Nepal Case Study on

Environmental Impact Assessment of

MIDDLE-MARSYANGDI HYDRO-ELECTRIC PROJECT

1.0 Introduction

1.1 The Project

The Middle Marsyangdi Hydro Electric Project (MMHEP) proposed for development by Nepal Electricity Authority (NEA) has a capacity of 70 MW and it generates annual average energy of 380 GWH with annual peak energy of 114 GWH. It is designed to meet the energy demand of the year 2004 by utilizing the available Marsyangdi River flow and head without serious implications to the environment.

1.2 Location

The MMHEP is located on the Marsyangdi River in Lamjung District of the Western Development Region of Nepal. The project site is accessed by Dumre–Besisahar single lane black-topped Feeder Road which connects district headquarters of Lamjung "Besisahar". The project site can be approached from Dumre situated at 130 km west from Kathmandu and 70 km east from Pokhara on Kathmandu-Pokhara National Highway (Prithibi Rajmarga). The Project site extends more than 10 km and is situated by the side of Dumre-Besisahar road at about 33 km north-east from Dumre Bazar.

1.3 Salient Features of the Project

This is a run-off-river project with 5 hours peaking facility. The main project components of MMHEP are:

- **Dam:** At Phalia Sangu in Lamjung District, a 55 m high, 74 m (in the central section), gravity concrete dam with a crest length of 85 m will be constructed across Marsyangdi River.
- **Spillway:** So as to release the probable maximum floods of 4,270 m^3/s (design flood, 10,000 years return period) a Spillway will be constructed. Three radial type spillway gates of 10 m x 20 m will also be constructed.
- **Reservoir:** A reservoir with a surface area of about 36.3 ha will be created by the damming of Marsyangdi river at Phalia Sanghu. The live storage volume of the reservoir is estimated to be 1.65 million m^3.
- **River Diversion:** Two cofferdams made of earth & rocks will be constructed one each at upstream and downstream capable of releasing 415 m^3/s (20 years return period, dry season flood). A 420 m long concrete-lined diversion tunnel having its cross sectional area of 47 m^2 will also be constructed.

- **Desanding Basin:** Three of underground desanding basins will be constructed with vertical flushing facility. The flushing operation will have removal efficiency of 95% of particle size 0.2 mm.
- **Headrace Tunnel:** The designed length of headrace tunnel is estimated to be 5,325 m. The excavated diameter of the tunnel section will be 6.0 m with a lined diameter of 5.4 m. Two adits with a length of 320 m and 570 m will also be constructed.
- **Surge Tank:** One concrete-lined circular surge tank will be constructed. The diameter of the tank will be 20 m with an orifice 2.90 m in diameter and 51 m in height.
- **Penstock:** One steel penstock pipe of 385 m length will be laid on concrete base on cut and cover section from surge tank to the powerhouse.
- **Power House:** In an open excavated pit of about 25 m deep, a powerhouse having respective length, breadth, and height of 85 m, 36 m, 36 m will be constructed. The powerhouse will have two 35 MW turbines, transformers and switchyard, including facilities for administrative works. A 35 m long tailrace tunnel will also be constructed.
- **Access Road:** Access road of 3 km length will be constructed from the Dumre Besisahar road including 450 m long temporary access roads required for project construction.
- **Project Office:** A permanent project office and work area will be established in Phedikuna, Bhote Odar. The workers' camps will be established at Udipur.
- **Other Ancillary Sites:** Quarry site will be established at Amile Khola area, Udipur and Spoil disposal facility will be made at Jyamire Khola, Udipur Odar and Tallo Baluwa.

1.4 Project Constructions and Operation

Construction of the project has started in 25 June 2001. Initially, it was expected to be completed by 2005 but now due to security reason it is expected to be completed by 2007.

This project requires a total of about 78 ha of land, about 64 ha will be occupied permanently by the project structures and facilities and remaining 14 ha will be acquired temporarily for the project construction period. Of the total permanent land, about 30 ha of the land is the reverine area including riverbed and river flood plains.

At the peak construction period, nearly 1,500 staff is expected to be involved. About 900 workers including technical and non-technical personnel shall be involved on the daily basis during project construction period. Nearly 60 to 100 construction vehicles will be employed during the construction period and support light vehicles are expected to be 50 in numbers.

A total sum of US$ 173 million is estimated for the construction of the project.

2.0 NATURE AND SCOPE OF ISSUES

2.1 Major Issues

The major environmental issues identified are as follows:

- Land use, land form, drainage changes, soil erosion, sedimentation, and land instability arising from the construction as well as during operation and maintenance phase.
- Surface hydrology, change in groundwater hydrology as the consequence of tunneling and excavation works.
- Degradation of air & water quality, raise in levels of noise during constructional and operation phase.
- Loss of terrestrial vegetation, wildlife and habitats during constructional and operational phases of the project.
- Loss of fish diversity, micro-aquatic flora & fauna and their habitats due to water diversion, barrier effects and increased fishing activities.
- Land and or property acquisition and its implication on the people's livelihood.
- Impacts on the social structure, social amenities, community resources, community property/services/infrastructure facilities/local cultural resources, traditions, norms and values.
- Impacts on the health and sanitation of the local community due to increase in vectors disease and exposure to outside workforce, degradation of air quality, water quality, noise levels and solid waste.
- Displacement of the people and implication to the displace and host communities due to resettlement and rehabilitation programs.
- Boom town development during construction phase and withdrawal of economic activities after the phase.
- Occupational health & safety to the project staff and probable natural hazards to both the staff and local communities.

2.2 Key Players:

HMG of Nepal and NEA, a government of Nepal owned utility decided to construct a 70 MW Project in Marsyangdi River. The project was financed by the German Government through KFW, HMG/N and NEA. Detailed design and supervision of this project is being done by Fichtner JV.

3.0 Process and Procedural Context:

3.1 Present Policies and Environmental Legislations:

By law, EIA has been made mandatory for the hydropower projects having capacity of more than 5 MW. For the projects from 1 MW to 5 MW, IEE is sufficient, provided that it does not exert significant impacts in terms of magnitude, extent, and duration on the physical, biological, social, economic, and cultural environment.

Some of the existing environmental policies and legislations which are related to EIA/IEE are briefly mentioned here:

- The Constitution of Nepal, 2047 (1990)
- The National Conservation Strategy for Nepal (1988)
- Eighth Five Year Plan (1992 - 1997)
- Ninth Five Year Plan (1998 - 2002)
- National Environmental Impact Assessment Guideline, 2050 (1993)
- Water Resources Sector Guidelines for Power and Irrigation, 2051/1994 (Draft)
- National Environmental Policy and Action Plan (NEPAP) (2050/1993)
- Industrial Enterprise Act, 2049 (1992)
- Land Acquisition Act, 2034 (1977) and first amendment 2049 (1992)
- Labour Act, 2048 (1991)
- Water Resources Act, 2049 (1992)
- Electricity Act, 2049 (1992).
- Local Self Governance Act, 2055 (1999)

3.2 Relevant Institutions

The following institutions are directly related to the administration of the EIA study of the MMHEP.

- The Ministry of Water Resources (MoWR)
- Ministry of Population and Environment (MoPE)
- Department of Electricity Development (DoED)
- Nepal Electricity Authority (NEA)

All the EIA/IEE studies and other environmental concerns are taken into consideration by Environmental Division of NEA. In case of MMHEP a separate office named as "Resettlement and Rehabilitation Unit (RERU)" has been suggested to be established which can emphasize on compliance monitoring of the action plans formulated in the Environmental Management Action Plan (EMAP). This unit will also make a good coordination between all the direct and indirect stakeholders for the effective and efficient implementation of the mitigation/enhancement measures suggested by EIA.

3.3 The Process

The legislative framework has given authority to the line ministries to approve IEE reports, whereas in case of EIA, the MOPE is authorized. Similarly, the line ministry (MOWR) is responsible for monitoring whereas MOPE is responsible for auditing. It is mandatory to conduct IEE/EIA for development projects depending upon size and significance of impacts of the project. Normally, it takes 15 to 24 months to conduct EIA study and get approval from the MOPE.

4.0 Approach of Study

4.1 Environmental Impact Assessment

4.1.1 The Impacts

MMHEP is a medium-sized hydropower project so it is inevitable to exert environmental impacts. The purpose of EIA is to identify the impacts, and mitigate negative impacts as much as possible. If it is not possible to mitigate all impacts, they should be minimized up to a tolerable limit. The first and foremost job of EIA is to identify impacts. The major adverse impacts of the project arise from the constructional activities and during the operation phase, the potential impact goes to the aquatic life and habitats.

It is estimated that the project will bring permanent land-use changes in 64.176 ha of land of which 31.28% is agricultural land. Riverine Zone including flood plain comprises 46.48% and the remaining consists of grassland and shrub land areas.

It is estimated that 3,475 numbers of trees will be cut down during construction from the occupied agricultural, grass land and shrub land areas which include fruit trees as well as timer and fodder trees. Except for the few trees of Champ and Simal, rests are not legally protected tree species. Maximum number of trees that require felling is from the riverine areas of reservoir site.

It is estimated that 306 households will be affected by the project due to permanent and temporary land and property acquisition. Out of the total 68 households will be affected by temporary acquisition and 238 households by the permanent acquisition. Of the 238 households 122 households will be affected seriously whereas 116 will be impacted marginally. Of the 122 seriously project-affected households, 49 families will need relocation because of the acquisition of their residential premises or business establishments.

Including one temple and one post office, 67 houses will be acquired. One temple, one post office, one suspension bridge, few electricity transmission poles and some irrigation canals may need relocation.

Water diversion by the dam (55 m height) at Phalia Sangu is envisaged to bring substantial physical changes in the river hydrology and riverbed morphology in the operational phase. Nearly 3.2 km stretch of the river above dam will be converted into a reservoir and will be the site for main sediment receptor. Regular changes in the reservoir levels are potential to bring land instabilities in the reservoir offshore. Considering the volume of the water in the reservoir, probability of reservoir-induced seismicity is negligible.

Diversion of water for hydropower generation will have serious implications on the river's hydrology, morphology, and aquatic life and habitat between dam and the tailrace. Below the dam and before the confluence of Dordi Khola, the implications are more acute in the stretch of 4.5 km.

It is envisaged that the dam will fragment the riverine ecology and obstruct the migration of migratory fishes across the dam wall. Reduced flows in between dam and tailrace will impact directly on the fish diversity and population due to loss of the habitats. Some implications are also envisaged on the local fishing communities.

4.1.2 Alternative Analysis

About 15% of the total population has access to electricity in the country. The demands for electricity both in rural and urban areas are very high. Lack of projects like the MMHEP, will result as increase in shortage of electric power supply. This may lead to a situation when load shedding needs to be initiated. Such a situation will hamper the industrial and economic fronts of the nation. So, no project option is disadvantageous to the nation. Many other energy development options can be considered as a part of project analysis. Amongst these are solar energy and fossil fuel power generation. Solar energy is mostly effective on a small scale but it is not possible for larger scale development purposes. Power generation from fossil fuel means, the nation needs to rely on import of fossil fuel, which is not economical in comparison to hydropower. Among the four alternatives of hydropower; i.e. micro, small, medium and large, the medium-size projects such as MMHEP are most suitable in the present context.

Development of run-off-river project with peaking reservoir capacity is advantageous in comparison to reservoir type alternative from the socio-economic and environmental consideration. The locations of dam and powerhouse are the only possible technically suitable alternatives compared to other alternatives considered. The ancillary facility sites of MMHEP have a number of advantages for operation and maintenance and are also

better than other alternatives examined in terms of technical, social, economical, and cultural environment.

4.2 Environmental Mitigation and Monitoring Plan

So as to eliminate or minimize the environmental impacts and to maximize the environmental benefits, a range of the environmental mitigation and monitoring prescriptions have been made, which are listed below:

For reducing erosion and sedimentation, it is recommended to minimize the cut and excavation works as much as possible with emphasis on the proper storage and management of spoil. Compaction of spoil, reuse of spoil and run-off-drainage management are also recommended for compliance in all the construction sites.

Clearance of vegetation is recommended to be minimized through pegging and tagging before site clearance. Guidelines for contractors and contractor's workforce have been designed to prevent off-site vegetation clearance with stringent monitoring mechanisms.

Reduction of pollution as per the standards and monitoring of compliance to the standards will also be done. Provisions of air quality control, noise level reduction, water quality control and vibration minimization have been recommended. Unmanaged and uncontrolled discharge of emissions, effluents, and solid wastes are prohibited and treatment of effluents shall be done. Similarly, safe disposal of wastes and regular emission check shall be done as per HMGN vehicular emission standards for reduction of pollution in air, water, and land. Special guidelines have been designed for the facilities to be provided in the campsites, which include provisions of adequate sanitation facilities, dining and recreation facilities, prohibition on fire wood, provision of kerosene and grocery depot and health care facility.

So as to minimize the impact on the aquatic environment, a minimum discharge of $1m^3/s$ throughout the year has been recommended as environmental amenity flow from the dam in the dewatered section of the river. A special open water fish stocking is proposed both in dewatered and upstream areas during the operational phase to maintain fish diversity and population in this section of Marsyangdi River. The trapping and hauling of the migratory fish species in the migration season is proposed as a part of the open water stocking through out the project operation. Restriction on fishing is recommended particularly in the first 4.5 Km of dewatered section and at confluence area of Dordi – Marsyangdi rivers as this area is critical spawning habitat for many migratory and resident fish species.

Comprehensive compensation, relocation, and rehabilitation plans have been developed so as to minimize the impacts on socio-economic and cultural spheres of the affected people.

Cash compensation will be based on the principle of compensating for losses at replacement costs. All the households who lose their current residential premises or business establishments or rental residents will be relocated in the near by areas. They will be provided with disturbance or hardship allowances. So as to rehabilitate the affected people's livelihood at levels better than the current status, special provisions such as preference to project job, vocational training, skill enhancement opportunities and facilitation in micro credit funds have been designed and put into the Environmental Management Action Plan.

4.3 Environmental Enhancement Plan

To minimize the direct and indirect impacts and to maintain and enhance the standard of life to levels equal or better than the present levels, environmental enhancement programs have been proposed. Special attention has been given when developing the proposals for community support and participation along with its sustainability. These enhancement programs are recommended for implementation during project construction and operation phase which comprise of the followings:

i. Agricultural extension and training program
- General awareness program on the opportunities to increase the agricultural production
- Vegetable farming training program
- Fruit farming training program
- Animal husbandry and poultry training program

ii. Off-farm skill development training program
- Construction related training programs
- Small business related training programs
- Office and secretarial training programs
- Women skill enhancement training program

iii. Community development program
- Water source protection program
- Health and sanitation support program
- Education and education facility support program
- Rural agricultural road rehabilitation support program
- Rural electricity extension program
- Rural irrigation rehabilitation support program
- Women development program

iv. Environmental improvement program

- Community forestry support program including nursery development and training
- Afforestation program for degraded areas.

4.5 Public Consultation and Concerns

The project has given due consideration to public consultation in the subsequent pre-feasibility, feasibility and upgraded feasibility study phases. During this EIA, public consultation was given top priority, right from identifying environmental issues for EIA consideration to formulation of Environmental Management Action Plan and Environmental Enhancement Program. Hence, a number of public consultations were done along with one full-scale Public Hearing session which was organized by MMHEP during EIA study. The public concerns were mostly focused on the compensation, rehabilitation and relocation issues. All of the project area people including the directly affected households were positive and desired the project to be implemented without delay. Community request mostly was related with the appropriate and market based compensation and resettlement/rehabilitation, transparency of project activities and implementation of vocational training, priority on job opportunities, some contribution from the project to the local infrastructure and social development.

Only some village elites and the VDC officials showed concerns on the potential pollution and related health aspects during project constructional, operational, and maintenance phase.

4.6 Environmental Management Action Plan

The preparation of Environmental Management Action Plan (EMAP) for the middle Marsyangdi Hydro-Electric Project (MMHEP) has been done so as to set out environmental management requirements and to develop procedures to ensure that all mitigation measures and monitoring requirements specified in this Environmental Impact Assessment (EIA) study report will actually be carried out in subsequent stages of project implementation.

The RERU/MMHEP/NEA has the prime responsibility of environmental management. Nevertheless, the parties involved for different purposes have important roles and responsibilities for the effective implementation of the EMAP in order to maintain the naturally balanced environment by creating fewer disturbances to the possible extent.

5.0 Results and Implications

5.1 Project Benefits and costs

As per the legal provisions, EIA was carried out by the proponent, NEA and approved by the MOPE. This report was also appreciated by the financers and donors. So, in line with the recommendations made in EIA, the contract documents were modified before tendering and awarding contract for construction. Similarly, a separate environmental unit was established at the project site in order to oversee the actual implementation of the mitigation measures and perform various monitoring requirements stated in the EMAP. It is believed that this project will exert no negative residual impacts of significance to the physical, biological, social, economic, and cultural environment.

Hydropower is the only major resource, which if developed sustainably, will catapult the economy of Nepal. It can also help to achieve the national goal of poverty reduction.

A substantial annual income will accrue to NEA and also to HMG, right from the first year of production from the project. The direct annual revenue estimated is 2,052 million Nepali rupees (equivalent to 26 million US$) at the price of 2004. MMHEP will also provide a number of subsidiaries benefits to the local people though a number of plans and programs. Quantification of the benefits monetary terms is very difficult. However, based on the experience of the World Bank, about US$ 3 million will be contributed to the local economy during the construction investment phase between June 25, 2001 to 2007.

As per the feasibility study, the total cost for MMHEP implementation is estimated to be about US$ 173 million. The cost mentioned is composed of financing, inflation, interest during construction, cost of environmental mitigation and improvement measures apart from the construction and erection of main project components.

The total value of the private land which will permanently be lost due to construction of various project structures is estimated to be 1.12 million US$ (equivalent to 77.952 million Nepali Rupees) based on the prevailing market price of the land in the project affected areas. The annual production losses from the lands and other project affected services and facilities are estimated to be US$ 0.101 million (equivalent to Rs. 7.07 million).

The environmental mitigation, monitoring, and improvement costs of the project for construction and operation periods are depicted in Table no. 5 & 6. Those not included in this table are the costs for standard contractual mitigation measures such as erosion and sedimentation control, control of air pollution, water pollution, noise pollution, site rehabilitation, bio-engineering and afforestation programs. These costs will be met by the construction contractor as a part of contract. The cost for supervision consultants are also

not incorporated in the given costs as it is customarily covered in the total costs of project supervision.

The total cost estimated for environmental mitigation and enhancement measures during construction and operation & maintenance phase (25 yrs.) of project and cost for monitoring is estimated to be US$ 3.51 million, which constitutes approximately 2.03% of the total project development cost.

5.2 Lessons Learned

As per the EIA study, the MMHEP does not exert significant impacts which are not mitigable in terms of magnitude extent and duration both in construction and operation & maintenance phases of the project. The residual impacts are within the tolerable limit in case of physical, biological, social, economic, and cultural environment.

Due to loss of environmental resources, direct annual economic losses from the project are estimated at about 0.34% of annual revenue earned by the project at 2004 prices. Total asset loss incurred by the project due to permanent land acquisition is 4.3% (i.e. Rs. 89.89 million) of the annual revenue of the project. In economic terms the loss above is very minimal. Provision of 10% of the HMG revenue to the local administrative bodies (DDC) from the total revenue amount paid by MMHEP to HMG during its operation period, as per the Local Self Governance Act, is the other source of income for the local administrative bodies for the sustainable development of the local areas. Similarly, 1% of the total revenue earned by the government, will also be distributed among the project affected Village Development Committees for electrification. Therefore, MMHEP will play a greater role in the sustainable development of the local area along with meeting the power need of the nation that will ultimately boost the national economy and help meet the national goal of poverty reduction.

6.0 Conclusion and Recommendation

All the physical, biological, socio-economic and cultural impacts that were identified during EIA study are mitigable. So, it is recommended to implement the project only after incorporating the proposed mitigation and enhancement measures. This will bring down the level of pollution and negative impacts to the acceptable limit. Besides the management of waste water, solid waste, and other effluents; vigilance through monitoring the issues of air quality, noise level, water & soil quality, public health, occupational health & safety measures, fire & accident, and vegetation should be continually done. Similarly, good care should be taken of social, economic and cultural impacts mostly during constructional

period. Proper and efficient management of human resources (Project staff) as well as good public relation with all the stakeholders should be maintained in a balanced way.

However, the environmental agencies, both the non-governmental and governmental, and the local area people are required to be more vigilant in the implementation of mitigation and enhancement measures as enshrined in the Environmental Management Action Plan. Set up of one strong and efficient monitoring and auditing unit in the project during construction and operation phase are highly desirable. To make the project activities more transparent, visible, and effective, regular public consultation from the project proponent is essential.

7.0 References

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Annexure-1

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