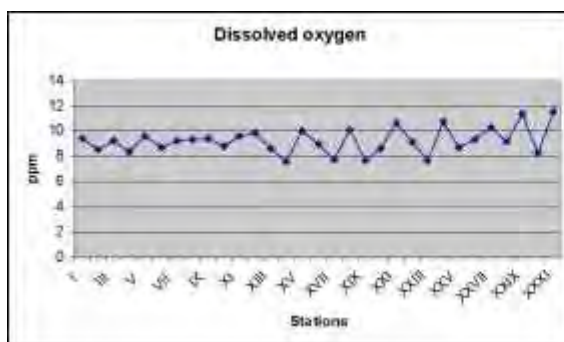


Fig. 6.1.1.5 Dissolved oxygen distribution along Myitsone Dam environment.

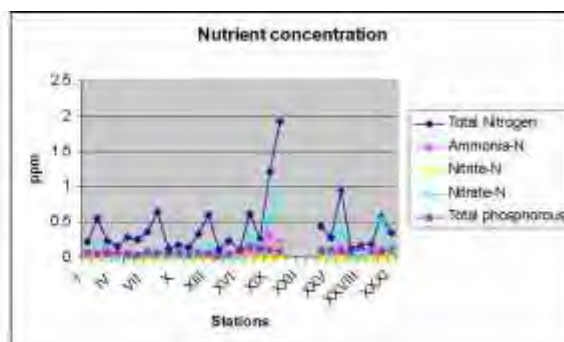


Fig 6.1.1.6 Nutrient concentration distribution along Myitsone Dam environment.

WUSOK:

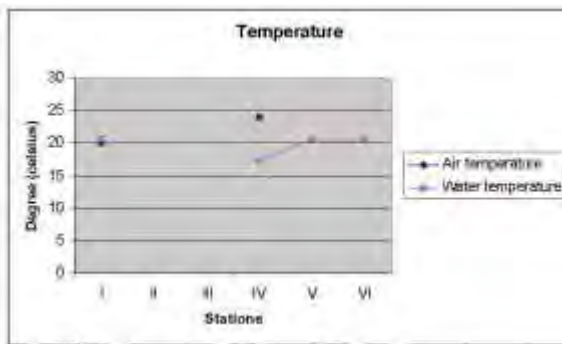


Fig. 6.1.2.1 Temperature distribution along Lasa Dam environment.

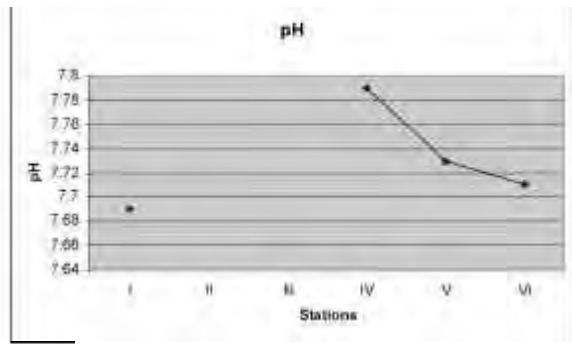


Fig. 6.1.2.2 pH distribution along Lasa Dam environment.

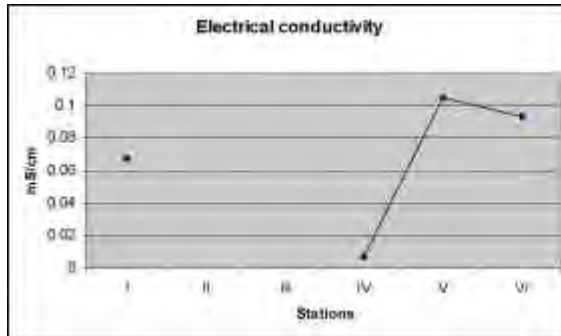


Fig. 6.1.2.3 Electrical conductivity distribution along Lasa Dam environment.

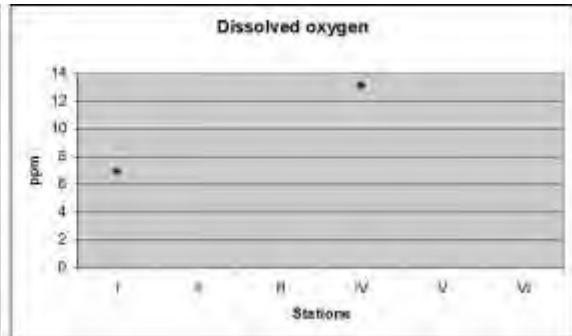


Fig. 6.1.2.4 Dissolved oxygen distribution along Lasa Dam environment.

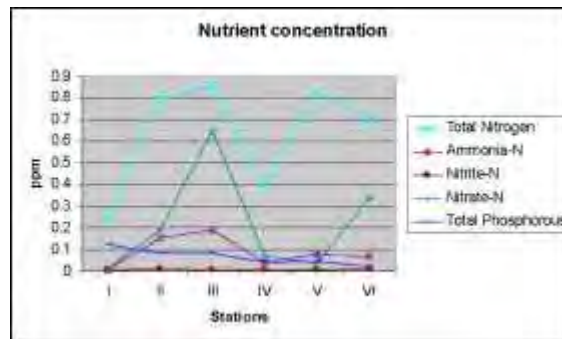


Fig. 6.1.2.5 Nutrient concentration distribution along Lasa Dam environment.

YENAM:

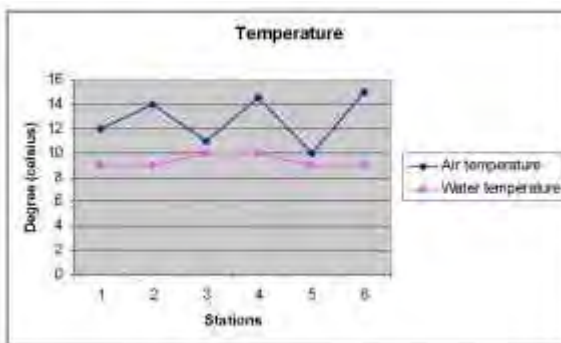


Fig. 6.1.3.1 Temperature distribution along Yenam Dam environment.

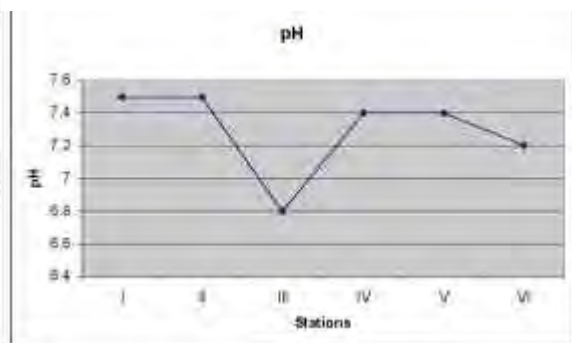


Fig. 6.1.3.2 pH distribution along Yenam Dam environment.

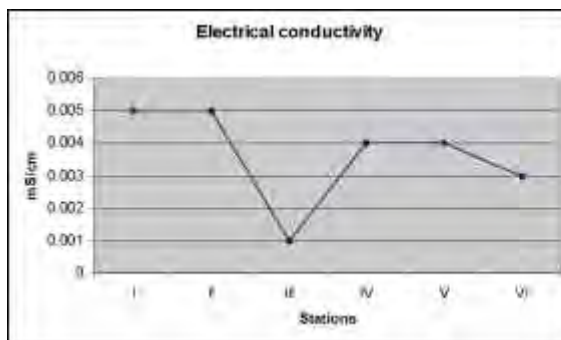
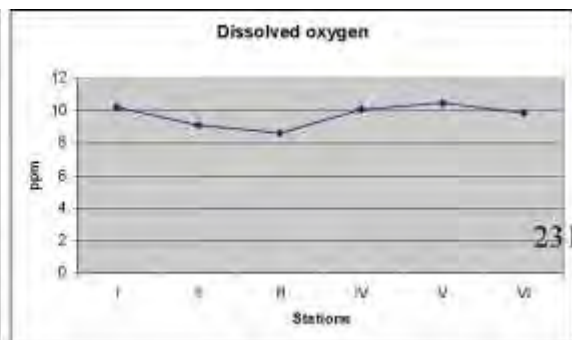


Fig. 6.1.3.3 Electrical conductivity distribution along Yenam Dam environment.

Fig. 6.1.3.4 Dissolved oxygen distribution along Yenam Dam environment.

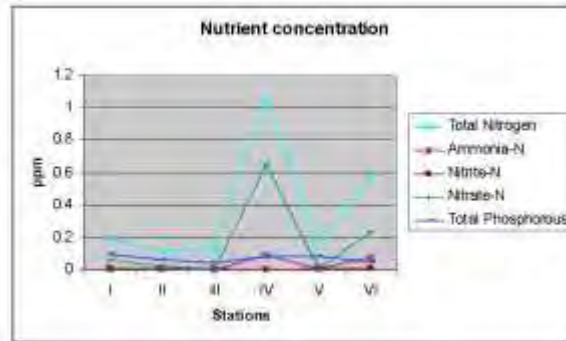


Fig. 6.1.3.5 Nutrient concentration distribution along Yenam Dam environment.

KAUNGLANGHPU:

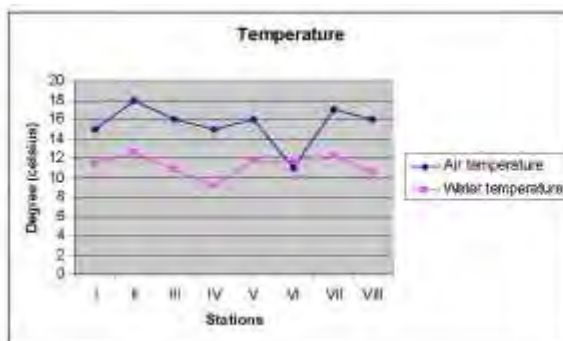


Fig. 6.1.4.1 Temperature distribution along Kaunglanghpu Dam environment.

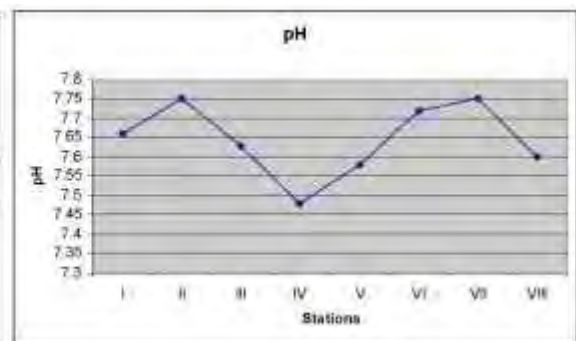


Fig. 6.1.4.2 pH distribution along Kaunglanghpu Dam environment.

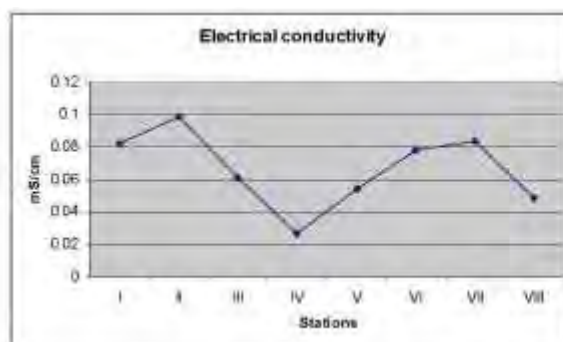


Fig. 6.1.4.3 Electrical conductivity distribution along Kaunglanghpu Dam.

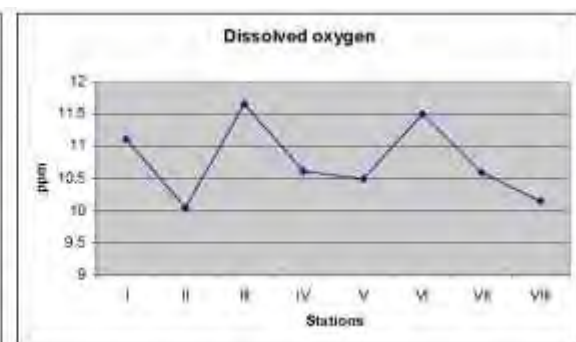


Fig. 6.1.4.4 Dissolved oxygen distribution along Kaunglanghpu Dam environment.

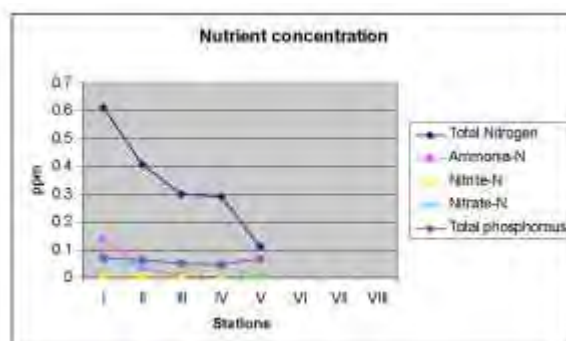


Fig. 6.1.4.5 Nutrient concentration distribution along Kaunglanghpu Dam environment.

PISA:

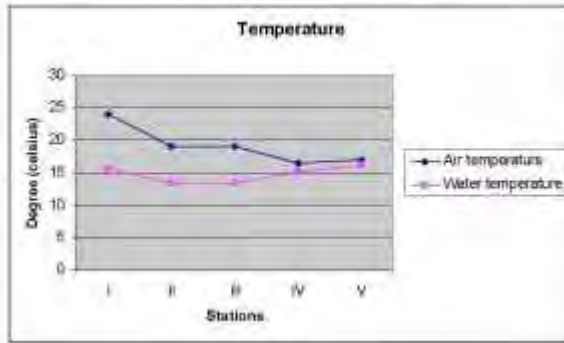


Fig. 6.1.5.1 Temperature distribution along Pisa Dam environment.

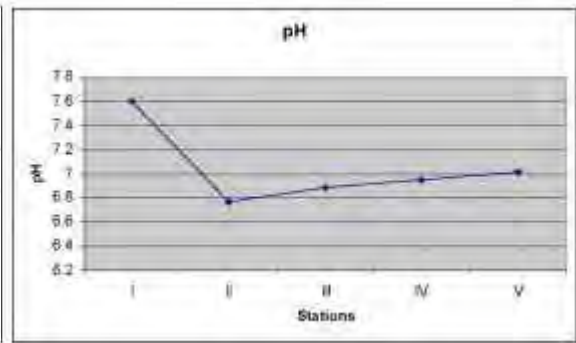


Fig. 6.1.5.2 pH distribution along Pisa Dam environment.

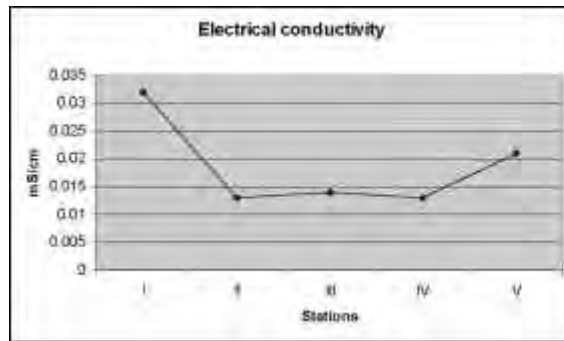


Fig. 6.1.5.3 Electrical conductivity distribution along Pisa Dam environment.

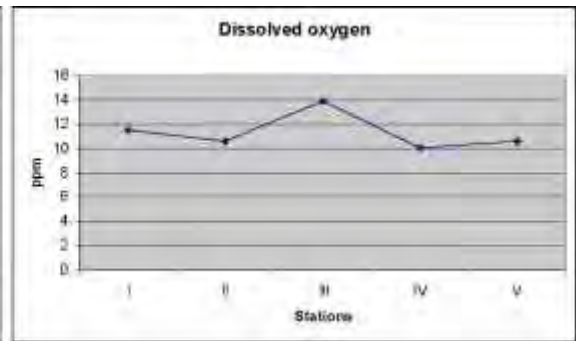


Fig. 6.1.5.4 Dissolved oxygen distribution along Pisa Dam environment.

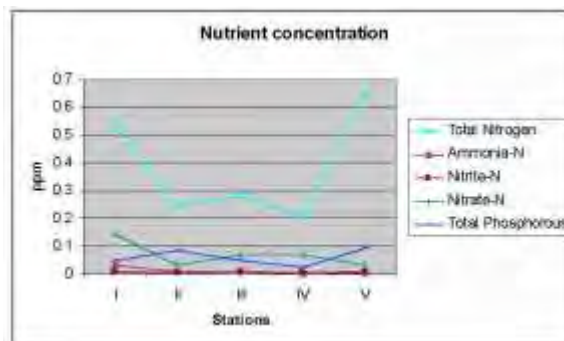


Fig. 6.1.5.5 Nutrient concentration distribution along Pisa Dam environment.

WUSOK:

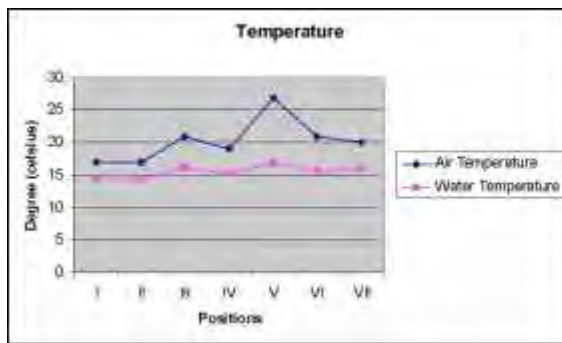


Fig. 6.1.6.1 Temperature distribution along Wusok Dam environment.

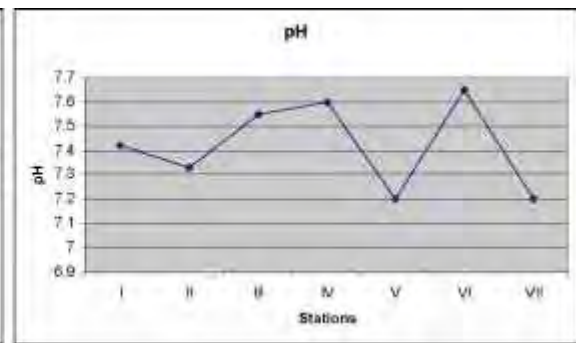


Fig. 6.1.6.2 pH distribution along Wusok Dam environment.

Fig. 6.1.6.3 Electrical conductivity distribution along Wusok Dam environment.

Fig. 6.1.6.4 Dissolved oxygen distribution along Wusok Dam environment.

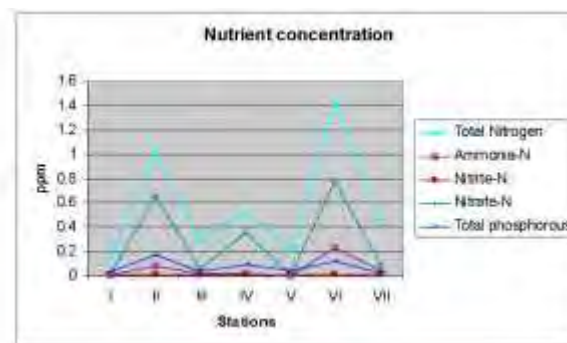


Fig. 6.1.6.5 Nutrient concentration distribution along Wusok Dam environment

CHIBWE:

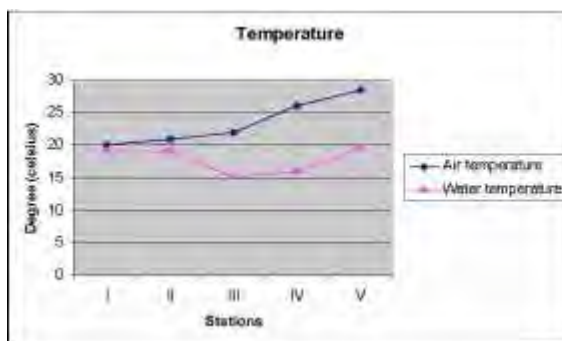


Fig. 6.1.7.1 Temperature distribution along Chibwe Dam environment.

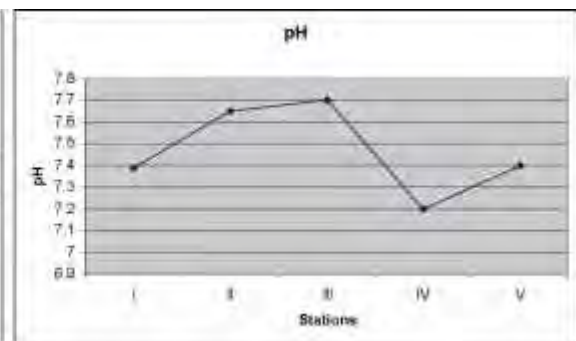


Fig. 6.1.7.2 pH distribution along Chibwe Dam environment.

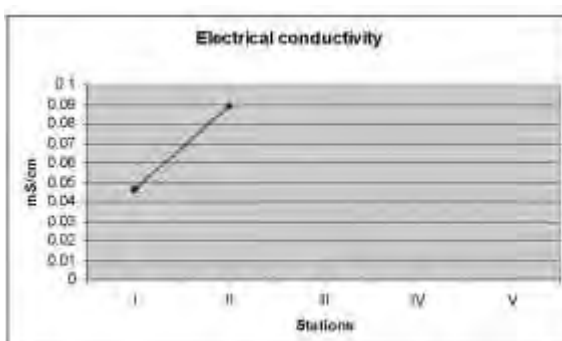
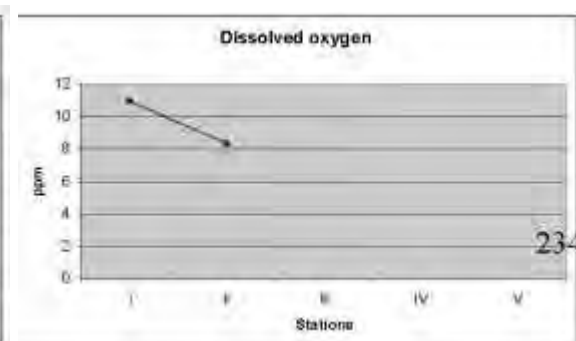


Fig. 6.1.7.3 Electrical conductivity distribution along Chibwe Dam environment.

Fig. 6.1.7.4 Dissolved oxygen distribution along Chibwe Dam environment.

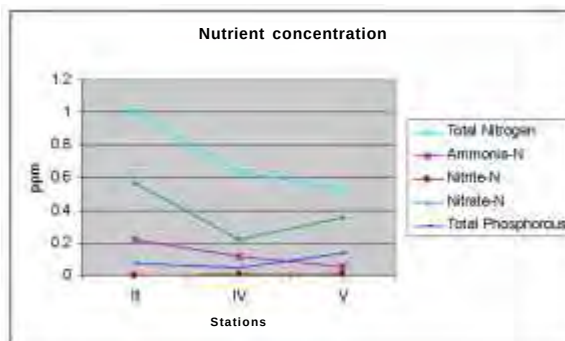


Fig. 6.1.7.5 Nutrient concentration distribution along Chibwe Dam environment.



Fig. 6.3.1 Critically endangered species recorded in surveyed areas.
Schizothorax grahami (Regan)



Fig. 6.3.2 Data deficient species recorded in surveyed areas.
Macrornathus aral (Bloch & Schneider 1801)



Fig. 6.3.3 *Schizothorax* sp. carried matured eggs in Wusok Dam area in April.



Anguilla nebulosa



Tor putitora

Fig. 6.3.4 Long migrant species recorded in surveyed areas.



Eutropiichthys vacha



Pangasius pangasius



Neolissochilus hexagonolepis



Tor putitora



Bangana devdevi



Garra qiaojiensis

Fig. 6.3.5 Economically important fish species recorded in surveyed areas.



Fig. 6.3.6 Cray fish, one kind of possible species for aquaculture in Kachin State.