CHAPTER I
INTRODUCTION

1.1 Background

Nepal is the second richest country with inland water resources in the world, possessing about 2.27% of the world water resources (CBS 2005). About 5% of the total surface area of the country is covered by water (Bhandari 1992). The major sources of water are glacier snow melt from the Himalayas, rainfall and ground water. Out of 818500ha of total water surface area, there are about 6000 rivers including rivulets and tributaries totaling about 45,00km in length and covering 395,000ha (DOFD 1961/62)

About 70% of the country is drained by four major river systems originating in the higher Himalayan zone: Sapt Koshi in the eastern part, Sapta Gandaki(Narayani) in the central part, Karnali in the western part and Mahakali in the far western part of the country. Rivers like Bagmati, Rapti, Kamala, Kankai, Tinau are medium sized rivers originating from the midland zone or the Mahabharata range. Several small mostly seasonal rivers originating from the Churia range dissect the terai plain (Majupuria 1999). Development of Hydroelectric project or more precisely river valley projects has become a lifeline of progress and prosperity of the country. Water Resources Development projects are indispensable as they are inexorably linked to the Nepalese economy, as economy is largely based on agriculture.

Hydropower is a proven renewable source of electrical energy. It has an unquestionable edge over other sources of energy with minimum adverse impact on the environment. The edge likely adverse impact of hydropower scheme can be adequately taken care of by taking appropriate mitigation measures. (Jatana et *al*.2000).

Hydroelectric scheme are of three types (Rao *et al.* 2000).

- Storage scheme with big reservoir for seasonal and multipurpose utility
- Run-of-River dam for meeting diurnal peaking requirements without any storage and

- Run-of-River high dam with reservoir with regulated flow for diurnal peaking operation.

A large dam project shall effect the environment where as with a Run-of-River scheme the impact is very insignificant during construction activities of the project (Sharma, *et al*. 2000)

Before a hydropower project is under taken, it is important to predict in what way the project is likely to affect the area and inhabitants and also to include action plan that will prevent, mitigate or compensate for negative impacts (Ames & Buetlkofer, 2003). Similarly the various environmental implications and interrelationship amongst the physical, biological, geo-chemical and bio-geo-chemical and socio-economic aspect as affected by the hydropower development scheme should be correctly assessed at the time when constructions activity is conducted in the local environment.

The Hydropower Development Policy (2001) emphasizes the need to develop environmental friendly hydropower scheme to meet the country's energy need and to encourage private sector to invest in hydropower.

EIA is a process of identification prediction and evaluation of project impact on the environment and is essentially, an aid to the decision makers responsible for planning (Brismar, 2003).It could also be manipulated as a management tool for environmental sustainability so that a project will be both economically and environmentally sound (Hartley and wood 2005).

In Nepal the need for EIA was stressed in the 7^{th} fifth year plan (1985-1990) which required preparation of EIA for all major development projects related to tourism, Water resources, transportation, urbanization, agriculture, forestry and industry sectors (GoN/IUCN 1993,).

EIA of hydropower project consists of studies on environmental aspect and their management in river valley project. These studies are aimed to achieve an ecologically sound design of project, maintain the ecological balance in the vicinity of the project area and to quantify the impact on the environment due to project (Sharma *et al.* 2000).

1.2 History of Environmental Assessment

Environmental Assessment is a method used to identify the main impacts of the activities of project may have on the environment. The negative and positive consequences of projects are assessed to provide decision-makers with holistic and informed opinions based on sound research and analysis related to the objective of the project.

Environmental assessments -

• are necessary to guide development, both at the strategic level and at the project level;

• can serve as early warning systems;

• help to identify alternative approaches;

• identify cross-sectoral impacts and enable managers to view project proposals in a local, regional and global perspective; and

• involve dialogue and interaction between various ministries, NGOs, local authorities, municipalities and the private sector.

Nepal has internalized this tool through policies and laws. Since 1980s, several acts provided a foundation for addressing environmental related issues. Nevertheless, the integration of EIA in development projects was largely donor driven and confined to larger projects only without any formal and uniform structure of EIA reports and not possessing any legal mandate. The Constitution of the Kingdom of Nepal, 1990; Water Resources Act, 1992; Electricity Act, 1992; Electricity Regulation, 1993 and Hydropower Development Policy, 1992 emphasized on the protection of the existing environment and stated that no significant adverse environmental impacts in terms of physical, biological, social, economic and cultural aspects should occur due to any development project. The government of Nepal introduced the National Environmental Impact Assessment Guidelines (NEIAG) in 1993. These Guidelines provided a general methodology for conducting an EIA study but there was no approval process and legal requirements of an EIA study. Only after enactment of the Environment Protection Act, 1997 (EPA97) and the Environment Protection Regulation, 1997 (EPR97) the EIA study became legally binding and it is made mandatory for the projects to get approval from the Ministry of Environment (MoE) for EIA and line ministries in case of Initial Environment Examination (IEE) study.

1.3 Environmental Monitoring of Hydropower Projects

Monitoring is an essential aspect of environmental management. It consists collection of data to measure environmental changes associated with construction and operation of the project. Ministry of Energy is the responsible organization for the environmental monitoring of hydropower projects as per EPR 97. The monitoring should be conducted in construction and operation phases which are mainly of three types.

1.3.1 Baseline Monitoring

Baseline monitoring is conducted to update the baseline condition of the project area prior to implementation of the project. The baseline covers the major components of physical, biological and socio-economic and cultural environment

1.3.2 Impact Monitoring

Impact monitoring is carried out to assess actual level of impact during construction as well as operation phase of the project. The impact monitoring includes:

- Monitoring of the impacts of the projects on physical, biological and socio-economic and cultural environment of the area.
- Monitoring of the accuracy of the predicted impacts.
- Monitoring of the effectiveness of mitigation measures

1.3.3 Compliance Monitoring

The compliance monitoring is conducted to monitor the compliance of the recommended mitigation measures and monitoring activities. The compliance monitoring is mainly focuses on

- Compliance of the tender clause
- Compliance of the mitigation measures
- Monitoring of the allocation of adequate budget for the implementation of the mitigation measures and monitoring works.

1.4 Hydropower Development in Nepal

Hydropower potential in Nepal ranks second in the world after Brazil. Despite being tremendously rich in hydro resources with its theoretical potentiality of 83,280 MW and techno- economically feasible potentiality of 45,092MW, Nepal's exploitation of hydropower has been meager and limited to 617 MW. To bring population in Nepal above poverty level by 2027, a GDP growth of 8%,will require the generation of 22000MW (Karmacharya, 2006) As per such an enormous potential, numerous run-of- scheme and multipurpose hydro schemes have been identified but mostly remain undeveloped. The small and micro hydropower potentials remain virtually untapped in the country. Nepal has large hydropower potential of which slightly more than 1.4% of the techno-economically viable potential has been harnessed so far. Although the history of hydro electricity in Nepal has started since 1911 with the development of Pharping hydro power plant and later Sundarijal, expansion of hydropower has been slow as compared to the other countries. Less than 1% of the energy demand is met by hydroelectricity and serving about 40% of the country's total population (IPPAN 2005). One reason for the low electrification of the country is that 80% of the country's land area comprises of rugged hills, difficult mountain terrain with undeveloped road infrastructures, and scattered house holds making extension of power grid difficult and costly. Peak demand and total energy available for 2008 were 721.73MW and 3185.95GWh respectively. Similarly the peak demand and total energy available were 812MW and 3130.77GWh for 2009 (NEA 2009).There was imbalance between power demand and supply, so power supply to about 16hours was being restricted in 2009. With this background of power demand supply, the developments of new hydro electric power sources were urgently required. KaliGandaki A (144MW), Marsyangdi (69MW), Kulekhani I (60MW), Kulekhani II (32MW) and Trisuli (24MW) are some major commissioned hydropower projects by government sector. Chameliya and Kulekhani III are being under construction and both of these projects will add about 44 MW after their completion.

Map1: Hydropower Projects of Nepal

1.5 Chameliya Hydroelectric Project: A short introduction

The Chameliya Hydroelectric Project is being constructed on River Chameliya situated in Darchula district of Far western development region of Nepal, totally in lent money of Government of Nepal and NEA. Construction work of the project has been started since 2007 and will be completed in the year 2011 at a cost of 78.853 million US $ including all civil and electromechanical design with transmission line. It envisages harnessing of 30MW hydel power potential utilizing 36 cumecs of river water in the form of a six- hour daily peaking run-of-river scheme by constructing 54m high concrete gravity dam with two 13.5m high radial gates, underground de-sander with 2 basins, 4067m long headrace tunnel, 49.8m high restricted orifice type surge tank, 461m long penstock and semi-underground powerhouse with two units of 15.3MW vertical Francis turbines. Power generated from the project will be evacuated through 131km long 132kV transmission line to Attariya substation in Kailali district. The project is estimated to generate an average of 184.21GWh energy annually.

China Gezhouba water and power Group Co. Ltd was given the contract for the construction of the civil works of the project on 21 December 2006. Excavation

works for 308m, 1,214m and 2,274m long adits, 3,203m long diversion tunnel, 116m long connecting tunnel 2,156m long aeration tunnel and 182m long access tunnel to de-sander have already been completed by the August 2009.

1.6 Justification of the Study

The increased knowledge of the influences of river valley project on environmental components has led to the study of environmental consequences of these development activities. A need arose that all River valley project should be subjected to rigorous assessment of their environmental impact so that necessary mitigation measure could be incorporated in the project right at its inception stage. Chameliya Hydroelectric Project, being a run-of-river project, is an eco-friendly scheme but still some impact on the environment are bound to take place because of its construction activities. To maintain the ecological balance in the project area vicinity and to reduce the impact on the environment due to the project, implementation of mitigation measures and stringent monitoring programme for impact assessment are required. This study helps to assess the significant environmental impact vis-à-vis mitigation measures to be adopted during construction phase of Chameliya Hydroelectric Project.

1.7 Objectives of the Study

1.7.1 Broad Objective

The broad objective of the study is to assess the environmental impact of Chameliya hydroelectric project during construction stage.

1.7.2 Specific objectives

- To conduct frequency analysis for the flows of Chameliya River.
- To analyze the physico-chemical and biological characteristics of Chameliya River water
- To monitor the status of air, and noise quality due to project construction.
- To explore the potential impact on fish species of Chameliya River and fisherman livelihood.
- To identify the actual level of impact on vegetation and wild life.
- To analyze the effectiveness of mitigation measures.

1.8 Limitations

i. Final results of this study are not free from errors due to the following constraints

ii. Constraints on financial support to conduct research study.

iii. Frequent field visits could not be made because study area is far from Kathmandu.

iv. Seasonal variation in river water quality was not assessed due to time constraint of seasonal field visits.

v. Data analysis is based on only two years during the construction, since the thesis had to be submitted near this time.

CHAPTER-II

LITERATURE RIVIEW

2.1 Related Environmental Assessment Studies:

CIWEC (Canadian international water and energy consultants 1970) conducted studies on 'Tamur-Mewa Hydroelectric Project and had reported 12ha mixed hardwood type of forest during construction phase of the project. The study further concluded that the project would lead to the loss and fragmentation of vegetation cover as well as disturbance to the associated wildlife.

Pradhan (1987) has studied the fish fauna of Kulekhani reservoir and reported that construction of dam in the Kulekhani River had also introduced substantial change in the fish composition.

IUCN (1998) conducted a study on Environmental monitoring of upper Bhote Koshi Hydroelectric Project for Bhote Koshi Power Company. The study revealed that decreases in turbidity, suspended solids and substantial improvements in the chemical and biological quantities of river water in comparison to the similar test carried out during the first quarter of the monitoring time schedule.

Gurung (2000) had studied the major socio-economic and physical impact of the project during construction period. He mentioned that during the construction period flora, fauna and ambient air quality was highly affected. Similarly Socio-economic condition of the people in project area had also been changed, some people were migrated to other place and some of them became landless and worked as a labor in the project.

Pandey (2001) conducted a research on Environmental impacts of Kaligandaki, a hydroelectric project on vegetation resources in dam and reservoir area and found that the vegetation pattern and composition was highly affected by the construction activities of the project.

NEA (2002) conducted study on the Environmental auditing of Modi Khola Hydroelectric Project. The study revealed that the proposed mitigation measures were implemented during the construction and operation phase

Kumar (2002) had been described Yamuna river pollution taking simple parameters viz; coli form, DO & BOD.

Sharma (2003) conducted study on biological impacts and local perceptions of Tinau river dam and conclude that dam buildings have profound impacts on the macro-invertebrate within the reservoir area and there were not impact on other areas .The negative impacts of the Tinau dam on the utilization of the river resources were very small.

NEA (2003) made the "Post constructional Environmental Impact Audit study of Kaligandaki A Hydroelectric Project. This study identified the actual magnitude and extent of impact in which 65ha of forest, agriculture and other lands had been submerged. Approximately 208.63ha of land were lost for construction of powerhouse and other project structure. This study did not report the hunting and poaching activities and impact on fish during construction phase.

Singh (2003) made a study on "Environmental Auditing of Ilam Puwa Khola Hydropower Project (IHPP)". In his study, he found that the green campaigns were frequently conducted by the project to conserve the forest resource and the local people have the employment opportunities and trainings. On the other hand, he also pointed that the project creates cultural shock after its completions.

Sharma (2004) made study on the Post Project Evaluation of Environmental Mitigation Measures of Kali Gandaki 'A' Hydroelectric Project and 132kV Transmission Line. The study revealed that around 97ha of land were disturbed during the project construction and total 6093 trees of different species were removed. In addition, it was reported that to minimize impact on natural resource some mitigation measures such as plantation of seedling, land reinstatement, and bioengineering measure were implemented.

Khadka (2004) conducted the study on "Environmental Auditing of Modi Khola Hydropower Project in which he had pointed out that there was lack of friendly and closely coordination and communication between employers, proponent and Stakeholder of the project during construction phase. So that the mitigation measure as prescribed in EIA report, did not seem to implement effectively.

Ghimire (2004) conducted the study on "Effect of sedimentation on the life span of Kulekhani Hydropower Project. He suggested that the major portion of the sediments in the River is due to the Land slide and stream bank cutting.

Poudel (2004) conducted the study on Environmental auditing on biological parameters of upper Bhote Koshi hydropower project. In the Research, he compared the status of fishes, wildlife and vegetation between pre-project and post project to notice the changes.

Pandey (2005) conducted a research on Environmental study of Middle Marshyangdi Hydroelectric Project during construction phase. She concluded that water quality of Marshyangdi River had been affected by the project related activities. Among all measured physical, chemical, biochemical and microbiological parameters, the Marshyangdi River possesses very high level of turbidity, suspended solid, iron, T. Coliform and Faecal Coliform.

Magar (2005) studied the Socio-economic impact of Piluwa Khola small Hydropower Project at Sankhuwasuva District of Nepal. He found that the project brought about various socio-economic impacts on people in the surrounding. The land of 23 households had been occupied by the project. The average land holding of 40.70 ropani per PAF before project construction changed to that of 39.38 ropani per PAF at the project completion. PAF used the compensated money to purchase better cultivation land, to pay debt, invest on business and so on.52.17% of total PAFs and 36.5% household of study area had been electrified before completion of the project respectively where as 73.19% and 49.23% families of PAFs and the whole areas have got the electricity facility to the study date.

Timsina (2006) conducted the study on implementation of environmental mitigation measures in Khudi Hydropower Project. He found that there was no proper implementation of the proposed mitigation measures as included in final EIA report of Khudi Hydropower Project during construction phases of the project.

Dhakal (2007) conducted the study on monitoring of baseline environmental condition during construction stage of Thoppal Khola Hydropower Project and found that out of 599 trees 99 no of Sal and 7 no of *Acacia catechu* were chopped down by the project.

2.2 Review of Policies, Laws, Rules, Regulations and Guidelines

2.2.1The Interim Constitution of Nepal

Articles 35(5) of the interim constitution of Nepal, 2063BS, states that the state shall implement necessary management to conserve the environment. The state shall aware public to maintain environment and gives priority for the protection of environment and prevention of further damage of the environment on the account of physical development activities and shall take special measures for the conservation of environment rare and endangered species. The state shall act to conserve forest and vegetation, biodiversity and their sustainable uses, and the benefits thus obtained from these resources shall be equally shared.

2.2.2 Acts

i) Environmental Protection Act 1997

This is an umbrella Act for institutionalization of Environmental Assessment in Nepal and was commenced on 24th June 1997. The legal provisions under this Act are:

- Section 3: The proponent should carry out IEE and EIA in relation to the prescribed proposals.
- Section 7(1): Nobody shall create pollution, such as discharge, emit or dispose waste, sound, radiation or any such acts which will cause pollution or to allow pollution to be caused in a manner which is likely to have significant adverse impacts on the environment or to harm life or public health.
- Section 24: GoN may frame necessary rules for sources of pollution, standards, pollution prevention and control, water, air, sound and soil pollution conduction of IEE or EIA.

ii) Aquatic Animals Protection Act 1961 (Amendment 1999)

The act obliges the proponent to construct fish ladder at the dam site to ensure the movement of the aquatic animals, particularly the fish. If it is not possible, the proponent should establish a fish hatchery or a nursery, close to the dam site of the water resource projects for artificial reproduction and ex-situ conservation (Section 5 b). This act provides legislative protection for the habitats of aquatic species.

- Section 3: Confers the punishment to any party introducing poisonous, noxious or explosive materials into water sources or destroying any weirs, bridges or water systems, with the intent of catching or killing aquatic life.
- Section 4: Empowers the government to prohibit catching, killing and harming of aquatic animals through notification in the Nepal Gazette.

iii) Water Resources Act 1992

This is the primary status regulating water quality in Nepal. Along with the Environmental Protection Act (1997) it provides for the establishment of rules and standards for regulating the discharge of pollutants to aquatic systems and for the prevention of degradation to the resources.

- Section 18,19 and 20 of the act provide for the fixing of the quality standards of water resources, establishment of tolerance limits for the discharge of pollutants and reduction in adverse effects to water quality due to erosion, floods, landslides or similar other causes.

iv) Electricity Act 1992

- Section 24 forbids negative impacts on the environment such as soil erosion, floods, landslides and air pollution while producing, transmitting and distributing electricity.

i) Local Self-Governance Act 1999

It empowers the local bodies for the conservation of soil, forest and other natural resources and implements environmental conservation activities.

- Section 28 and 189 of the Act provide that Village Development Committee and District Development Committee are liable to formulate and implement the programs related to the protection of the environment and biodiversity.

2.2.3 Rules and regulations

i) Environmental Protection Regulation 1997 (Amendment 1999)

In accordance with the power conferred by Section 24 of EPA 1997, GoN has framed the EPR 1997 and it has entered into force on 26th June 1997.

- Rule 3: A proponent shall be required to carry out the IEE of the proposals mentioned in Schedule 1 and EIA of the proposals mentioned in Schedule 2.

- Schedule 1, Section E: The concerned party shall conduct an Initial Environmental Examination (IEE) for proposals of less than 50MW.
- Schedule 2, Section E: The concerned party shall conduct an Environmental Impact Assessment (EIA) for proposals exceeding 50MW.
- Rule 13: The concerned body should monitor and evaluate the impact of the proposal on the environment resulting from the implementation of the proposal. If greater impacts than those stated in the EIA report are noticed, the relevant agency is required to give necessary directives to the proponent to mitigate the adverse impacts or to adopt measures to control them. The proponent is obliged to carry out those directives.

ii) Water Resources Regulation 1993

Rule 17 (e) of the regulation describe that any person or corporate body, who desires to obtain a license for utilization of water resource must state in his application that appropriate measures will be taken to lessen the adverse effects due to the project on the overall environment. Measures are to be taken for the conservation of aquatic life and water environment and for mitigation social and economic effects of the project in the concerned area.

iii) Electricity Rules 1993

Rule 12 and 13 obliges the proponent willing to produce and transmit electricity to analyze environmental impacts of the proposed projects and include environment protection measures including arrangements for the settlements of the displaced people.

iv) Local Self Government Regulation 2000

Local self governance regulation empowers the local bodies to coordinate and implement development program and for rationale utilization of local natural resources.

- Rule 7 (68) empowers the VDCs for monitoring and supervision of development work implemented in the VDC.

V) Land Acquisition Regulation, 1970

His Majesty's Government shall, on request, make a available land to the private sector for the construction of Hydroelectric project on the same ground as it acquires land for any institution under the land acquisition Act, 2034 (1997) .If the

Government owns the land ,it shall be made available on lease throughout the period of license.

2.2.4 Guidelines

i) National EIA Guidelines 1993

Prior to the enactment of the environmental legislation, GoN implemented the National EIA guidelines since July 1993 in order to integrate environmental aspects in the development project and programs by conducting IEE or EIA. These guidelines call for identifying socio-economic, biological, physico-chemical and cultural impacts and proposing mitigation measures to avoid, eliminate, minimize or mitigate each adverse impact to augment beneficial impacts resulting from the project.

ii) Water Resource EIA Guidelines 1993

This document laid down a number of guidelines by which to conduct an EIA report prior to the national requirements. These recommendations were later confirmed in the Environmental Protection Rules (1997).

iii) Environmental Planning Guideline 1998

This guideline includes environmental issues to be considered during the preparation of environmental plans at village, municipality and district levels. This also includes institutions roles and responsibilities for their implementation including the approval process.

2.2.5 Policies

i) Hydropower Development Policy 1992

This policy incorporated the concept of EIA for identification and minimization of adverse impacts of hydropower projects and made commitment to implement Environmental Protection Measures recommended by the EIA study. One of the objectives of this policy was to “render assistance in the conservation of environment by supplying clean energy through the development of hydroelectric power.” The policy clearly requires maintaining minimum monthly downstream water release in the river and stream at 10 percent of the total discharge or as recommended by the EIA study.

ii) Nepal Environmental Policy and Acton Plan (NEPAP) 1993

NEPAP emphasis the need for mitigating adverse environmental impacts to address urban and industrial development, air and water pollution and infrastructure development through effective implementation of EIA guidelines for water resources. It identifies alteration of ecology from riverine to lake interventions and deals with destruction of forests and wildlife, threats to the survival of migratory aquatic species, climate changes and the risk of dam failures due to seismic activities, loss of agricultural land and displacement of local population as most significant environmental impacts of a hydropower project

iii) National Conservation Strategy 1988

The National Conservation Strategy was endorsed in 1988 which includes a number of programmes to internalize EIA system in Nepal. According to the Strategy: The proponent of a development project or industrial activity that may have significant detrimental social and or environmental impacts must prepare and file with an Assessment and Review Office, a statement concerning the potential socio-economic and environmental effects of the proposed development project. The impact statement must be prepared in accordance with the guidelines provided by ARO.

iv) The Water Resources Strategy 2002

This Strategy emphasis to understand the environmental processes fully, to avoid adverse impacts, improve conditions and/or to reduce negative elements (WECS, 2002). The Strategy underscores the need for effective implementation of EIA and SEA norms and recommendations

v) The Biodiversity Strategy 2002

This has also a strategy to conduct EIA in accordance with the provisions of EPA 1997 and EPR 1997 to assess significant impacts of development activities on biodiversity.

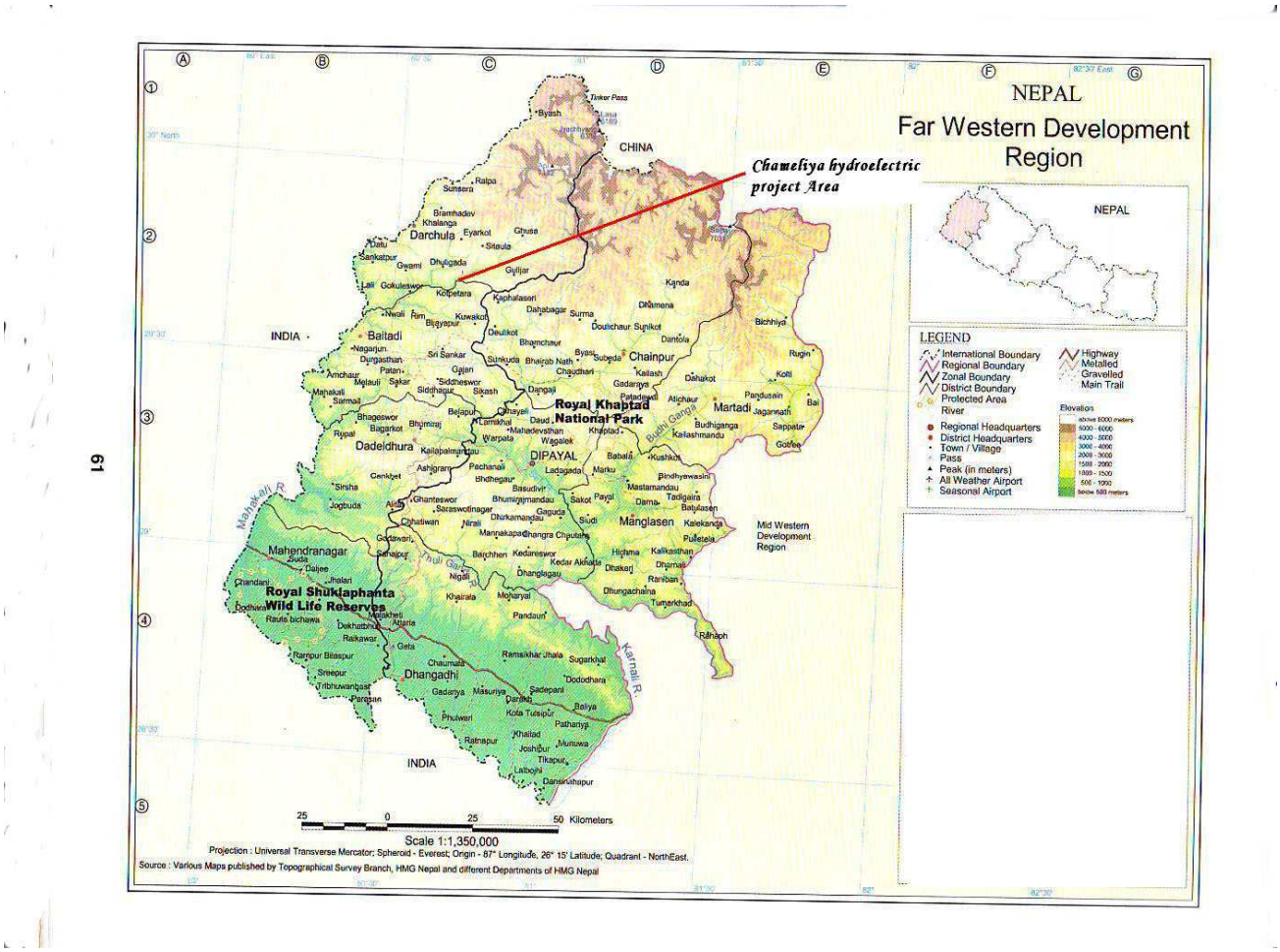
CHAPTER-III

STUDY AREA

3.1. Description of the study area

The Chameliya peaking Run -Of- River Hydroelectric Project is located in Darchula district in the Far western development region of Nepal. Geologically the project lies between latitude $29^0 30^{|}$ N and $30^0 10^{|}$N and longitude $80^0 30^{|}$ E and$81^0 10^{|}$ E The site is about 950km west of Katmandu Chameliya HEP doesn't fall in the National park, wildlife Sanctuary, Conservation Area, Buffer Zone and environmentally fragile area. The project area is accessible through Baitadi Darchula sector of Mahakali highway. The weir site is located at Chameliya River between the cliff of Bitule and Bhadale of Seri and Latinath VDCs whereas the powerhouse is located in Balanch (Ward no 4) of Shikhar VDC. The dam will have crest level at 876m above mean sea level. This weir will inundate areas lying in the upstream up to Chiureni.Seri and Shikhar VDC of Darchula District lie on the right bank of Chameliya River. Latinath VDC of Darchula and Kotpatera and Rudreshwor VDC of Baitadi district are located on the left bank of Chameliya River

Map:2 Map showing Chameliya River



Map:3 Location map of Chameliya hydroelectric project

3.1.1 Topography

The Chameliya Hydroelectric Project is located in the Chameliya river basin which lies in the far-western mountain district of Darchula but very close to the adjoining district of Baitadi, since the Chameliya River forms the boundary between the two districts in its lower reaches.

Physiographically, the Chameliya basin which extends from $29^0 30'$ to $30^0 10'$N parallels of latitude and from $80^0 30'$ and $81^0 30'$ E meridian of longitude can be divided into three different ecological belts viz .(i)High Himalaya, (ii)High Mountain and (iii)Middle Mountain belts. The project area is in the Middle Mountain belt. The elevation ranges from 700 to 2,200 masl. The topography in the area is comparatively subdued but differs from place to place and contains fairly wide river valleys and flanked by a series of terraces above which lie steep slope of the hills

3.1.2 Geology

The project area falls on the zone of pre-Cambrian Meta sedimentary rock of the mid land and Surkhet group. The main rock types with in the project area are Dolomite, Sandstone Slate, Dolomite intercalated with slate, Talcosic Dolomite interbadded with Phyllitte. The proposed dam is located in narrow gorge or V shaped valley along the Chameliya River. The right abutment is characterized by hard, massive, light grey and pink colored micro cracked dolomite exposure. In desanding basin the rock type is hard and massive dolomite. The headrace tunnel alignment passes through light grey and pink colored Dolomite, Sandstone Slate, and Dolomite intercalated with Slate, Talcosic Dolomite interbadded with Phyllitte. The penstock alignment passes through Dolomite interbedded with Phyllitte sandy soil deposit mixed with boulders, cobbles and gravels. The power house lies on cobbles to gravel mixed sandy soil deposit with quartzite, dolomite and gneiss boulders, cobbles and gravel in silty sand matrix to the furthers depth

3.1.3 Climate

The maximum annual average rainfall was found to be 271.36 mm in 2007 (Fig 3.2). Similarly the minimum annual rainfall was 134mm in 1988 (Fig 3.2). The highest mean monthly rainfall of 709 mm occurs in July and the lowest monthly rainfall of 7 mm occurs on November (Fig. 3.1).

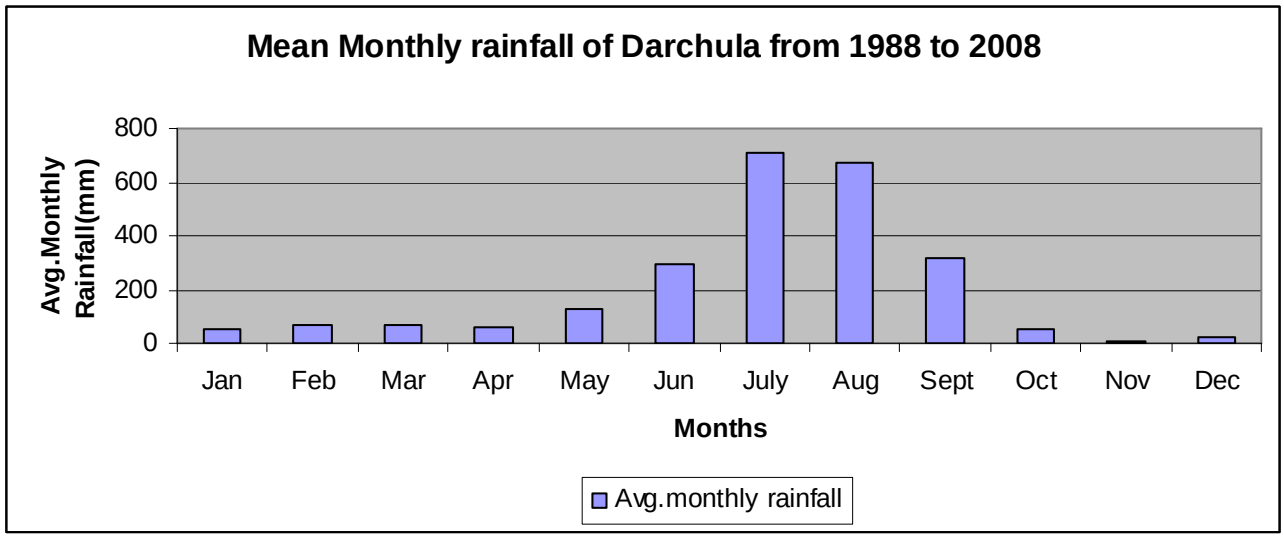


Figure.3.1 Monthly variations in average monthly rainfall (mm) for the year 1988-2008

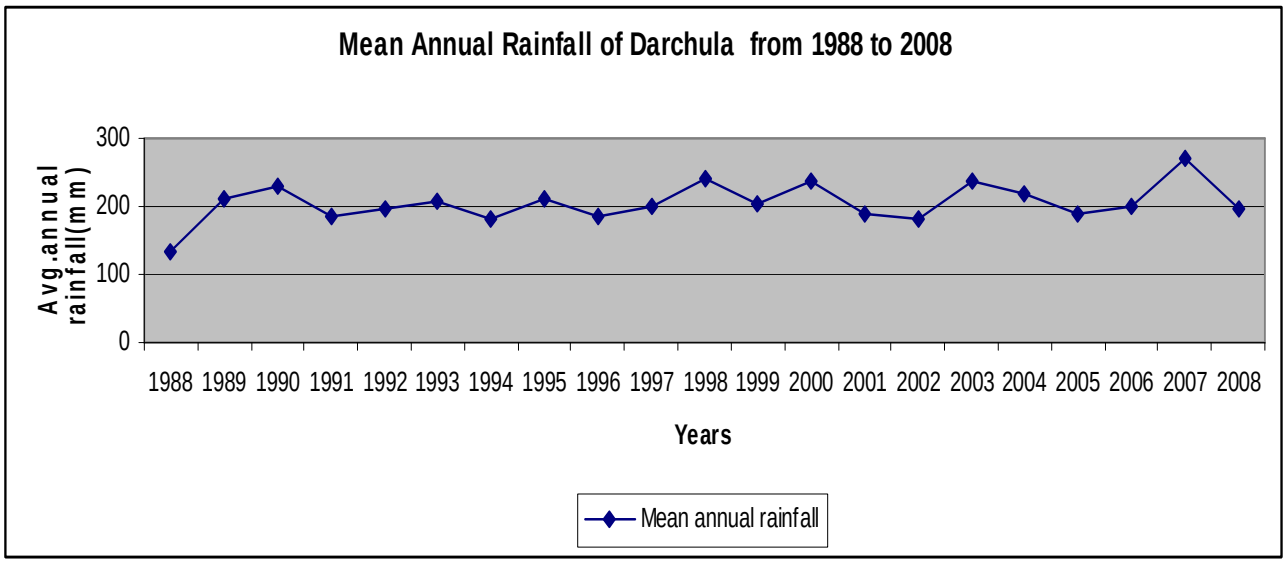


Figure.3.2 Annual variations in average annual rainfall (mm) for the year 1988-2008

By analyzing the 18 years data from 1990 to 2007 of Darchula, the mean maximum temperature of the hottest month was found to be 33.72^{o}C (June) and that of the coldest month was 19.12^{o}C (Jan). Similarly the mean minimum temperature of the coldest month was 4.41^{o}C (Jan) and that of the hottest month was 20.31^{o}C (July).

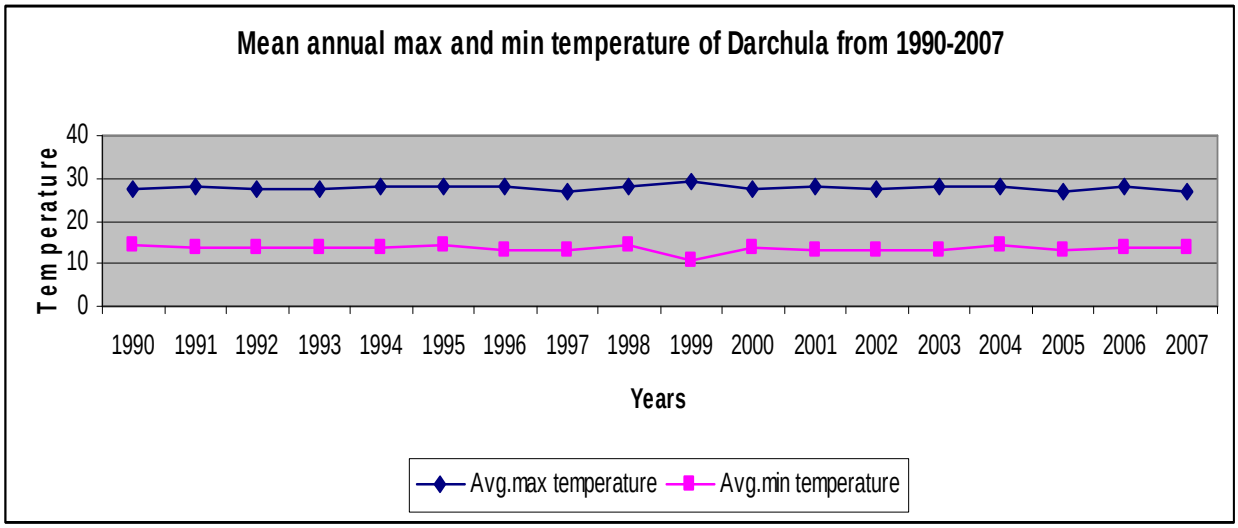


Figure 3.3 Average annual max and min temperature of Darchula from 1990 – 2007

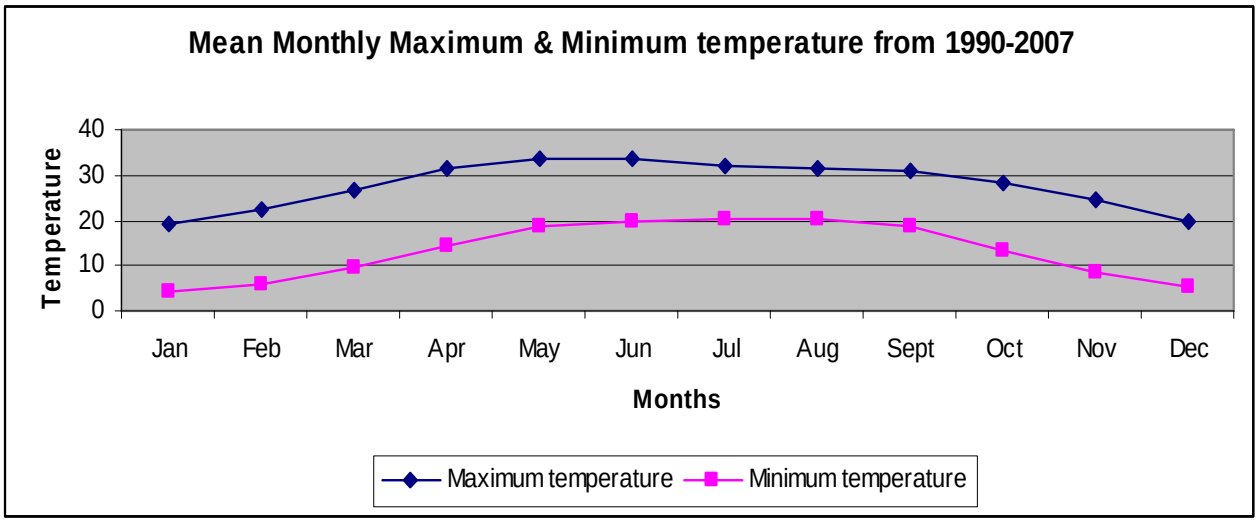


Figure 3.4 Average monthly max and min temperature of Darchula from 1990 – 2007

(Source: DHM, 2010)

3.1.4. Hydrology and Drainage system

The Chameliya River is snow fed river, a major tributary of Mahakali River, which originates from the high Himalaya, at an altitude of 7,132m. It merges with the Mahakali River at sera at an elevation of 520 masl. The catchment area of Chameliya river basin at proposed headwork is 835km^2.The main tributaries from the dam site to powerhouse site is Gandi Gad located in the left bank of Chameliya River. The discharge of Gandi Gad is 0.6m^3/s in dry period. Other tributary joining at left bank are Kaldigad, Mate, Raigad Dhakuse and their discharge in dry period are 0.03, 0.075, and 0.015 m^3/s respectively. Similarly right bank tributaries are Balligad and topkan and their discharge in dry period are 0.05 m^3/s and 0.75 m^3/s each respectively.

By analyzing 21 years data from 1985-2006 of Chameliya River, the highest value of extreme discharge was recorded in the year 2000(643 m^3/s) and annual minimum flow was recorded in the year 1987(14.0 m^3/s) respectively (Fig3.5).

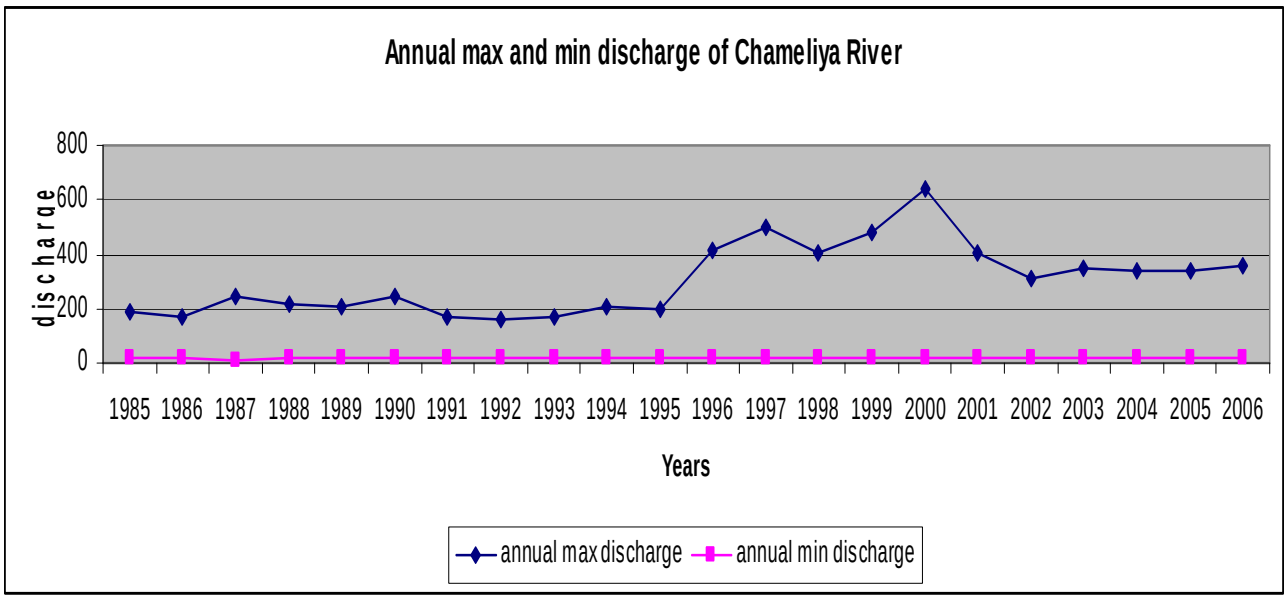


Figure 3.5:-Annual maximum and minimum discharge of Chameliya River

3.1.5 Vegetation

The Chameliya Hydroelectric Project areas falls within the tropical and sub tropical forest zone this extends from 780-1500m. The vegetation of dam and inundation area is mixed broad leaved forest type with Khair (*Acacia catechu*) as a major tree species. The dam site is dominated by Saj (*Terminalia alata*), Khamari (*Ficus auriculata*), Kutmero (*Litsea monopetala*) and inundation site is dominated by Simal (*Bombax ceiba*), Chuwa phool (*Plumeria rubr*a), Anap (*Magnifera indica*), Amba (*psidium guajava*), Bhimal (*Grewia optiva*) Bel (*Aegle marmelos*).The major dominant species at the proposed powerhouse is Khair (*Acacia catechu*) *Adina cordifolia*, Khanayu (*Ficus semicordata*), Gargalo (*Behmeria platyphylla*), Amala (*Phyllanthus embelica*), Dhudhe laharo (*Hedyotis scandens*), Sal (*Shorea robusta*)

3.1.6 Socioeconomic Status

a. Population

The total population of the project area is 17312 and number of households are 2896 (DDP, 2004).The male and female population are 8563 (49.46%) and 8749 (50.53%), respectively. The average household size of the project area is 5.97. (Silt Consult, 2006).

b. Occupation

Agriculture followed by the small scale trade and seasonally employment are the main occupation of the people of project area. The occupational distribution of the sample population (core project area) shows that 90% has agriculture as their main occupation, 8% employment and about 2% in trading. (Silt Consult, 2006)

c. Literacy rate

The literacy rate of Latinath, Seri and Shikhar VDCs are 42.5%, 33.7%, &48.6% respectively. Similarly in Baitadi part of the project area the literacy rate is 32.9% and 49.7% for Kotpatera and Rudreshwor VDCs respectively. . (Silt Consult, 2006)

d. Ethnicity

The project area is occupied by the different ethnic groups. The Brahmins (6.9%) and Chhetri (81.6%) are the main ethnic group found in project area. The other caste includes Jogi (3.9%), and occupation castes (Kami, Sarki and Damai) 7.6 %.(Silt consult 2006)

e. Energy Use

The entire household use firewood as fuel from private plantation and government forest for domestic purpose. It is estimated that approximately 7-9kg firewood and 4-5 liters of kerosene have been used daily by individual household in the project area. (Silt Consult, 2006)

CHAPTER IV

METHODS AND MATERIALS

4.1 Field Visit

The project area was visited two times during the study period from March 2009 to July 2009, to collect the primary data related to various parameters of environmental components. The frequency of data collection was single for each parameter in sampling site and the entire project site was thoroughly investigated and visual observations were made.

4.2 Primary data

The study was based on both primary and secondary data. Primary data were generated for water quality, noise quality, air quality and fish diversity where as secondary data were collected for analysis of river hydrology and vegetation.

4.3 Site selection

Noise quality: Powerhouse, Adit-1, Adit-2, Adit-3 and head works were selected for measurement of noise level since these areas could be at high risk of crossing the prescribed guidelines of noise due to the vehicular, mechanical and blasting activities.

Air Quality: - Powerhouse, Adit-1, and Adit-3 were selected for measurement of air quality.

Water Quality: U/S and D/S of Powerhouse and headwork were the selected sample site for water quality.

4.4 Primary data collection

The relevant information regarding the environmental quality, different parameters were measured during the field visit at each site. The methods for generation of such data include;

- Collection of samples and field and laboratory analysis
- Questionnaire survey and Focus group discussion
- Data analysis and interpretation

4.4.1 Sampling Procedure

4.4.1.1 Air Pollution

Air samples were collected for 12hrs using high volume Air sampler on 15 March 2009**.** Pre treated glass fiber filter paper and standard sampling cups were used for the analysis of total suspended particles and PM_{10} respectively.

4.4.1.2 Frequency Analysis

Gumbel's frequency distribution was adopted for discharge frequency analysis of Chameliya River. According to Gumbel's, the general equation for the hydrological frequency analysis is

$$X_T = \overline{X} + K\sigma$$

Where X_T = Any variable

$\overline{X}$ = mean of variates

. σ = Standard deviation of the variates

$$\sigma = \sqrt{\frac{N}{N-1}\left[\overline{X}^2 - \left(\overline{X}\right)^2\right]}$$

K=A constant called frequency factor depending on return period and assumed frequency distribution

$$K = \frac{y_T - y_n}{S_n}$$

Where y_T is reduced variate, a function of T and is given by

$$y_T = -\ln.\ln{}^{T}\!/_{T-1}$$

y_n and S_n are reduced mean and reduced standard deviation respectively and computed from standard table for sample size N. (Garg 2002)

4.4.1.3 Noise quality

In March 2009, the noise level was recorded for 10 minutes in different time zone in each site by using data logging sound level meter (calibrated at 94.4dBA). From the obtained sound pressure levels the Leq, L5, L_{10}, L_{50}, L_{90}, L_{95}, L_{max}, L_{min} and L_d were calculated using standard formulae. The formulae used to calculate these are direct bar graph display software (Monarch 322).

4.4.1.4 Water sample collection and preservation

Five liter samples were collected from each sampling site in PVC bottles (2.5liter, two 1 liter and 0.5liter). For the measurement of NH_3-N, BOD_5 and other general test,

the collected water samples were preserved by adding concentrated H_2SO_4 to fix pH below 2 by keeping in ice box as soon as possible (APHA, 1998).

4.4.2 Analysis of Physico-chemical parameter of water

Water sampling from the study sites was taken by clean plastic bottle. Parameters like Temperature, Transparency, pH, Dissolved Oxygen, free CO_2, Total Alkalinity, Total Hardness, and Chloride Content were measured in field and for the TDS, Total Nitrogen, Phosphorus and microbial analysis, water samples were brought to the lab of CDES, TU, Kirtipur. Each parameter was examined by standard methods given by APHA (1998).

4.4.2.1Temperature

Temperature of surface water and atmosphere of sampling site was recorded by an ordinary mercury thermometer.

4.4.2.2 pH

The pH of water was recorded by portable digital pH meter (HANA).The probe of which was dipped in beaker with half filled sample water. The displayed reading was noted down.

4.4.2.3 Total Dissolved Solids (TDS)

For Total Dissolved solids, a porcelain basin was taken and heated for an hour, then cooled off in desiccator and weighted. The sample was filtered through the Whiteman filter paper and 50 ml of filtered sample was taken in the porcelain basin and heated. The sample was evaporated completely and final weighted was taken after cooling in desiccator.

Calculation,

Total dissolved solids (mg/l) =A-B×1000×1000

Where, A=Final weight of the disc in gm.

B=Initial weight of the disc in gm.

V=Volume of sample taken.

4.4.2.4 Dissolved Oxygen (DO)

The dissolved oxygen was determined by Winkler's Method. The sample of water was filled in the BOD bottle of 300ml.The stopper was placed tightened and checked on air bubbles inside the bottle. The stopper was removed and Dissolved Oxygen was fixed in the air sampling spot by adding 2 ml of Maganous Sulphate and Alkaline Potassium Iodide Solution through the wall of bottle to form precipitate. Then 2ml of concentrated Sulphuric Acid was added to dissolve the precipitate and shaken well.50 ml of content was taken in a conical flask and titrated with Sodium Thiosulphate Solution (0.025N) using Starch as indicator until the dark blue colored to colorless. The concurrent reading was noted for all samples. The Dissolved Oxygen can be calculated by using formula as:

$$\text{Dissolved Oxygen mg/l} = \frac{\frac{(\text{vol}\times.\text{N})\text{of titrant}\times 8\times 1000}{\text{V2}(\text{V1}-\text{V})}}{\text{V1}}$$

Where, V2=Volume of the part of content titrated

V1=Volume of sample bottle after placing stopper.

V=Volume of MnSO4 and Alkaline KI added.

4.4.2.5Biological Oxygen Demand

First of all dilution water was prepared by mixing 1ml Phosphate Buffer, 1ml $MgSO_4.7H_2O$,1ml $CaCl_2$ and 1ml $FeCl_3.6\ H_2O$ in 1litre distilled water. 50 ml of sample water was taken in two liter bottle diluted it by adding 950ml of dilution water. The sample was aerated for 5min by bubbling air through a diffusion tube. Then two BOD bottles were taken and filled with sample water after it one bottle was wrapped with carbon paper and kept in BOD incubator at 20^{oC} for 5 days and after it DO was measured. The second bottle was used to determine the DO content (initial DO level) in water using Wrinkle's Iodometric Method.

BOD= (DO initial-DO_5) ×dilution factor

4.4.2.6 Iron

Iron contain in the collected sample was determined by using Atomic Absorption Spectrophotometer Method. It was done by taking 50ml sample in 150ml conical flask and 2ml conc. HCL and 1ml of Hydroxylamine Hydrochloride Solution was added. For dissolution of the iron, boiled the content of half of the volume, cooled and added 10ml Ammonium Acetate Buffer and 2ml Phenonthroline Solution.100ml

volume was made and after 10 minutes readings were taken at 510nm on a spectrometer. Standard curve was prepared in the range of 1 to 4mg/l of iron using various dilution of standard solution and concentration of Iron was calculated.

4.4.2.7 Total Hardness

Total Hardness of water was determined by Titrimetric Method. 50 ml of sample water was taken in a clean conical flask and added 1 ml of buffer solution (pH10) and pinch of Erichrome Black T indicator in it. The content was shaken well and titrated with standard EDTA solution until the wine red color of solution turned blue. Concurrent readings were noted for all samples.

Total Hardness was calculated by using formula as:

$$\text{Total Hardness as } (CaCO_3)\ \text{mg/l} = \frac{\text{ml of EDTA used} \times 100}{V}$$

Where, $V =$ Volume of water sample taken (ml)

4.4.2.8 Calcium Hardness

50 ml of sample water was taken in a clean conical flask and added 2ml of NaOH solution in the sample and 100 mg of Murexide indicator. The content was shaken well and titrated with standard EDTA solution until the pink color of solution turned purple. Concurrent readings were noted for all samples.

Calculation,

$$\text{Calcium (mg/l)} = \frac{\text{ml of EDTA used} \times 400 \times 8}{\text{Volume of sample taken}}$$

4.4.2.9 Mg-Hardness

Magnesium Hardness was determined by subtracting Calcium Hardness from Total Hardness.

Magnesium Hardness = Total Hardness – Calcium Hardness

4.4.2.10 Total Alkalinity

Total Alkalinity of water was determined by Titrimetric Method.50 ml of sample was taken in a clean conical flask and added few drops of Phenolphthain indicator to it there was no any color change then Methyl Orange indicator was added (2 drops) and the content was titrated against 0.01 NHCL until the yellow color changed into pink.

$$\text{Total Alkalinity (mg/lit) as } CaCO_3 = \frac{\text{ml} \times \text{N of HCL} \times 1000 \times 50}{\text{Volume of sample taken}}$$

4.4.2.11. Total Phosphates (PO_4)

50 ml of filtrate clear sample was taken in a conical flask, and then 2 ml of Ammonium Molybdate was added and followed by 5 drops of SnCl2 solution. Blue color appeared the reading was taken at 690nm on a spectrophotometer using distilled water blank with then same amount of chemicals. The reading was taken after 5 minutes but before 12 minutes of the addition of reagents. The standard curve was prepared between the concentration Vs absorbance. Then the concentrations of Phosphate in the samples were noted down by using the standard curve.

4.4.2.12. Potassium

Potassium was determined by flame photometric method. For highly polluted sample, sample of suitable size in a 250ml conical flask was taken and acidify it with Nitric Acid. It was evaporated upto dryness on a water bath. Then 25ml of concentrated HNO_3 was added and heat to near boiling until the acid was evaporated to small volume. Some more conc. HNO_3 and small quantities of H_2O_2 was added for complete ashing of organic matter. The final residue was colorless on drying. The residue was dissolved in small amount of HCL and warm distilled water then filtered the content, neutralize with conc.NH_4OH and dilute to a suitable volume.

For non polluted sample, sample was filtered through a filter at 768nm wavelength and calibration curve was prepared in the range of 0-1, 0-10 and 0-100ml of K by using various standard equation of K.

K mg/l = mg/l K in diluted aliquot $\times$ dilution factor.

4.4.2.13 Chloride

Chloride was determined by Titrimetric Method. It was done by titrating 50 ml of sample containing 4-5 drops of Potassium Chromate with 0.02N Silver Nitrate Solution. The yellow color produced by indicator was converted to brick red at the end point.
Concurrent readings were noted for all samples.

Chloride was calculated by the formula as:

$$\text{Chloride (mg/l)} = \frac{\text{ml.} \times \text{N of AgNO} \times 35.5 \times 100}{\text{Volume of sample taken}}$$

4.4.2.14 Conductivity

The conductivity of water was determined with the help of a digital conductivity meter (Model 4150 by Wagtech). The conductivity meter was first calibrated with standard Potassium Chloride solution of 0.01N and the temperature was adjusted at 25^0C. The instrument was first brought into the conductivity mode. Then the electrode was washed and rinsed a few times with distilled water and then dipped in the beaker containing the lake water sample.

4.4.2.15 Total Coli form

Total Coliform in water sample was calculated by Most Probable Number (MPN) test (Trivedi and Goel, 1984).This test was carried in three successive steps as following:

4.4.2.15.1 Presumptive Test

This technique involves inoculating the sample in a suitable liquid medium and incubating for suitable period, the tubes are examined for gas production by the Coliform organisms.

For each water sample, 15 test tubes with inverted Durham's tube and Mcconkey Broth (MB) were prepared. Five tubes containing 10ml of double strength MB and other 10tubes containing same amount (i.e.10 ml) of single strength MB was set up. Then all these tubes with cotton plugs were sterilized by autoclaving at 15l bs pressure and 121^oC for 15 minutes. After autoclaving these tubes were cooled at room temperature. Then 10ml of water sample was inoculated into 5 tubes labeling double strength or first set. Similarly, 1 ml and 0.1ml of water sample was inoculated into 2 sets of single strength. These were labeled as second and third set of single strength. Then these sets of tubes were inoculated at 37^oC for 24 hours in an incubator. Color change and gas production was observed in positive test on complete incubation.

4.4.2.15.2 Confirmatory Test

Since organism other than coli form may also produce gas, the +tubes form the presumptive test are subjected to confirmatory test. This test is carried out for a definite presence of bacteria.

In this test, a loopful of the sample from each +ve presumptive test was transferred to tubes of Brilliant Green Lactose Broth (BGLB) with inverted Durham's tube. Then the tubes were incubated at 37^{oC} for 48±2hours.The tube with gas formation in

Durham's tube was recorded as positive confirmatory test. The tubes of negative confirmatory test were discarded.

4.4.2.15.3 Complete Test

From the each tube of +ve confirmatory test, the sample was streaked on the Petri plate of Eocene Methyl Blue (EMB) agar and incubated at 37^{o}C for 24 hours. After incubation, bacterial colonies were observed. The colonies with pink and dark centre along with greenish metallic luster were taken as typical colonies, the colonies with only pink color and not nucleated were atypical and those with other than pink color were recorded as non typical colonies. Among these three sorts of colonies typical and atypical colonies were reported as positive while non-typical colonies were as negative.

Again isolated Coliform colonies from each plate positive test plate were subjected to presumptive test as described above for 48hours at 37^{oC}.Then Petri plate with colonies showing positive presumptive test were gram strained. The colonies from each plate showing gram negative test was recorded as positive completed test.

The numbers of plate showing +ve completed test from each three sets of dilutions were noted and that combination was used to calculate MPN/100ml from MPN chart (Annex 11)

4.4.2.16 Faecal Coliform

For the detection of Faecal Coliform in the water sample the same steps were followed as described above for total Coliform. But in the confirmatory test, the inoculated BGLB medium was incubated at 44^{oC}in water bath for 24 hours within 30minutes after inoculation.

4.4.3. Fish diversity

The types of species and their availability were found in Chameliya River by identifying first by direct sampling and through the questionnaire survey with the local fisherman. Fishes were sampled by using the multipannel gillnets of 25-50mm mesh size with the help of local fisherman. This rectangular net was tied across the water fixing horizontally in the evening for overnight. Next morning the fishes had netted out and collected. These fish specimens collected from the sampling areas was brought to the laboratory of CDES and identified by using standard method of

taxonomy after (Shrestha 1995, Jayaram 1993, Day 1994 and Talwar and Jhingran 1991).

4.4.4 Vegetation

The vegetation found in the river side and nearby impact area was identified. The affected amount of vegetation mainly trees in numbers were calculated.

4.4.5 Wild Animals

The types of wild animals found and impact of the project area were identified by questionnaire survey to the local and through literature review.

4.4.6 Mitigation Measures

Compliance Status of mitigation measures as adopted by project was identified through checklist (Annex 10)

4.5 Secondary data

The secondary data was used to support the primary data to give the complete analysis of the study. Relevant information was extracted and analyzed from various sources like project document reports, thesis, journal, and book, published and unpublished articles through internet, library of ICIMOD, TUCL, CDES, and WECS etc. Beside these, the Polices, Acts, Regulation and guideline of GoV/N were also referred. The EIA and EMP reports were reviewed for the comparative analysis with the present data.

CHAPTER-V

RESULT

5.1 Frequency Analysis of River

Determination of frequency of occurrence of extreme hydrological events like flood and severe storms are important in water resource planning and management Data on annual maximum peak discharge at Nayalbadi station from 1967 to 2006 were collected from Hydrological Records of Nepal published by DHM (Annex12). Gumbel's theoretical distribution was fitted to the data.

Here total number of data available N =20

Mean of maximum instantaneous discharge, $\overline{X}$ =317.85m^3/s

Standard Deviation of discharge=131.61 m^3/s

Table 5.1 presents a summary of the calculated discharge from Gumbel's method. Discharge values have been plotted against Return period (Annex 14)

Table5.1: Computation of Discharge from Gumbel's Method

T(Years)	Peak Discharge(m^3/s)
5	445.11
10	531.71
15	584.09
20	620.81
25	649.11
30	671.88
50	736.24
60	759.01
75	786.78
100	822.71

5.2 Impact analysis

5.2.1 Water quality

Three samples were collected from Chameliya River to investigate the over all impact of the project activities on Chameliya River. The parameters analyzed for the collected water samples are presented in graph below.

5.2.1.1Temperature

Temperature is an important and commonly measured physical property of water. Observed temperature was 18.3, 18.6, 18.5oC at u/s of power house, at d/s of power house and at u/s of head work respectively (fig5.1). The result showed that temperature at d/s of the power house site was highest than other sites.

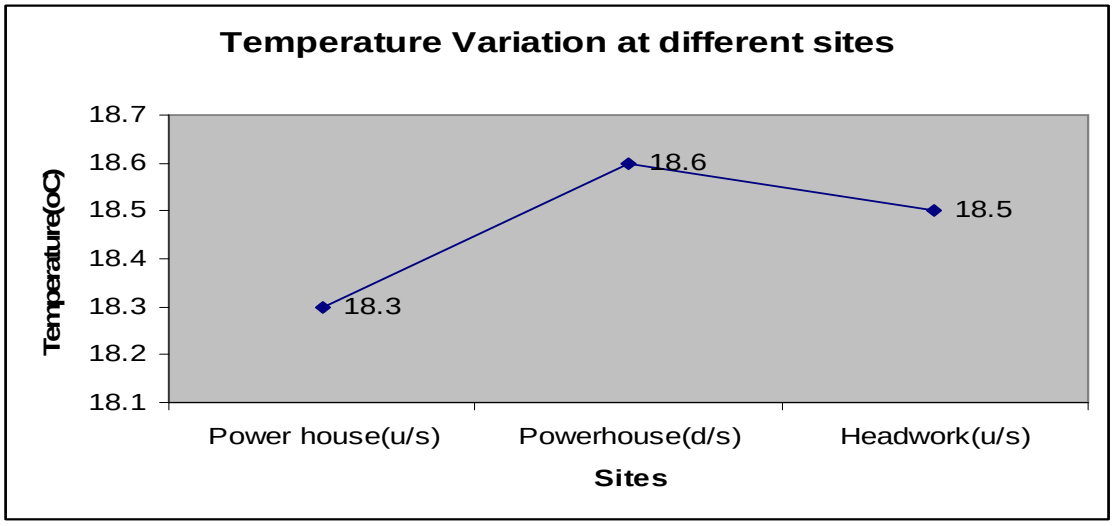


Figure 5.1:- Temperature variation at different sites

5.2.1.2 pH Observation

The pH value is an important factor in maintaining the bicarbonates and carbonates systems. The values of pH were found to be 8.0, 8.0 and 8.3 at u/s of power house, d/s of power house and at u/s of head work respectively (fig5.2). The data reflect that there was no significant difference between all three sites.

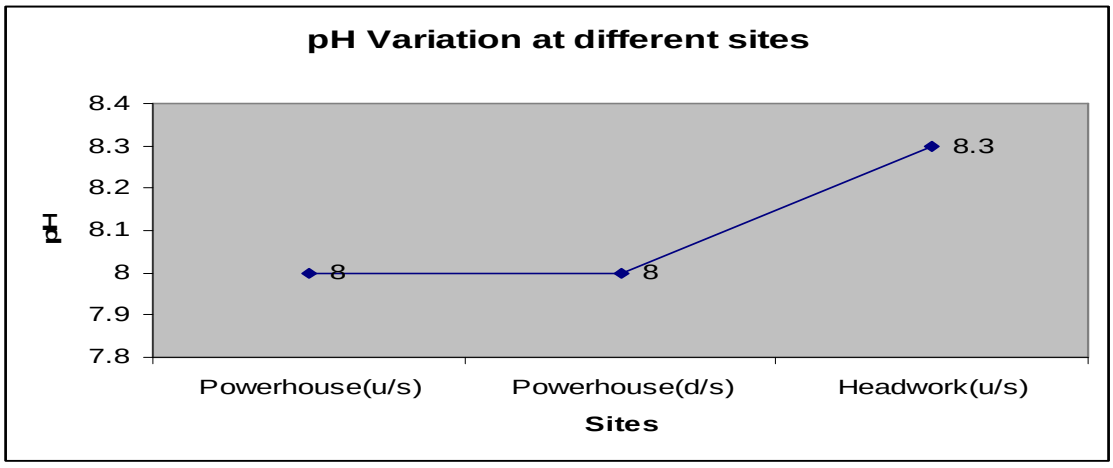


Figure 5.2:- pH variation at different sites

5.2.1.3 Dissolved Oxygen

Dissolved Oxygen is one of the most important factors in water quality assessment and reflects the physical and biological process prevailing in natural water. Its presence is essential to maintain the higher form of biological life in water. It is essential for the metabolism of all aquatic organisms that possess aerobic respiratory

biochemistry. The dissolved oxygen saturation levels were found to be 9.8, 9.7, 9.5 mg/l at u/s of power house, at d/s of power house and at u/s of head work site respectively (fig5.3). The result showed that the value of DO was high in u/s of power house site and low in headwork site.

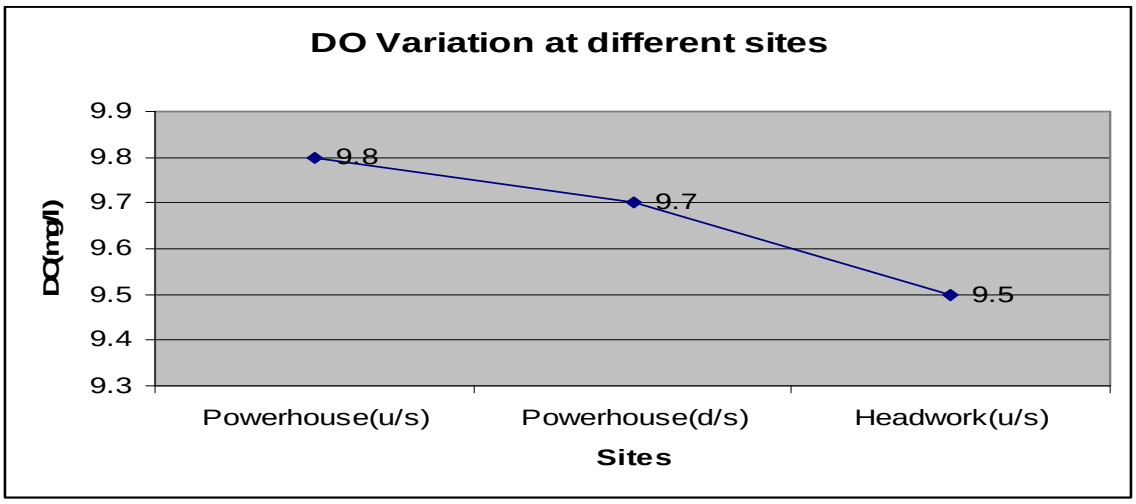


Figure 5.3:- Dissolved oxygen variation at different sites

5.2.1.4 Hardness

Ca- Calcium ions are important component of plant tissue and participate in various cellular functions. It is also required as a nutrient for various metabolic processes and assists in proper translocation of carbohydrates that facilitates the availability of other ions. The Ca was 32.8, 32.5.and 35.2mg/l at head work, at u/s of power house and at d/s of power house site respectively (fig5.4).

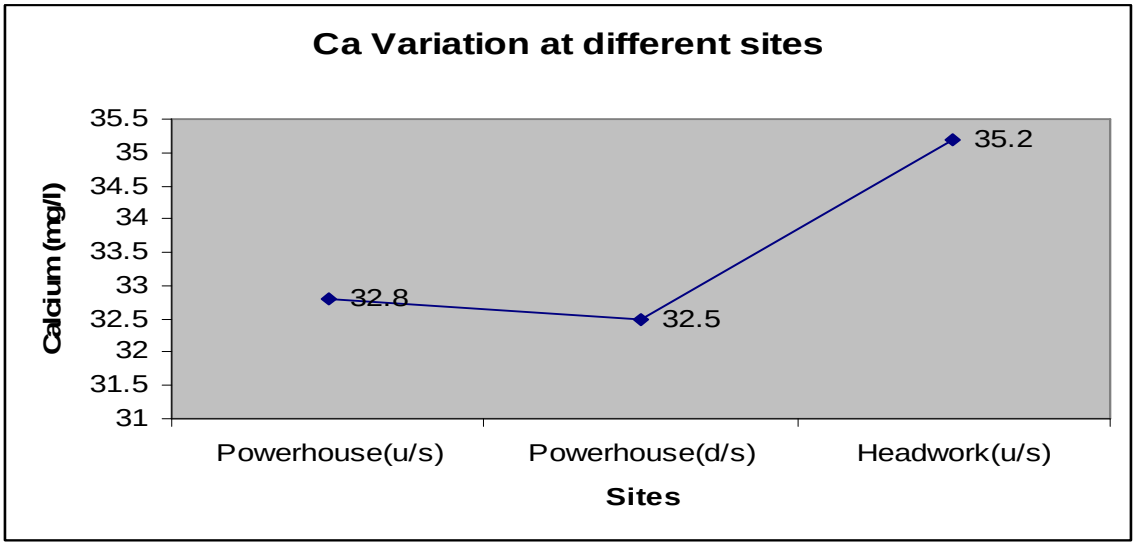


Figure 5.4:- Calcium variation at different sites

Mg- Mg is required universally by chlorophyllous plant as the Mg Prophyrin component of the chlorophyll molecules and as cofactor for various enzymatic transformation within the cell. The values of Mg at u/s of power house, d/s of power house and u/s of headwork were found to be 11.6, 11.6 and 8.74 mg/l respectively (fig5.5).

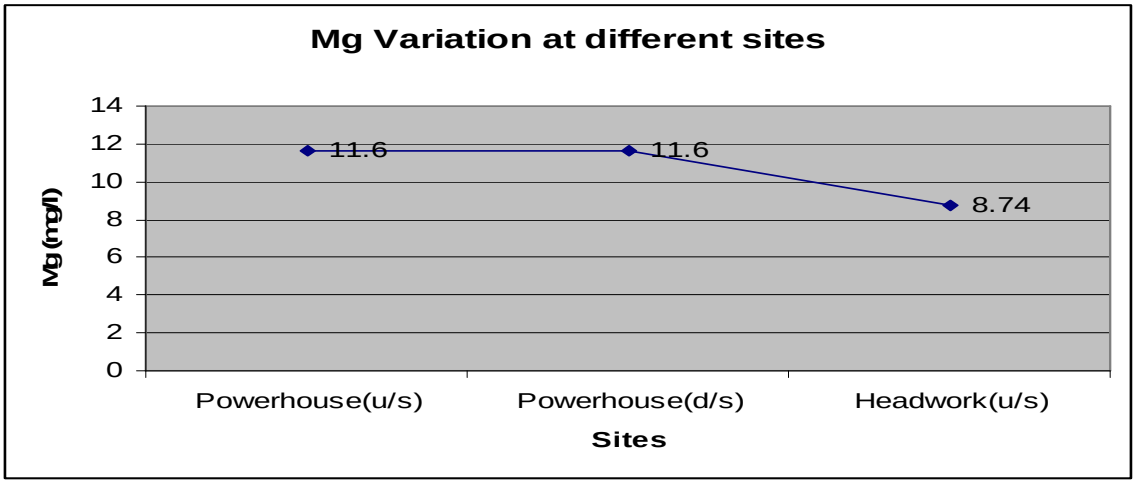


Figure 5.5:- Magnesium variation at different sites

5.2.1.5 Biological Oxygen Demand (BOD)

BOD is a great importance in water quality assessment. Seasonal variation in the values of BOD appears to be a function of changes in the degree of dilution, quantity of organic matter and the activities of microorganism carrying out decomposition of carbonaceous and nitrogenous matter. The values of BOD at u/s of power house, at d/s of Power hose and u/s of headwork were found to be 0.36, 1.8 and 1.1mg/l respectively (Fig5.6).

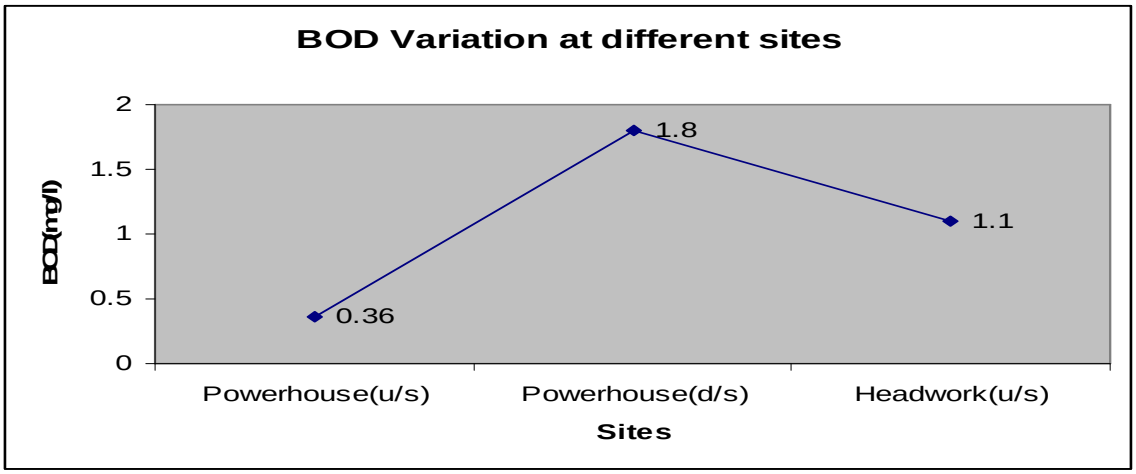


Figure 5.6:-BOD variation at different sites

5.2.1.6 Potassium

The maximum value of Potassium was found at d/s of power house site i.e. 1.6mg/l and minimum was at u/s of head work site i.e. 0.8mg/l. The average value was recorded 1.2 mg/l during study period. These values are depicted in Figure 5.7.

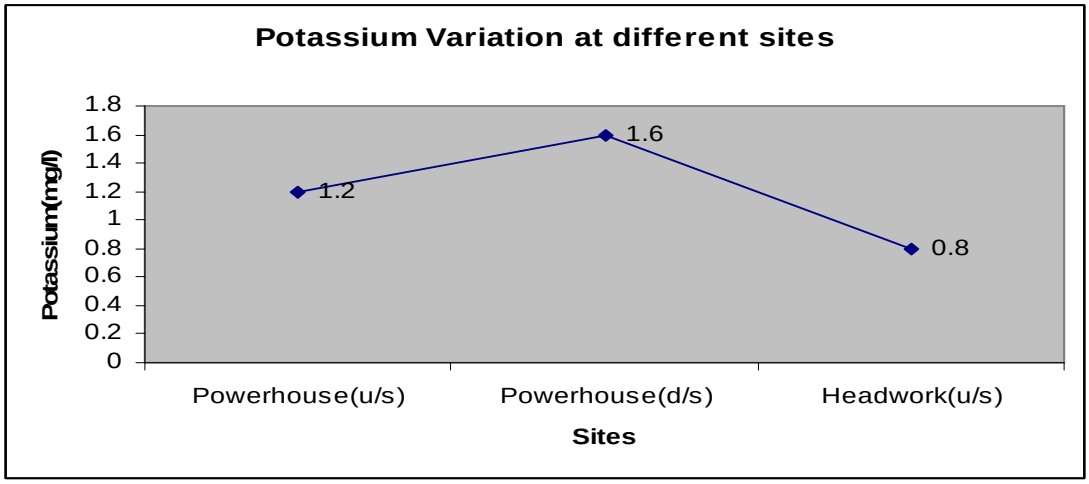


Figure 5.7:-Potassium variation at different sites

5.2.1.7 Iron

Iron was found maximum at d/s of power house site i.e.0.03mg/l and minimum at u/s of head work site i.e. 0.01mg/l respectively (Fig5.8). The average value of Iron was found to be 0.02mg/l in study sites. The result showed that the value of iron was slightly increased from head work to d/s of power house.

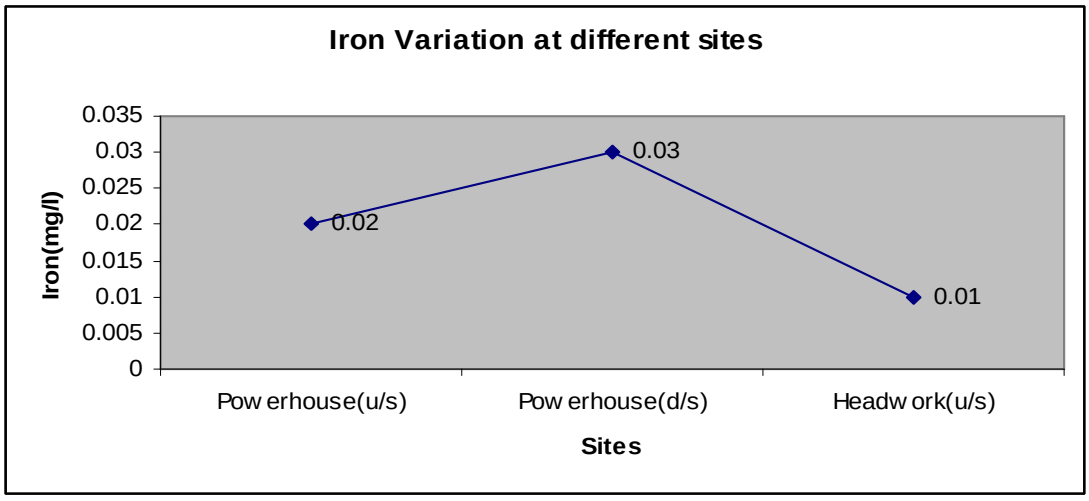


Figure 5.8: - Iron Variation at different sites

5.2.1.8 Total Alkalinity

The maximum value of Total Alkalinity was found at u/s of head work site i.e. 113.0mg/l and minimum was recorded at u/s of Powerhouse site i.e.87.0mg/l (fig5.9). The average value was found to be 1.2 mg/l during study period.

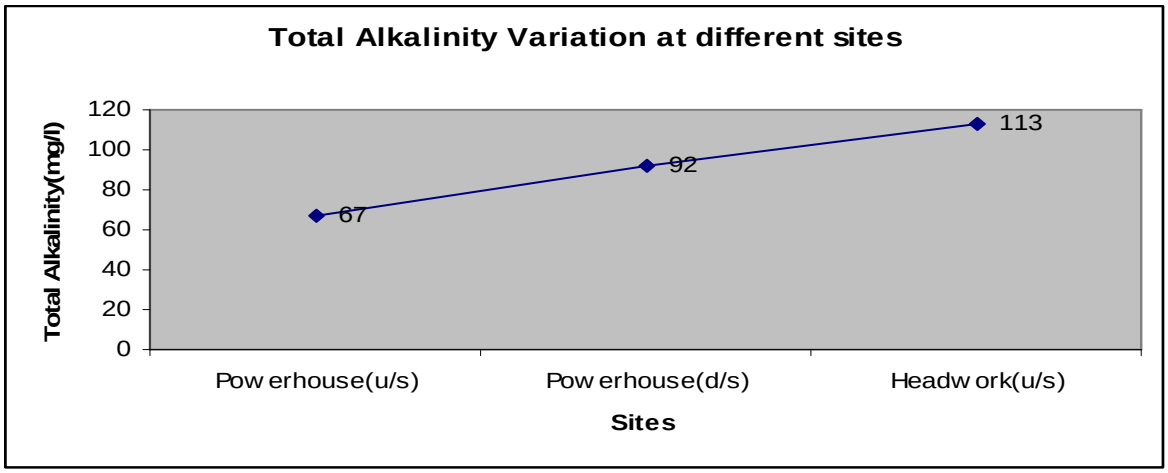


Figure5.9: - Total Alkalinity Variation at different sites

5.2.1.9 Specific Conductance

Figure 5.10 shows that the maximum and minimum value of specific conductance were found to be 290 mhos and 286mhos at u/s of head work site and at u/s of power house site respectively. The average value of Spec. conductance for three sampling sites was recorded 287.67mhos.

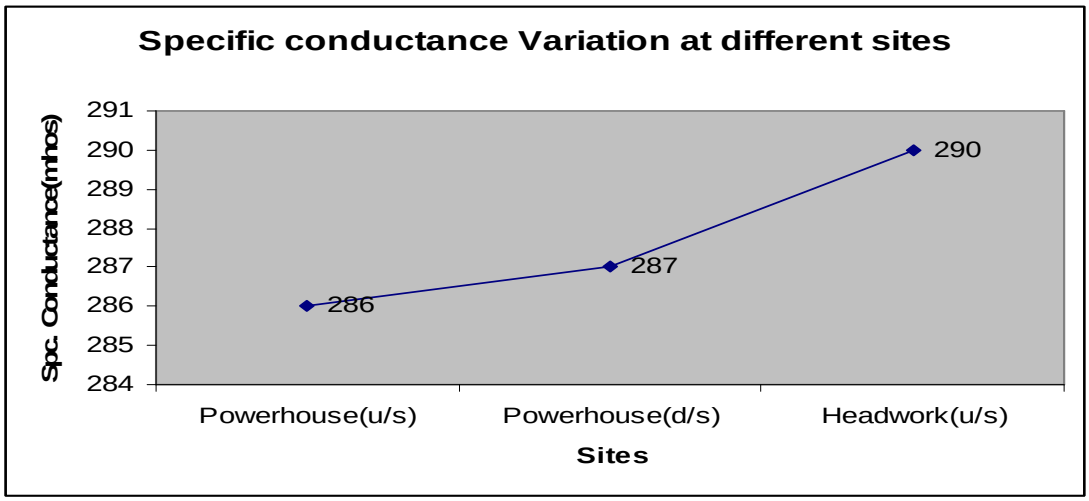


Figure5.10: - Specific conductance Variation at different sites

5.2.1.10. Total dissolved solid (TDS)

Figure 5.11 shows that the maximum and minimum value of Total dissolved solid were found to be 189mg/l and 182mg/l at u/s of head work site and at d/s of power house site respectively. The average value of Total dissolved solid for three sampling sites was recorded 185mg/l.

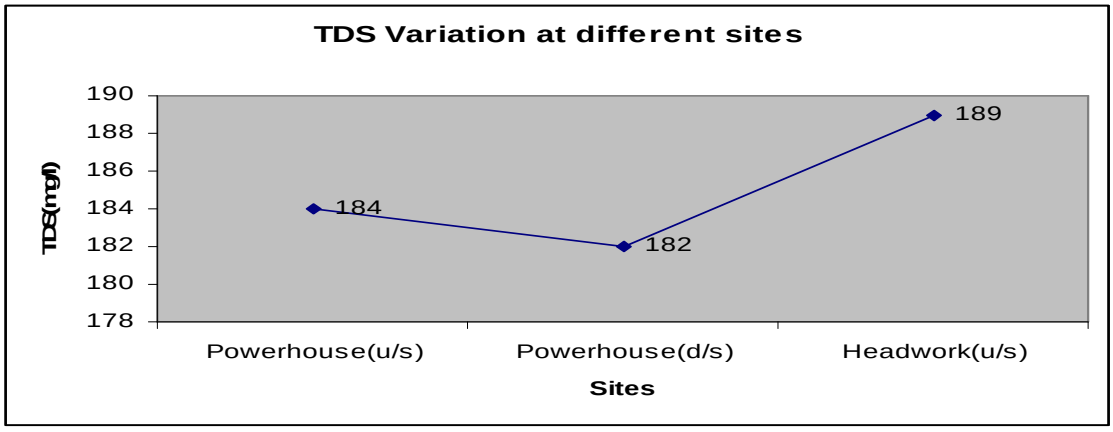


Figure 5.11: - Total Dissolved Solid Variation at different sites

5.2.1.11 Total Coliform and Faecal Coliform

Total Coliform was found to be 210,460 per 100ml and Nil at u/s of powerhouse site, d/s of powerhouse site and u/s of headwork site respectively. Similarly *E. coli* was found to be 7, 3 per 100 ml and Nil at u/s of powerhouse site, d/s of powerhouse site and u/s of headwork site respectively.

5.2.2 Air Quality

The air quality data from table 5.2 depicts that the observed level of PM_{10} at Powerhouse, Adit-3 and Adit-1 were 164.2, 141.0 and 108.0 $\mu g/m^3$ respectively. Similarly the air quality data tabulated below shows the observed level of TSP in Powerhouse, Adit-3 and Adit-1 were 663.2, 840.7 and 497.3 $\mu g/m^3$ respectively.

Table 5.2-Total Suspended Particulate Matters (TSP) and Total Respirable Particulate Matter (PM10) recorded within CHP construction area

Recorded date	location	TSP	PM_{10}
		($\mu g/m^3$)	
15 March 2009	Power house	663.2	164.2
16 March 2009	Adit-3	840.7	141.0
17 March 2009	Adit-1	497.3	108.0

5.2.3 Noise Quality

The noise quality data from Figure 5.12 at powerhouse site depicts that the Average Equivalent Sound Level at different time zone 8:05, 10:05, 14:45 and 16:10 hrs were 45.8, 51.4, 48.3 and 43.4 dBA respectively. The max and min Sound Pressure Level measured were 59.3 and 38.8 dBA respectively.

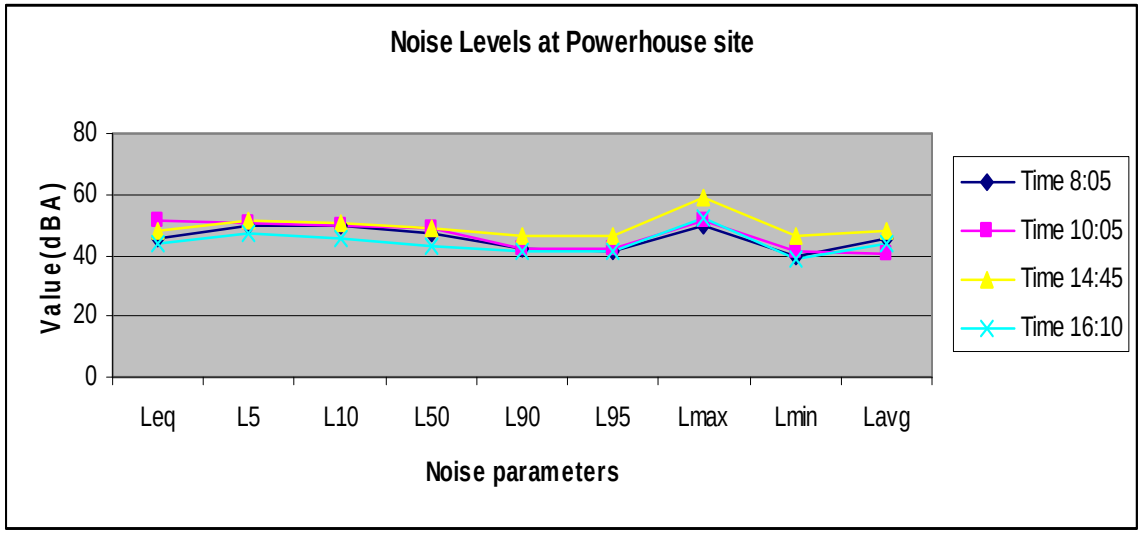


Figure5.12: Noise Level measured at Powerhouse site

The noise quality data from Figure 5.13 at Adit-3 shows that the Average Equivalent Sound Level at different time zone 8:45, 12:30, 15:30 and 17:10 hrs were 56.5, 61.7, 60.0 and 62.5 dBA respectively. The max and min Sound Pressure Level measured were 80.2 and 52.9 dBA respectively.

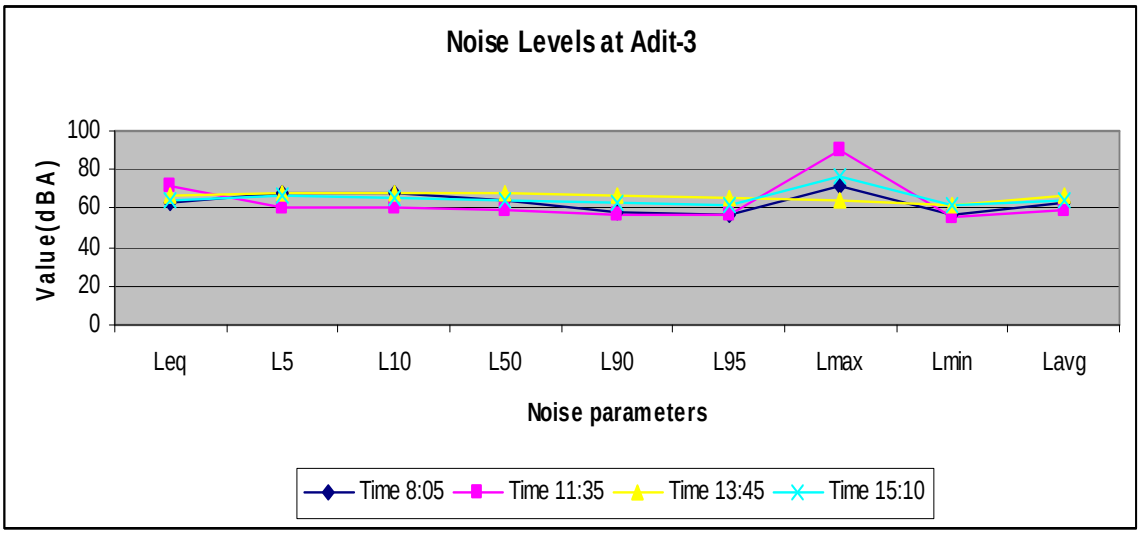


Figure5.13: Noise Level measured at Adit-3

From Figure 5.14 the noise quality data at Adit-2 shows that the Average Equivalent Sound Level at different time zone 8:05, 11:35, 13:45 and 15:10 hrs were 63.0, 72.0, 66.4 and 64.6 dBA respectively. The max and min Sound Pressure Level measured were 89.7 and 56.1 dBA respectively.

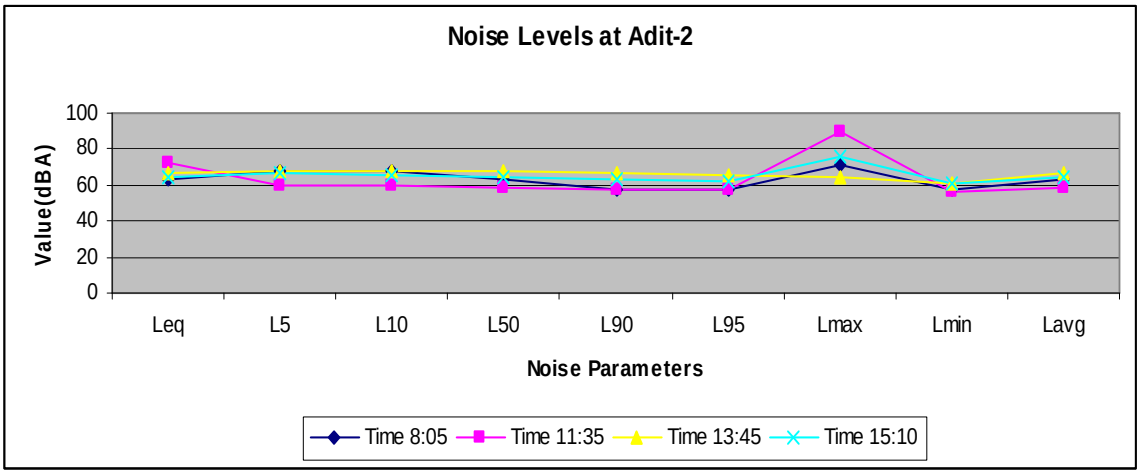


Figure5.14: Noise Level measured at Adit-2

From Figure 5.15 the noise quality data at Adit-1 shows that the Average Equivalent Sound Level at different time zone 8:05, 10:05, 13:35 and 16:40 hrs were 60.1, 60.3, 60.1 and 60.1 dBA respectively. The max and min Sound Pressure Level measured were 66.7 and 59.2 dBA respectively.

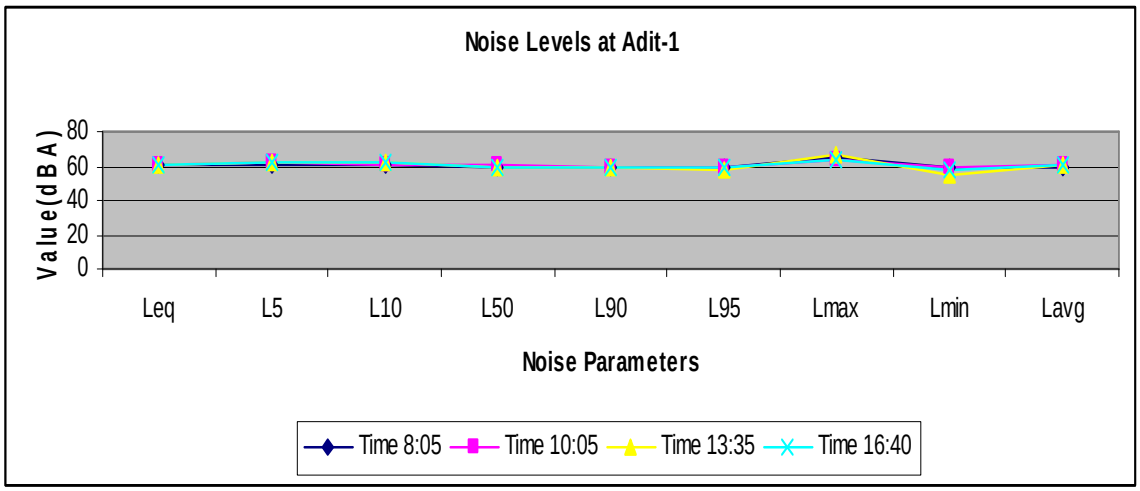
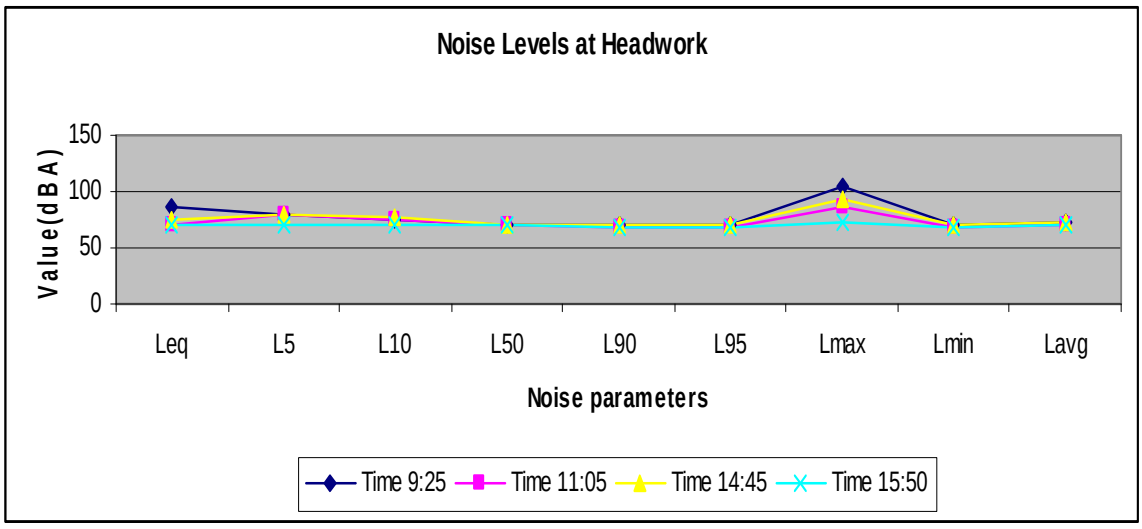


Figure5.15: Noise Level measured at Adit-1

Similarly the noise quality data from Figure 5.16 at head work site shows that the Average Equivalent Sound Level at different time zone 9:25, 11:05, 14:45 and 15:50 hrs were 85.4, 71.3, 74.6 and 69.8 dBA respectively. The max and min Sound Pressure Level measured were 104.0and 69.4 dBA respectively.



. Figure5.16: Noise Level measured at Head Work

The Average Equivalent Sound Level for day (L_d) was found to be 47.2 dBA, 60.2 dBA, 66.5 dBA, 60.1 dBA and 75.3 dBA at Powerhouse, Adit-3, Adit-2 and Headwork site respectively. From Figure 5.17, highest and lowest value of Average Equivalent Sound Level for day was found at Headwork Site and Powerhouse Site respectively.

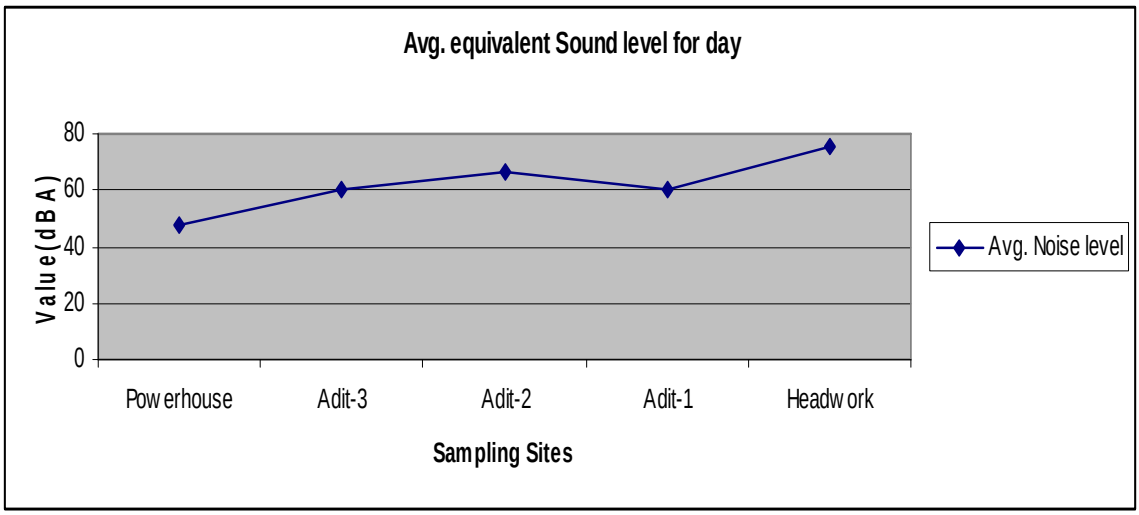


Figure 5.17 Average Equivalent Sound Levels for day (L_d)

5.2.4 Wildlife

According to the questionnaire survey and visual observations it was reported that the wild animals like Rhesus and Entellus monkey (*Macaca mullata &Presbytes entellus*), Jackal (*Canis aerus*), Munt jack (*Muticus muntjack*), Otter (*Lutra lutra*) and Porcupine (*Hystrix indica)* were occasionally seen in the project area. Among these animals, Entellus monkey (*Presbytes entellus*), Rhesus monkey (*Macaca mullata) and* Jackal (*Canis aerus*) are listed in CITIES I, CITIES II and CITIES III respectively.

5.2.5 Fish

Fishes were caught by using the multipannel gillnets of 25-50mm mesh size with the help of a local fisherman. Their abundance and species composition at Ghategad khola and Chameliya river confluence U/S of Dam site and Chameliya & Karkale section near power house site were recorded.

5.2.5.1 Abundance of Fish

5.2.5.1.1 At Ghategad khola and Chameliya river confluence

Composition of fish species recorded during study period revealed that Snow trout had the highest value of abundance i.e.45% where as stone carps had the least value i.e.5% at Ghategad khola and Chameliya river confluence which is shown in Figure 5.18 below.

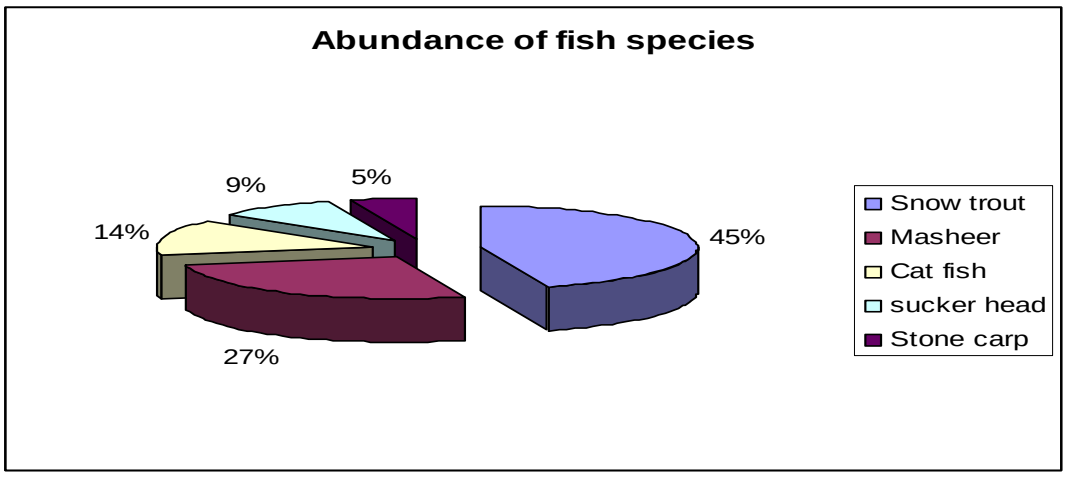


Figure5.18:-Composition of fish species recorded during study period

5.2.5.1.2 At Chameliya river and Karkale section

Composition of fish species in Chameliya River and Karkale section confluence were found to be 29%, 46%, 10%, 8%, 2% and 5% for Masheer, Snowtrout, Torrent catfish, Sucker head, Sidra and stone carp respectively which are shown in figure 5.19.

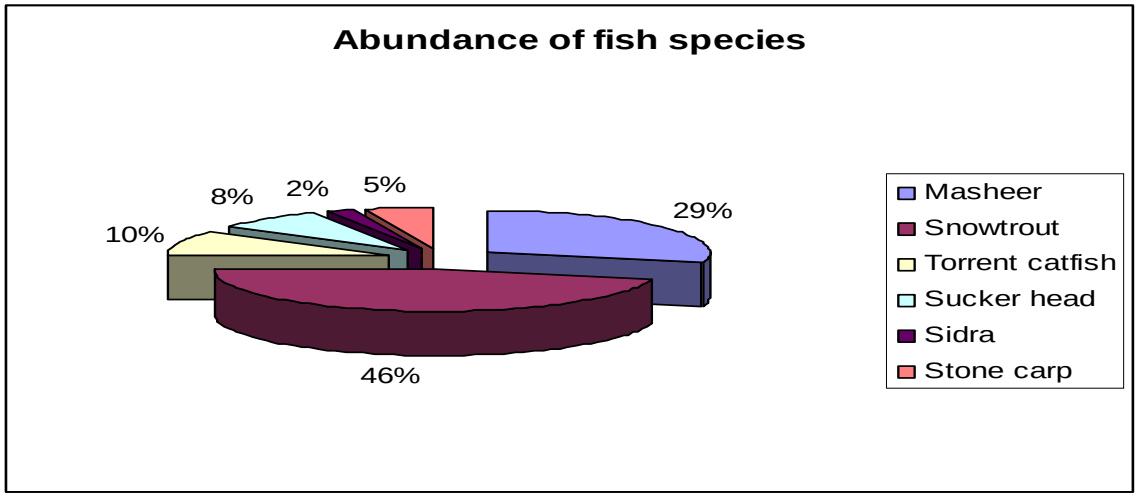


Figure5.19. Composition of fish species recorded during study period

5.2.5.2 Method of fishing and its frequency

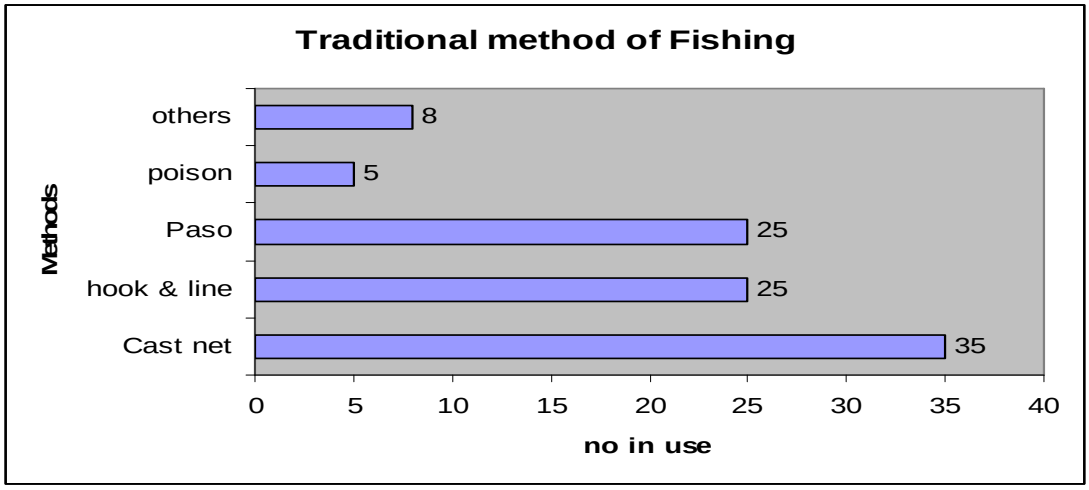


Figure5.20: - Traditional method of fishing and its frequency

5.2.6 Vegetation

The Project chopped down 3075 plants of 46 species with 10-25m height and 20-80cm of dBH. The project chopped down 1850 plant from private land and 1225 plant from government forest. It was found that the impact was high in reservoir area, burrows area and power house area. The major protected species chopped down by the project were Khair (*Acacia catechu*) (57), Simal (*Bombax ceiba*) (150) and Sal (*Shorea robusta*). (70).These species are protected as per sub rules 12 and 13 of the forest rule 1995. An attempt was made to compare the EIA prediction and actual scenario of no of trees chopped down during construction phase at the end of April 2009

Table 5.8: - Attempt to Compare the EIA Prediction and Actual Scenario of no of Trees chopped down during Construction Phase at End of April 2009

EIA Prediction*			Actually Finding	
S. N.	Name of species	No of individuals	Name of species	No of individuals
1	Khair (*Acacia catechu*)	85	Khair (*Acacia catechu*)	57
2	Simal (*Bombax ceiba*)	45	Simal(*Bombax ceiba*)	150
3	Sal (*Shorea robusta*).	80	Sal (*Shorea robusta*).	70
4	Khari*(Celtis austalis)*	8	Khari*(Celtis austalis)*	112
5	Toni (*Toona ciliate*)	70	Toni (*Toona ciliate*)	201
6	Khanayu(*Ficus semicordata*)	30	Khanayu(*Ficus semicordata*)	100
7	Daleghas(karma,koiralo,t	369	Daleghas	818

	aki, faledo,chagilo,dudhilo,etc)			
8	Chiuri (*Saurauia napaulensis*)	52	Chiuri (*Saurauia napaulensis*)	420
9	Sisso(*Dalbergia sissoo*)	90	Sisso(*Dalbergia sissoo*)	162
10	Rittha *(Sapindus mukorossi)*	8	Rittha *(Sapindus mukorossi)*	196
11	Bakaino (*Malia azedarach*)	7	Bakaino (*Malia azedarach*)	132
12	Saj(*Terminalia alata*)	170	Saj(*Terminalia alata*)	71
13	Others	701	Others	586
14	Total	1715	Total	3075

***-Baseline data from EIA Report, 2006**

5.2 Mitigation Measures as Adopted During Construction Phase

Mitigation measures should be implemented during the construction as well as during operation phase in the Hydropower project. As the construction work had not been completed in CHEP so only implementation level of proposed mitigation measures as adopted by project during construction phase in two years period from project execution was observed by field visits,Checklist and interviews with project authorized persons and the finding are presented in Table 5.9.

Table 5.9 –Compliance Status of the Proposed Mitigation Measures

S.N	Proposed Mitigation Measures	Compliance status			
		Premature	Partially complied	Complied	Not complied
1	Slope protection structure such as revetment wall ,retaining wall, benches or terraces riprap and spur shall be build at appropriate location in order to retain unstable soil masses		✓		
2	Compensatory plantation	✓			
3	Water quality protection measures such as provision of settling tanks, Water treatment	✓			

	plant, brim, lining of storage area				
4	Provision of noise suppression system, earmuffs or plugs, use of limited detonator in small lots		✓		
5	Spoil materials will be reused as much as possible onsite for road maintenance and site labeling and all remaining spoil material will be deposited in designated area			✓	
6	Contractor will provide a sufficient number of closable solid waste bins at each workforce camps and all work areas			✓	
7	Hazardous waste will be stored in designated enclosed and covered areas on impermeable surfaces such as clays, asphalt or concrete with adequate containment capacity		✓		
9	Contractor will provide stove and kerosene to outside workforce at subsidized rates to match local price of fuel wood and warm blanket will be provided to people living in work force camps during cold months to discourage them from using fire for warming up.			✓	
10	Project will establish Nursery and conservation awareness programmed shall be implemented	✓			
11	Restriction of labor force for hunting and trapping			✓	
12	Camp with adequate facilities		✓		
13	Training will be given to workforce and		✓		

	local women's group on STDs and means to counter the potential increase in prostitution in the area.				
15	In peak spawning periods(March/April, June/July, September/October) boulders are not collected from spawning areas		✓		
16	When diesel equipment are repaired on fuelled away from designated area catchments pan or plastic sheet will be installed under the equipment and spilled product will be collected immediately		✓		✓
17	Assessment of Chameliya River water quality variation			✓	
18	Water spray in dust prone area at least thrice a day for four dry months.			✓	
19	Proper disposal of waste material			✓	
21	Availability of construction related safety equipment.		✓		
22	Establishment of fair price shop			✓	
23	Measure recommended to limit the release sediment in the river by project activities will be strictly observed during low flow period.(December to May)			✓	
24	River habit management programme	✓			
25	Compensation for the loss of private plants			✓	
26	Compensation for the land, house and other properties acquisition			✓	
27	Construction of 5 public toilets			✓	
28	Fencing of the construction area and other			✓	

	work facilities				
29	Fencing of the Sri Krishna higher secondary school			✓	
30	Speed limit of vehicles in school area		✓		
31	Good coordination with local people, VDC, NGOs		✓		

CHAPTER-VI
DISCUSSION

6.1 Frequency Analysis

The frequency analysis of hydrological data provides the magnitude of future extreme events with their frequency of occurrence as indicated by probabilities or return period. Flood frequency analysis considers the annual peak flows at a site for all the years. The method of analysis and predicting flood from the data of run of peaks is called frequency analysis. It gives only the magnitude of flood peak of desired recurrence interval or return period, but does not provide information about the complete hydrograph or the flood volume. Gumbel's method is based on probability distribution. It takes into account the actual record of flood in the basin for flood estimation. So it is taken as more reliable than other empirical formulae for flood frequency analysis. Floods of magnitude 445.11,531.17,584.09,620.81,649.11,671.88,736.24,759.01,786.78 and 822.71 m3/s were found to have return period 5,10,15,20,25,30,50,60,75 and 100 years respectively(Table 5.1).The average peak flood for Chameliya River is 317.85 m3/s by analyzing 20 yrs hydrological data. The 5 year flood was found to be slightly greater than average flood. The design flood of 710m^3/s was adopted for the hydroelectric plant. Since the return period of the design flood was not available, Gumbel's distribution function was used to calculate the return period as 50years.

6.2 Water Quality

Water temperature is one of the important factors in aquatic environment as it affects the aquatic life as well as chemical properties of water (ABDO, 2005). The temperature of Chameliya River was found to be with in the range 18.3^{0C} to 18.6^{0C} which implies no thermal pollution. Similar situation was observed by Pandey (2005) in Marshyangdi River. According to Nepal Water Quality Guidelines temperature value should not be allowed to vary from the range of the background average daily water temperature for a specific site and time of day by greater than 2^{o}C for aquatic ecosystem. However temperature of Chameliya river water has fluctuated from its baseline value

pH affects many chemical and biological processes in the water. It precludes many form of life from living in the water. The pH level recorded during the study was ranged from 8.0 to 8.3 which indicate that the river water is slightly basic in nature. PH values at all sites were beyond the specified range of water quality (6.5 - 7.5) as prescribed by WHO guidelines during the study period. According Ellis (1973) pH value ranging from 6.7 to 8.4 is suitable for aquatic life. A change in acidity is caused by certain wastewater discharges in river. Similarly according to Nepal water quality guidelines, pH value should not be allowed to vary from the range of the background pH value for a specific site and time of day by greater than 0.5 for aquatic ecosystem.

Conductivity has been found to be in the range of 286 to 290 µmhos/cm. This high value indicates the presence of high dissolved solids. River supporting good mixed fisheries has ,it's a ranged between 150-500 µmhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macro invertebrates (USEPA, 2003).

The Total Alkalinity of water is mainly caused by the cations of Calcium, Magnesium, Sodium, Potassium, Ammonium and Iron combined either as hydroxides or as carbonates and bicarbonates. Total Alkalinity levels in all sampling sites were found to be with in the range 87 to 113mg/l. The value was within the prescribed level of WHO guidelines i.e. 500mg/l .A desirable range of Total Alkalinity for fish production is between 75-200mg/l (Wurts & Durborow1992), which indicates that Chameliya river water has not been deteriorated for fish production in term of Total Alkalinity. Dhakal (2007) observed the same value within the range 25-70mg/l in Thoppal Khola.

The concentration of Dissolved Oxygen affects the solubility and availability of many nutrients and therefore the productivity of aquatic system (Wetzel, 1983). A low concentration of Dissolved Oxygen indicates organic pollution of the river or stream (Verma and Agrawal, 1986).The DO levels in all sampling sites were found to be at the saturated level, between the ranges of 9.5 to 9.8 mg/l. Pandey (2005) also observed the similar pattern in Marshyangdi River. Dissolved Oxygen level of 5 to 6 mg/l is usually required for normal growth and activities of aquatic life (Field Ecology Lab, 2000). All the values of DO content in water samples recorded were found above the suggested values recommended by Field Ecology Lab and WHO value of 5 mg/l.

Mg- Hardness levels in all sampling sites were found to be with in the range 8.74 to 11.3mg/l.Similarly Ca- Hardness levels in all sampling sites were found to be with in the range 32.5 to 35.2mg/l during the study time.

Phosphorus occurs in the neutral water mostly in the form of phosphates. It promotes growth but excessive level can lead to eutrophication and fish kills and there is reduction in biodiversity. The Orthophosphate levels in all sampling sites of Chameliya River were found to be less than 0.01mg/l. The permissible level for Orthophosphate is 250mg/l (Kudesia 1980).

Iron values varied considerably among all sampling sites and were found to be with in the range 0.01 to 0.03mg/l. However no values were outside the level as prescribed by WHO guidelines i.e.0.3mg/l

BOD is a measure of organic pollution to both waste and surface water. High BOD is an indication of poor water quality. . In the present study BOD_5 varied considerably among all sampling sites and were found to be with in the range 0.36 to 1.8mg/l.Dhakal (2007) also observed the similar result in Thoppa Khola.

The Total Dissolved Solids in water consist of inorganic salts and dissolved materials. In the present study total dissolved solid varied considerably among all sampling sites and were found to be with in the range 182.0 to 189.0mg/l. However no values were outside the level as prescribed by WHO guidelines i.e.1000mg/l but Dhakal (2007) recorded very low value in Thoppal Khola Hydroelectric Project than the present value. According to Nepal Water Quality Guidelines TDS value should not be allowed to vary from the range of the background TDS value for a specific site and time of day by greater than 15%for aquatic ecosystem. From this point of view TDS of Chameliya River water has increased greater than 15% from the baseline value so finding reflect that it is not suitable for aquatic ecosystem

Potassium is micro nutrient element for plant growth. It can occur naturally in minerals and from soils. High levels in surface water, especially in areas where there are agricultural activities as indicative of introduction of K due to application of fertilizers. Potassium levels in all sampling sites were found to be with in the range 0.8 to 1.6mg/l.

The study revealed the presence of high no of Total Coliform and Faecal Coliform in the river water, which therefore indicated poor water quality due to construction activities. Coliform group of bacteria is the principal indicator of suitability of water for domestic, dietetic or other uses (APHA 1998).The no of Total Coliform was found above 210 per 100ml in Powerhouse U/S & D/S sites but Nil in headwork site while the no of *E. coli* was between 3to 7 per 100ml in Powerhouse U/S &D/S sites but Nil in headwork site. So, Chameliya River water is unsuitable for any direct use. Pandey (2005) also observed the similar pattern in Middle Marshyangdi River.

6.2.1 Comparison of Chameliya River water quality to its baseline data

Comparison of Chameliya River water quality with respect to its baseline data reveals that water quality of Chameliya Rive has not been deteriorated to the large extent. Water quality data indicates that there is small increment in pH, Alkalinity and BOD_5 but significant increment in some parameter such as Conductivity, Magnesium, Sodium, and Total Dissolved Solid with base line value (Annex 3). Significant changes in Conductivity may be an indicator that a discharge or some other source of pollution has entered a river. With comparison to the baseline data the D.O., Calcium, Potassium and Orthophosphate are slightly low. The detected count of Total Coliform and *E. coli* were found to be very high. Bhattrai (2009) explained in his study that no serious changes occurred in water quality parameters except phosphate level in both intake and power house site of Ridikhola hydropower project during construction stage which shows the contrasting result in comparison to the CHEP.

6.3 Air Quality

The levels of TSP were found within the range of 497.3 to 840.7 $\mu g/m^3$in all sampling sites which are higher than the NAAQS guideline value 230 $\mu g/m^3$ for 24 hours mean set for the protection of the public health from the ambient exposure in location. The levels of PM_{10} were found within the range of 108.0 to 164.2 $\mu g/m^3$in all sampling sites which are higher than the NAAQS guideline value 120 $\mu g/m^3$ for 24 hours mean except in the Adit-1. In Adit-1 ambient concentration of PM_{10} was found within the recommended level. But according to WHO guideline values ambient concentration of PM_{10} were found beyond the recommended level i.e.50 $\mu g/m^3$ for 24hrs mean in all sampling sites. The increment of air pollution was due to the construction activities and vehicular movement with in the project area. The observation period was totally dry in weather so the dust particles were highly loaded

in the air. The impact on air was generated mainly from activities like blasting, quarrying, and emission from vehicles and construction equipment which generated fugitive dust, particulate matter, Sulpher dioxide and oxides of Nitrogen. The fugitive dust pollution is more acute during the dry season compared to the wet months. The magnitude of impact is considered to be low, extent is site specific and duration is short term.

6.3.1 Variation of Air Quality with respect to the Baseline.

The levels of suspended particulate matters both the TSP and PM_{10} were found to have increased by greater degree than their baseline concentrations. The increment in the TSP was found up to tenfold where as PM_{10} level was also found to have increased up to four folds higher than the baseline value (Annex 4). Compared to the baseline data, the highest degree of increment were observed at powerhouse and Adit-3 sites where as the lowest increment was observed at Adit-1.

6.4 Noise Level

Noise is an integral part of the hydropower construction technology. The operation of batching plant, crushing plant, drilling and blasting work and other construction activities generated noise. The maximum and minimum noise pressure levels of power house, Adit-3, Adit-2, Adit-1 and head work were recorded 59.3, 80.2, 89.7, 66.7 and 104.0 dBA and 38.8, 52.9, 56.1, 54.4 and 67.4 dBA respectively. From the observed data it has been found that the Equivalent Noise Level in the monitoring station were within the acceptable value expect in head works, at head works at the time 9:20 was 85.4 dBA The observed average day time noise pressure level at the monitoring station except at the headwork were within the acceptable range set by WHO (75dBA). The highest level of average daytime Noise Pressure Level recorded was found to be 75.3 dBA at head work and the lowest was found to be 47.2 dBA at power house. The result showed that baseline noise level (50dB) was increased during construction activities and the impact was confined more in dam and power house area, as these were located close to settlements. Timsina (2006) found the noise level of Khudi Hydroelectric Project area to be sufficiently high and quite above tolerable limit. Similarly Noise level was within the permissible limit in Ilam Puwa Khola Hydropower Project Area (Singh, 2003), Modi Khola Hydropower Project Area (Khadka, 2004) and Ridikhola Hydropower Project (Bhattarai, 2009). The

magnitude of impact is considered to be low, extent is site specific and duration is short term

6.5 Vegetation

The clearance of vegetation and the excavation works have resulted in the change of topographical setting as well as the scenic and aesthetic beauty of the nature. From the Table 5.8, Project chopped down 3075 plants of 46 species which were slightly higher than EIA report prediction of CHEP (2006) i.e.1715 number of individual plants. Among all chopped down plant species, number of Daleghas (Karma, Koiralo, Taki, Faledo, Chagilo ,Dudhilo ,etc) Khari *(Celtis austalis)* Khanayu (*Ficus semicordata*) Toni (*Toona ciliate*) Chiuri (*Saurauia napaulensis*) were increased irrationally than EIA Prediction . The number of tree felled would be increased as construction activities had not been completed. Bagale (2007) reported that about 664 trees having volume 219.77m^3 were chopped down during construction stage of Thoppa Khola Hydropower Project which is a lower in number than present finding for CHEP. CHEP project chopped down 1850 plant from private land and 1225 plant from government forest. It was found that impact was high in reservoir, burrows area and power house area which are similar to the finding of Pandey (2001). The major protected species chopped down by the project were *Acacia catechu* (57), *Bombax ceiba* (150) and *Shorea robusta* (70). The magnitude of impact is considered to be moderate, extent is site specific and duration is long term. According to EIA report of project in order to offset the environmental impact due to acquisition of forest land, compensatory afforestation was planned and 43000 Sapling would be planted by project.

6.6 Wildlife

As per questionnaire survey showed that the faunal bio-diversity has decreased with the construction activities of tunnel, clearance of forest and burial of vegetation. The habitat of wild animals like porcupine (*Hystrix indica)*, squirrel (*Ratufa Sps*) and fox (*Vulpes benghalensis*) was disturbed by construction activities. So Monkeys, Leopard (*Panthera paradus*), Jackal (*Canis aerus*), Porcupine (*Hystrix indica)*, squirrel (*Ratufa Sps*) and fox (*Vulpes benghalensis*) could not easily be seen, since they had migrated to the upper region. The movement of monkey is substantially reduced due to project activities. But migrating activities was lower in Rudreshwor, Kotpetra VDC of Baitadi district than Sikhar and Seri VDC of Darchula district because the

entire project component lies in the Darchula district. The finding of EIA report of CHEP (2006) showed that the project would obstruct the movement of wildlife by dissecting the habitat which is similar to the finding of the present study. Nepal (2003) found that Teesta hydropower project construction had destroyed wildlife habitat and no of birds and wildlife was reported to be declining. They were found to abandon their original place for secure habitat and fulfillment of their needs and similar pattern has been observed in the present study. Wildlife hunting and poaching by the construction workers were not reported.

6.7 Fish

6.7.1 Bio-physical aspect

a) At Ghategad khola and Chameliya river confluence

Compositions of fish species in Chameliya River and Ghatgad khola confluence were found to be 27%, 45%, 14%, 9%, and 5% for Mahseer (*Tor putitora* & *T.tor*) , Snow trout (*Schizothorax plagiostomus* and *S.progastus*), Torrent catfish (*Pseudecheneis sulcatus*), Sucker head (*Gurra gotyla*), and rock carp respectively which are shown in Fig 5.18. However fish compositions during EIA study were found to be 45%, 35%, 10%, 8%, 2% and for Mahseer, Snow trout, rock carp, torrent catfish, &stone loach respectively which is shown in Annex 9 It is observed that percentage of abundance was slightly reduced in Mahseer species i.e. golden sahar (*Tor putitora*), Chuche sahar (*Tor tor*) but stone loach species were not recorded during study period.

(b) At Chameliya river and Karkale section

Compositions of fish species in Chameliya River and Karkale section confluence were found to be 29%, 46%, 10%, 8%, 2% and 5% for Masheer (*Tor putitora & T.tor*), Snowtrout (*Schizothorax plagiostomus* & *S.progastus*), Torrent catfish (*Pseudecheneis sulcatus*), Sucker head (*Gurra gotyla*), Sidra (*Puntius chillinoides*) and rock carp respectively which are shown in Fig 5.19. Principal group of fish compositions during EIA study were recorded to be 63%, 25%, 5%, 3%, 2% and 2% for Golden Mahseer (*Tor putitora*), Copper mahseer (*Acrossocheilus hexagonolepis*), rock carp, cat fish, Jalkapoor, Eel &stone loach respectively(Annex 9). It is observed that percentage of abundance was slightly reduced for Masheer, rock carp species but Jalkapoor, eel &stone loach were not recorded during study period. It may be due to

that Mahseer are long ranged migratory species and might be migrated due to habitat destruction. Similarly Karkale section near powerhouse site was favorable spawning place for Mahseer species but it was disturbed by project construction activities. Eel &stone loach are incedently found in Chameliya River so these were not recorded during sampling period

Compared to the EIA study, reduction in the over all abundance of fish fauna in Chameliya River clearly indicates the impact of CHEP on fish diversity. The fish fauna recorded in the study area like *Acrossochelius hexagonolepis,Tor puttitora, Schizothorax plagiostomus, S. progastus* and *S. richardsonii* are coded as vulnerable and *Tor tor* is coded as Endangered in National Red Data Book (Shrestha, 1995). The habitat of fish is disturbed by boulder collection, spoil disposal at riverbank side, directly mixing of water in river from batching & crushing plant. These have increased water turbidity and suspended solids and changes in flow regime. Habitat destruction and some kind of disturbance in river have caused reduction in the abundance of fish fauna. The fish destructions visibly seen were local fish harvest by traditional means of fish catch or unseen means like illegal use of electrical appliances or poisoning. Questionnaire survey with local fisher men revealed that impact on fish have been more confined in power house and dam sites than other sites. During the construction period diversity of fish species were not affected in the project riverside in Modikhola hydropower project (Khadka, 2004).Similarly fish population was reduced to half of its total population in Khudi hydropower project (Timsina, 2006).

6.7.2 Socio-economic aspect

20 out of 35 surveyed were fisher man and other was involved in farming and fishing activities. Figure 5.20 shows that most favored method of fishing in Chameliya River was cast net; and the other methods such as hook and line, Paso were also in used occasionally. Use of poisons and blasting in killing fish are also used frequently. The study revealed that the use of Paso is favored now days because it is very effective in catching fish which reside in crevices.

The survey showed that the maximum number of fish caught was Asala. Apart from that, Sahar (*Tor. sps*.), Katle (*Acrossocheilus hexagonolepis*), Sidra (*Puntius sps*) and Carp (*Schizothorax sps.*) were also frequently caught. Asala was the most favorite fish for most of the respondent because of its taste and availability. 47% of the

respondents sell the fish in the local market. But the earning was not enough for their livelihood .Thirty six percent of the fishermen spend 4hrs, on average, in a day, only on fishing. Out of the 35 respondents surveyed 52.4% believed that the project would have positive impacts by providing electricity after its completion where as 47.6% consider its negative impact in terms of loss of fish species in river due to construction activities which degrade water quality and reduce water flow hence affecting the livelihood of the fisherman.

6.8 Socioeconomic and Cultural Environment

6.8.1 Acquisition of Land

The project acquired 24.5 ha of private land at different localities for the placement of project structures and facilities. This area excludes land acquired for the project access road. The EIA estimate that 18.09 ha of private land will be affected by the project but the actual acquisition is higher than the EIA estimate. Out of the total private land acquired for the project 99.16% was from Sikhar VDC and 0.84% from Seri VDC (Annex 5). Like wise in EIA it was estimated that 34.74 ha of public land will be affected by the project. The available data shows that actual acquisition of public land is far below the EIA estimate. Out of the total government land acquired for the project barren land (37.27%) forest (23.06%), shrub and grass (12.33%), plantation area (12.06%) were highly affected (Annex 6).

6.8.2 House Acquisition

The EIA estimated that 41 houses will be acquired due to implementation of the project which included 36 slate roofs and 5 thatches. EIA report also estimated acquisition of 8 cowsheds for the placement of project structures and facilities. According to house acquisition data provided by the project 19 houses, 5 cow sheds, 4 toilets and 9 compound walls were acquired by the project (Annex 7).

6.8.3 Local Economy

About 30 new houses have been constructed in powerhouse area to run the small business such as hotel, kirana, cosmetic, cloth, tailoring, fruit and vegetable shop, stationery and barber shop. Like wise about 15 shops and 11 shops were increased at Ganna and Bitule area. Kirana and hotel business have been mostly developed in

these areas to serve the project workers. Almost all of the business men were local and project affiliated families. Local people started to sell their commodities such as milk, vegetable, fruits dairy products and livestock products. Building rented for office and residential purpose were the other sources of income of local people.

6.8.4 Social and Cultural Practices

Due to interaction of different people social and cultural practices of the area have improved. People were more enthusiastic for work. There has been an increase of awareness on education, health and sanitation, farming and business. Young generations are more attracted to wards education due to available employment opportunity at their door. Like wise their day to day life style has been changed towards modernization.

Besides majority of positive impacts, some adverse impacts were also observed. Social conflicts within the family have been increase due to practice of drinking and modernization.

At Khali Bagad area crimination place of dalit and other caste has been disturbance due to the spoil disposal. Local people are facing problem for the funeral ceremony which causes adverse impact to local social and cultural practice.

6.9 Implementation mitigation measures

Although environmental considerations were internalized in the project cycle right at the planning stage, implementation during construction of the project was not satisfactory. Mitigation measures like river habit management programme, compensatory plantation, bioengineering work, Non Timber Forest Product and agro forestry training programme and water quality protection measures such as provision of settling tanks, water treatment plant, brim as prescribed by EIA report were found in pre-mature stage during study period. Compensation for land, house, plant, fodder and physical structure, environmental and social awareness programme, community support programme were found to be complied by project. Occupational safety, and other mitigation measures are partially complied but implementations of these were seen not effective. Khadka (2004) and Timsina (2006) also observed the similar pattern in Modikhola hydropower and Khudi hydropower project respectively.

CHAPTER VII

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Environmental assessment during construction period of Chameliya Hydroelectric Project was based on field survey and review of secondary information. The Chameliya Hydroelectric Project was conceived as one of the attractive project among peaking run of-river type of scheme in the Far Western Development Region of Nepal. Floods of magnitude 445.11,531.17,584.09,620.81,649.11,671.88,736.24,759.01,786.78 and 822.71 m3/s were found to have return period 5,10,15,20,25,30,50,60,75 and 100 years respectively for Chameliya River. The average peak flood for Chameliya River is found to be 317.85m3/s by analyzing 20 yrs data from 1987 to 2006.The design flood of 710m^3/s was adopted for the hydroelectric plant and the corresponding return period was not available. Using Gumbels distribution function 50years return period was calculated for the design flood.

Water quality data indicates that the major chemical constituents of surface waters are of normal in characteristics and found to be least affected by the project activities. Adverse impact due to the load of waste discharged by the project especially from crushing and batching plant is very feeble and negligible to the river system in comparison with the flow volume of Chameliya River. Therefore the water quality was found to be insignificant to cause any detrimental harm in the river system.

The result showed that there is small increment in pH, Alkalinity and BOD_5 but significant increment in some parameters such as Total Coli form, Conductivity, Magnesium, Sodium, and Total Dissolved Solid with base line value.

The value of TSP and PM_{10} was found higher than the NAAQS guideline value 230 µg/m^3 for 24 hours mean. The increment in the TSP was found up to tenfold where as PM_{10} level was found increased up to four folds higher than the baseline value.

The study revealed that the average day time noise pressure levels at the monitoring station except at the headwork were within the acceptable range set by WHO (75dBA).

Prediction of EIA report is found reverse in tree felling because Project felled 3075 plants of 46 species which were higher than EIA report of CHEP i.e.1715 no of individual plants .During the project construction, the acquisition of Land and houses were also found to be more than EIA prediction.

Temporary diversion of river to facilitate construction activities has reduced flow and deteriorated water quality and these have adverse impacts on both fish diversity and local fishing communities. It was found that there is reduction in the over all abundance of fish fauna than the number stated in the EIA report. Asala is being mostly exploited, among other fish species. The study also revealed that the Cast net is mostly used by fisherman in catching fish. During the field study it was observed that the project obstruct the movement of wildlife like monkey, leopard, jackal and porcupine by dissecting the habitat The Social and cultural practices were being improved in the project area due to interaction of different people. The project acquired 24.5 ha of private land at different localities for the placement of project structures and facilities. Out of the total private land acquired for the project 99.16% was from Sikhar VDC and 0.84% from Seri VDC Implementation of mitigation measure was seen not satisfactory. Mitigation measures like river habit management programme, compensatory plantation, bioengineering work and water quality protection measures such as provision of settling tanks, water treatment plant, brim as prescribed by EIA report were found in pre-mature stage but if it would be not complied, it might deteriorate river ecology.

6.2 Recommendations

- Nominal water treatment will be required for drinking purpose
- Ensure that the recommended mitigation methods suggested in the EMP of CHEP are effectively implemented and followed
- Persuasion and awareness is more effective a tool enforcing implementation of environmental safeguards rather taking resource to legal action.

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ANNEX

Annex 1-Questionnaires for Wild Animal Study

Identification of interviewed

Name:

Sex: Male ( ) Female ( ) VDC:

Age: Ward No:

Occupation Location:

1) Is here any wildlife/wild animal in the forest around the project area? If yes please list them.

a) b) c) d)

e) f) g) h)

i) j) k) l)

2) Have you seen any of them? If yes when and which species?

a) One month ago b) One year ago c) More than a year ago

1) 2) 3) 4)

5) 6) 7) 8)

9) 10) 11) 12)

3) Which wild animal are more common in this area?

4) After the CHEP started its construction activities, have you seen them?

A) Yes B) No

5) After the CHEP started its construction activities, have you here about any villagers have seen them?

A) Yes B) No

6) In your opinion do the project construction activities affect activities of wild animal? If yes, how does affects occurs, give reason.

Annex 2-Questionnaires for Fish Study

Name of Questionnaires Administrator:-

Name of Respondent:-

Name of village:-

1) What species of fish are available in Chameliya River?

a)

b)

c)

d)

2) What species fish are being mostly exploited in this River?

a)

b)

c)

d)

3) How do you consume fishes that you have captured?

Domestic:

Market

4) If you sell in the market

Where you sell?

What is the price/kg

How much you sell/year

5) In which section of the river do you usually fish catch?

6) What is happening today's in River than previous days either number of fish is increased----------or decreased----------

If increased, main cause----------

If decreased, main cause----------

7) How many process are used to capture fish in this river?

a)

b)

c)

8) Which process is more used to capture fishes?

9) How much time is spent to capture fishes in a day?

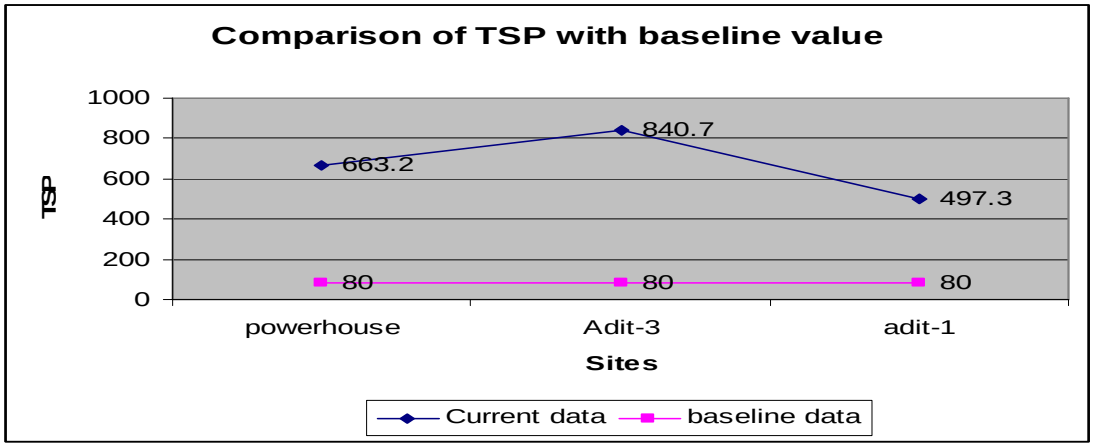
10) What happens when water of Chameliya is used for Hydropower generation? Give your opinion.

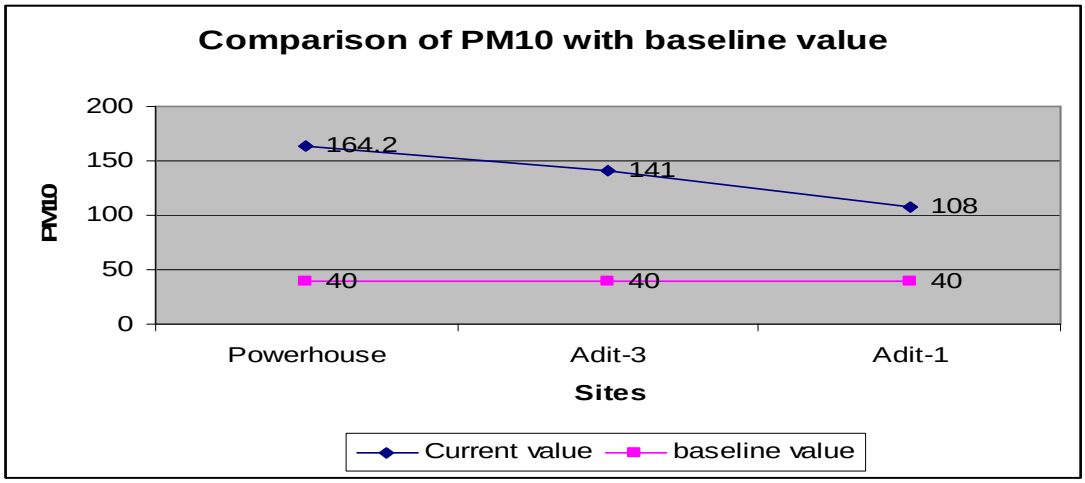
Annex 3-Comparison of physico-chemical parameters of river water with baseline value.

SN	Parameters	Analytical data			Baseline data of Chameliya River*
		Powerhouse(U/S)	Powerhouse(D/S)	Headwork(U/S)	
1	Temperature	17.3	18.9	18.5	25.5^{0C}
2	P^H	8.0	8.0	8.3	7.5
3	Dissolved oxygen mg/l	9.5	9.2	9.3	11.8
4	Biochemical oxygen demand BOD mg/l	0.36	1.8	1.1	0.18
5	Specific conductance(mhos)	286.0	287.0	290.0	138
6	Total alkalinity as $CaCo_3$	87	92.0	113.0	75.2
7	Calcium mg/l	32.8	32.5	35.2	85
8	Magnesium mg/l	11.6	11.6	8.74	1.0
9	Potassium mg/l	1.2	1.6	0.8	1.8
10	Sodium mg/l	4.2	6.1	3.8	1.3
11	Iron	0.02	0.03	0.01	0.12
12	Orthophosphate mg/l	<0.01	<0.01	<0.01	0.5
13	Total dissolved solid mg/l	184.0	182.0	189.0	85
14	Total suspended solid mg/l	<1.0	<1.0	<1.0	0.4
15	Total coli form(MPN Index/100ml)	210	460	Nil	-
16	E. Coli(MPN Index/100ml)	7	3	Nil	-

***-Baseline data from EIA Report, 2006**

Annex 4-Comparison of Air Quality with baseline value.





Annex 5-VDC Wise Land Acquired for the Project

S.No.	Name of VDC	Acquired land (ha)	Percentage
1	Sikhar	24.32	99.16
2	Seri	0.18	0.84
	Total	24.5	100.00

Source; Project records, August 2009

Annex 6- Public land Acquired by the Project

S.No.	Land Use	VDCs	Ward	Area (ha)	%
1	Trail/road	Shikhar	4	0.64	3.43
2	Forest	Latinath and Shikhar	9 and 1	4.30	23.06
3	Shrub and grass land	Seri	3 & 4	2.30	12.33
	do	Shikhar	4	0.66	3.54

4	River and Streams	Shikhar	4 and 5	0.41	2.20
5	Barren land	Shikhar	4	6.95	37.27
6	School land	Shikhar	4	0.13	0.70
7	Plantation area	Shikhar	4	2.25	12.06
8	Pasture land	Shikhar	1	0.96	5.15
9	VDC land	Shikhar	1 and 4	0.05	0.27
	Total			18.65	100.00

Source; Project records 2008

Annex7: List of the Household Affected by the House and Toilet Acquisition

S.No.	Name of Affected Households	Address	No of House Acquired	No. of Cowshed Acquired	No. of Toilet Acquired	Compound Wall	**Others**
1	Dhanbir Lohar	Shikhar -1	1			1	1
2	Innare Khadayat	Shikhar -4	1			1	
3	Yaduraj Khadayat	Shikhar -4	3	1	1	1	
4	Dalbahadur Khadayat	Shikhar -4	3	1	1	1	1
5	Udavraj Khadayat	Shikhar -4	2	1	1	-	-
6	Harikrishna Khadayat	Shikhar -4	1			1	
7	Mannam Khadayat	Shikhar -4	1	1		1	
8	Harinandan Khadayat	Shikhar -4	1			1	
9	Karadi Khadayat and sons	Shikhar -4	3	1	1	1	
10	Krishna Bahadur Khadyat	Shikhar -4	1			1	1
11	Kashi Khadayat	Shikhar -4	1				
12	Madhab Khayat	Shikhar -4	1				
13	Harihar Khayat	Shikhar -4	1				
	Total		19	5	4	9	3

Annex 8-Analytical data of Noise Levels at Different Sites

Location-Power house			Date:-20 March 2009	
Parameters Noise Levels in dBA	Time			
	8:05	10:05	14:45	16:10
Leq	45.8	51.4	48.3	43.4
L_5	49.8	50.2	51.1	46.9
L_{10}	49.6	49.8	50.2	45.6
L_{50}	46.9	48.5	48.6	43.0
L_{90}	41.8	42.1	46.3	41.3
L_{95}	41.2	41.8	46.2	40.9
L_{max}	50.0	51.4	59.3	52.4
L_{min}	39.5	41.2	46.0	38.8
L_{avg}	45.8	40.4	48.3	43.4
L_d	47.2			

Location-Adit-3	Date:- 21 March 2009			
Parameters Noise Levels in dBA	Time			
	8:45	12:30	15:30	17:10
Leq	56.5	61.7	60.0	62.5
L_5	61.7	77.0	76.0	73.0
L_{10}	60.4	76.1	74.1	70.1
L_{50}	56.1	73.2	63.0	57.0
L_{90}	53.8	61.0	54.5	53.8
L_{95}	53.5	60.6	54.1	53.5
L_{max}	62.3	80.2	78.0	80.2
L_{min}	53.0	60.1	53.4	52.9
L_{avg}	56.5	70.4	63.6	59.1
L_d	60.2			

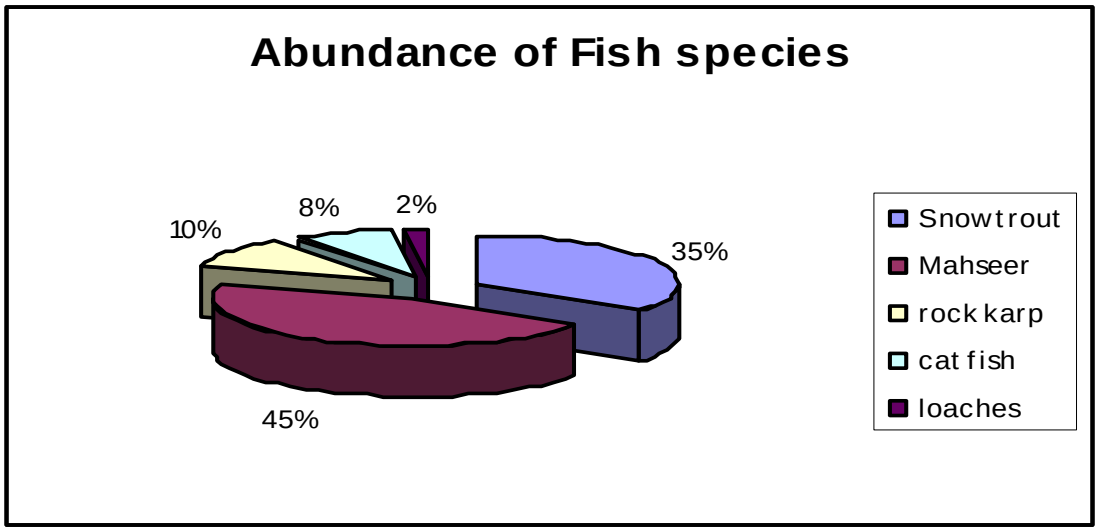
Location-Adit-2	Date:- 22 March 2009			
Parameters Noise Levels in dBA	Time			
	8:05	11:35	13:45	15:10
Leq	63.0	72.0	66.4	64.6
L_5	68.1	60.0	68.1	66.6
L_{10}	68.1	59.9	68.0	65.8
L_{50}	63.7	59.1	68.0	64.5
L_{90}	57.8	57.4	66.2	62.8
L_{95}	57.4	57.1	65.3	62.3
L_{max}	71.0	89.7	64.4	76.0
L_{min}	57.3	56.1	61.2	61.4
L_{avg}	63	59.1	66.4	64.6
L_d	66.5			

Location-Adit-1 Date:- 23 March 2009				
Parameters Noise Levels in dBA	Time			
	8:05	10:05	13:35	16:40
Leq	60.1	60.3	60.1	60.1
L_5	61.4	61.6	62.8	62.5
L_{10}	60.7	61.2	62.1	61.9
L_{50}	59.9	60.2	59.7	59.7
L_{90}	59.4	59.6	59.0	59.0
L_{95}	59.4	59.4	58.2	58.9
L_{max}	64.5	64.2	66.7	64.2
L_{min}	59.2	59.2	54.4	57.7
L_{avg}	60.0	60.3	60.1	60.1
L_d	60.1			

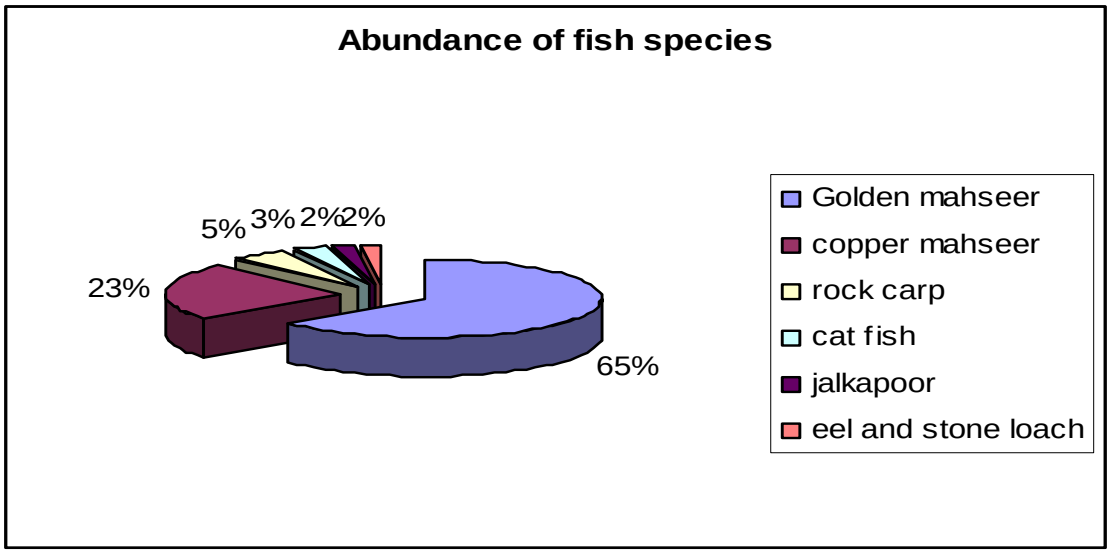
Location-Headwork Date:- 24 March 2009				
Parameters Noise Levels in dBA	Time			
	9:25	11:05	14:45	15:50
Leq	85.4	71.3	74.6	69.8
L_5	79.9	78.5	79.9	70.9
L_{10}	75.7	74.9	76.6	70.7
L_{50}	70.4	70.7	70.1	69.8
L_{90}	69.7	68.8	69.5	69
L_{95}	69.6	68.7	69.5	68.8
L_{max}	104.0	85.8	93.2	71.7
L_{min}	69.4	67.4	69.4	67.4
L_{avg}	71.8	71.3	71.8	69.8
L_d	75.3			

Annex 9-Abundance of Fish species in EIA study period

- **In Ghategad khola and Chameliya river confluence**



- **In Chameliya River & Karkale section**



Annex 10 –Checklist for Proposed Mitigation Measures

S.N	Proposed Mitigation Measures	Compliance status			
		Premature	Partially complied	Complied	Not complied
1	Slope protection structure such as revetment wall ,retaining wall, benches or terraces riprap and spur shall be build at appropriate location in order to retain unstable soil masses				
2	Compensatory plantation				
3	Water quality protection measures such as provision of settling tanks, Water treatment plant, brim, lining of storage area				
4	Provision of noise suppression system, earmuffs or plugs, use of limited detonator in small lots				
5	Spoil materials will be reused as much as possible onsite for road maintenance and site labeling and all remaining spoil material will be deposited in designated area				
6	Contractor will provide a sufficient number of closable solid waste bins at each workforce camps and all work areas				
7	Hazardous waste will be stored in designated enclosed and covered areas on impermeable surfaces such as clays, asphalt or concrete with adequate containment capacity				
9	Contractor will provide stove and kerosene to outside workforce at subsidized rates to match local price of fuel wood and warm blanket will be provided to people living in work force camps during cold months to discourage them from using fire for warming up.				
10	Project will establish Nursery and conservation awareness programmed shall be implemented				
11	Restriction of labor force for hunting and trapping				

12	Camp with adequate facilities				
13	Training will be given to workforce and local women's group on STDs and means to counter the potential increase in prostitution in the area.				
15	In peak spawning periods(March/April, June/July, September/October) boulders are not collected from spawning areas				
16	When diesel equipment are repaired on fuelled away from designated area catchments pan or plastic sheet will be installed under the equipment and spilled product will be collected immediately				
17	Assessment of Chameliya River water quality variation				
18	Water spray in dust prone area at least thrice a day for four dry months.				
19	Proper disposal of waste material				
21	Availability of construction related safety equipment.				
22	Establishment of fair price shop				
23	Measure recommended to limit the release sediment in the river by project activities will be strictly observed during low flow period.(December to May)				
24	River habit management programme				
25	Compensation for the loss of private plants				
26	Compensation for the land, house and other properties acquisition				
27	Construction of 5 public toilets				
28	Fencing of the construction area and other work facilities				
29	Fencing of the Sri Krishna higher secondary school				
30	Speed limit of vehicles in school area				
31	Good coordination with local people, VDC, NGOs				

Annex11: MPN Chart for Calculation of MPN/100ml for various Combination of Positive Result When Five Tubes Each of 10, 1 and 0.1ml Sample Fractions are used (After Trivedi and Goel 1984)

Combination	MPN/100 ml	Combination	MPN/100 ml
0-0-0	<2	4-3-0	27
0-0-1	2	4-3-1	33
0-1-0	2	4-4-0	34
0-2-0	4	5-0-0	23
1-0-0	2	5-0-1	31
1-0-1	4	5-0-2	43
1-1-0	4	5-1-0	33
1-1-1	6	5-1-1	46
1-2-0	6	5-1-2	63
2-0-0	5	5-2-0	49
2-0-1	7	5-2-1	70
2-1-0	7	5-2-2	94
2-1-1	9	5-3-0	79
2-2-0	9	5-3-1	110
2-3-0	12	5-3-2	140
3-0-0	8	5-3-3	180
3-0-1	11	5-4-0	130
3-1-0	11	5-4-1	170
3-1-1	14	5-4-2	220
3-2-0	14	5-4-3	280
3-2-1	17	5-4-4	350
4-0-0	13	5-5-0	240
4-0-1	17	5-5-1	350
4-1-0	17	5-5-2	540
4-1-1	21	5-5-3	920
4-1-2	26	5-5-4	1600
4-2-0	22	5-5-5	≥2400
4-2-1	26		

Annex-12Flood Frequency Analysis of Chameliya River from Recorded data

Year	Peak disch.(X)	Order	Rank	Return period($T = \frac{N+1}{m}$)yrs	X^2
1987	248	643	1	21	413449
1988	212	507	2	11.5	257049
1989	206	478	3	7	228484
1990	242	417	4	5.25	173889
1991	173	408	5	4.2	166464
1992	157	403	6	3.5	162409
1993	172	360	7	3	129600
1994	210	347	8	2.62	120409
1995	194	338	-	-	114244
1996	417	338	10	2.1	114244
1997	501	310	11	1.9	96100
1998	403	248	12	1.75	61504
1999	478	242	13	1.61	58564
2000	643	212	14	1.5	44944
2001	408	210	15	1.4	44100
2002	310	206	16	1.31	42436
2003	347	194	17	1.23	37636
2004	338	173	18	1.16	29929
2005	338	172	19	1.10	29584
2006	360	157	20	1.05	24649

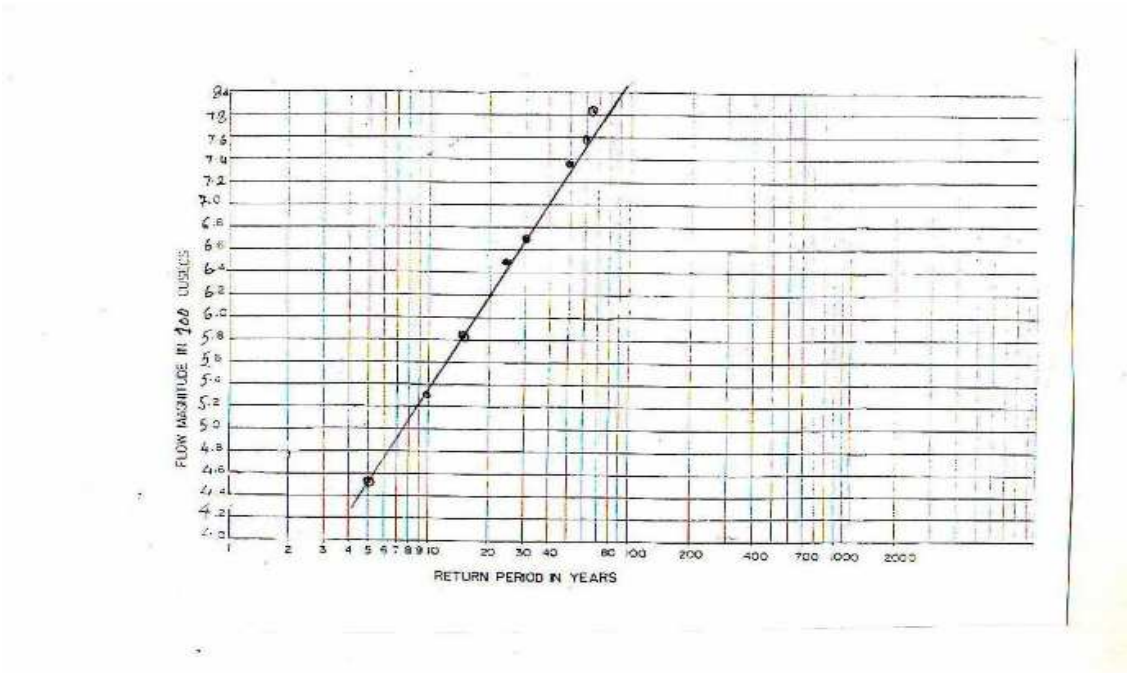
Source: DHM2010 and self computation

Annex-13 Frequency factor for Gumbel's Method

Sample size=20

Frequency(T) in years	**Value of K**
5	0.919
10	1.625
15	2.023
20	2.302
25	2.517
30	2.690
50	3.179
60	3.352
75	3.563
100	3.836

Annex 14 Flood frequency curve by Gumbel's method



Annex 15: Photo Plates

Asala caught in sampling period

Proposed Powerhouse site

Batching Plant near Chameliya River bank

Proposed dam site

Work Adit-2

Changed flow regime of River

Work force working inside tunnel

Adit-2

Spoil disposal at Chameliya Riverbank

L

Labor force working inside the tunnel

Spoil disposal at cultivated land

Power house