

Determination of the Significance of Environmental Impacts of Development Projects: A Case Study of Environmental Impact Assessment of Indrawati-3 Hydropower Project in Nepal

Ram B. Khadka¹, Ajay Mathema¹, Uttam Sagar Shrestha²

¹School of Environmental Science and Management, Pokhara University, Nepal; ²Departments of Geography, Tribhuvan University, Kathmandu, Nepal.

Email: khadka7777@hotmail.com, ram.khadka@aemsregional.org

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ABSTRACT

The environmental impacts are commonly quantified in the EIA studies by rating, ranking and scaling. The National EIA Guidelines, 1993, Nepal provides a guideline to score the impacts in terms of magnitude, extent, and duration. This step is commonly known as impact prediction in the EIA process. The predicted scores are multiplied by the weightage value of the resource likely to be affected. The application of the weightage transforms the predicted values of the impacts into their “significance”—a concept used in the environmental decision making. In other words the significance value entails assignment of relative judgment values to the impacts. The impacts, thus, can be ranked based on their significance. The impact ranking is more useful in evaluating the socio-economic impacts. Unlike air, water and noise quality, which can be assessed against established standards; the socio-economic impacts do not have standard scale and are difficult to rank. Importance weighting of socio-economic impacts are commonly determined by the consensus obtained from the interaction with the local people, agencies, NGOs and experts. The impact ranking in the EIA process is unavoidable, firstly to prioritize the urgent environmental issues and design mitigation measures accordingly and also provide coherent linkages among the issues, and plan monitoring and auditing linkage with the proposed mitigation measures. Furthermore, it also provides strong basis for decision making, and thus facilitates the decision makers. The process of impact prediction, determination of significance and ranking were applied in the EIA of Indrawati-3 Hydroelectric Project, which is one of the successful cases of EIA in Nepal. The authors believe that the impacts predicted and quantified through this method are focused on the local concerns since it seeks an active involvement of the local people who are likely to be affected.

Keywords: Environmental Impact Assessment, Environmental Significance, Ranking, Prediction of Impacts, Importance Weighting, Judgment Values

1. Introduction

Environmental Significance is an anthropogenic concept [1] used in decision making of the Environmental Assessment process. This concept remains undefined and has become a source of controversy among the EA professionals. Evaluation of the environmental significance requires expert judgment values and scientific criteria [2]. However, EIA legislation of developed and developing countries has categorically mentioned that the law is enforceable only if the impact is environmentally significant. The legal definition of environmentally significant in terms

of thresholds is usually not available [1]. Duinker and Beanlands [3], Hoge *et al.* [4], Sadler (1996), Gilpin [5] and Thompson [2] have proposed various definition of environmental significance and the common elements of their definitions are following [1].

- Environmental significance is a judgment,
- The degree of environmental significance depends upon the nature of the impacts (type, magnitude, extent and duration),
- The importance is based on biophysical and socio-economic values, and the amount of changes to the environment perceived to be acceptable to the com-

munity.

Determination of the significance entails the assignment of relative judgment values of impact prediction associated with the project and to determine the priority order in which the impacts are to be avoided, mitigated or compensated [6]. Evaluation of the significance of the predicted impacts can be made in different ways depending on particular environmental component in question. For example air, water and noise quality can be assessed against the established quality standards whereas changes in socio-economic conditions are more difficult to evaluate [1].

The major elements of assessing the significant impacts have been described for ecological and socio-economic components and the assessment is mostly based on subjective evaluation and includes the following [3]:

1) Ecological Component: This includes the criteria related to ecology and environmental parameters critical to the operation of valued ecosystem such as

- Plant and animal habitats,
- Rare, endangered and threatened species of biodiversity,
- Ecosystem resilience, biodiversity and carrying capacity, and
- The viability of local species.

2) Social and Economical Components: Effects on biophysical impacts when translated into human concerns; the following effects are to be considered:

- Effect on human health and safety,
- Loss of commercially productive lands,
- Loss of public resources such as social services,
- Loss of transportation and other infrastructures, and
- Demography.

3) Environmental Standards: The use of national standards enshrined into legislation/rules of the government/agencies are the most common means to assess the environmental significance. In most nations, standards/criteria for air/water/noise are available for reference [6].

While evaluating the impact significance, the current status of the environment is analyzed. This is followed by identification and prediction of potential impacts of the proposed action. In the third stage, it is determined whether the receiving environment will be able to absorb the effects of the predicted impacts without suffering irreversible change. This requires thorough understanding of their resilience of receiving environment. It is also required to evaluate whether the proposed proposal is within the scope of national policy and covered by the existing legislation and regulation and lastly the degree of public interest [7].

2. Procedures for Determination of Significance

Rau and Wooten [8] and Canter [9] have provided some

practical tools in evaluating environmental significance of development projects. According to them, the effects should be predicted in terms of magnitude, extent and duration.

For the prediction, a number of ways have been proposed such as symbolic signs, numerical values, (+) for positive and (-) for negative effects, etc. However, the most convenient way is to develop impact ranking framework as proposed by Canadian Federal Environmental Assessment Review [10]. National Environmental Impact Assessment Guidelines. Nepal has also adopted similar impact ranking method and applied successfully in number of cases [11]. The impacts are predicted and classified in terms of:

Magnitude: It is determined based on severity of impact. In case of high magnitude, the situation turns to be irreversible. Medium and low magnitude is thus considered to be reversible and acceptable by the public.

The spatial extent: This is another characteristic of the impact and indicates the zone of influence. The effects of the impacts may be of local or national or regional or international scopes.

Duration of impact: This is the temporal aspects of impacts, indicating how long the effects can last. Based on the prediction made on the above characteristics of the impacts, the following numerical values are assigned to each of the character and the degree on which they are likely to occur [11] (**Table 1**).

Each impact is predicted with its magnitude, extent and duration and respective scores. The total scores of all three parameters are often computed.

Importance weighting schemes are the most structured approach to impact scaling and permit direct transformation of impact ranking into impact significance. In order to determine the appropriate weightings of the resource expected to be affected, a procedure should be followed. While assigning values for resources the EIA study group, professionals, stakeholders, academicians, and knowledgeable people from the project area should be involved in the series of meetings and discussions. An interaction table is usually prepared where resources anticipated to be affected should be listed on the vertical column and the importance weighting should be marked in the horizontal column with the degree of importance from 1 to 3 where 1 indicates the least importance and 3 indicates the highest importance. Request should be made to the participants to fill out the table based on their own perceptions. The numerical values of the column are then summed up and individual value in the column is divided by the total value. This gives relative weighting of each resource to be considered [8].

The total score of magnitude, extent and duration is

Table 1. Categorization of impacts and their ranking.

Magnitude	Extent	Duration
High/major (H) 60	Regional @60	Long-term (Lt) 20
Moderate (M) 20	Local (L) 20	Medium-term (Mt) 10
Minor (L) 10	Site Specific (SP) 10	Short-term (St) 05

Source: National EIA Guidelines, 1993.

multiplied by corresponding relative weightings of resource which is the significance of that particular impact. In this way, significance can be determined for all the impacts identified and further consideration for impacts and mitigation measures can be proposed [6].

3. A Case Study on Determination of Environmental Impact Significance of Indrawati-3 Hydropower Project in Nepal

Nepal is endowed with enormous hydropower potential. However, only a small fraction of it has been exploited so far. Additional quantity of power is required to fulfill the power need of the country. Implementation of Indrawati-3 hydropower was one of the responses to fulfill the power need. The project started in 2002 and completed in 2007 and generated electricity which contributes to National grid.

Indrawati-3 hydropower project was constructed in Sindhupalchowk district located 58 km north-east of Kathmandu-the capital city of Nepal. The head work was built in the bank of Lapse River and the power house was located in Ratmate village. The project covers three village development committees viz Lagarche, Jaymire and Bhotenamlang (See map **Figure 1**).

3.1. Project Area Description

The project is located within the mid-hills of mountain at the altitude of 2000 m to 2500 m above the sea level. The geology of the project area consisted mainly quartzite, phyllites and schist. The sedimentation in river is quite high and the specific load was recorded at 0.304×10^6 m³/year.

Indrawati is a snow-fed river originating from the Jugal Himal range. The maximum flow of Indrawati River near project area is 40.5 m³/sec in average and minimum flow is 6.5 m³/sec recorded during the months of February to March. In the project area, a few patches of vegetation comprising particularly *Lyonia ovalifolia*, *Pinus ruxburghii*, *Alnus nepalensis*, *Castanopsis indica*, and *Shorea robusta* were present. Some species of the mammals and birds were reportedly available in the area but

no rare, endangered and protected species were available. Among the fish species in Indrawati River, 20 species of the fresh water fish existed in the River with a few migratory species. The project area covered only three Village Development Committees, consisting 7500 populations and were mostly farmers, traders, and service holders.

3.2. Project Description

The project consisted of 5-meter high diversion weir constructed at the intake site, 2.9 km long headrace tunnel, a surface type of power house with 3 generating sets, 2.8 km long access road and accommodation complex for workers and staff. The project was designed to divert water flow of 17.2 m³/sec from the River to the tunnel and the power house to generate electricity. As per the rules 0.5 m³/sec of water flow has been released as environmental flow for downstream during the dry period. The project required occupying 120 ha of land. Most of the land was acquired from the local farmers with adequate compensation. Approximately, 1500 workers were employed during the project construction and in the operational stage, only 45 project staffs were employed [12].

3.3. Environmental Impact Assessment (EIA)

As per the requirement Environmental Protection Regulation of Government of Nepal [13], hydropower project generating more than 5 MW required to undergo an EIA process to obtain environmental clearance from the government of Nepal prior to the start of project construction. Accordingly, an EIA was carried out for this project; for which scoping and TOR documents were prepared and were approved by the government on July 28 2004 [14] The EIA study including public hearing was completed on August 2005 and was submitted to the concerned agency of the government for approval. The EIA was approved by the government on October 2005. The project was constructed and operated by a local Hydropower company called "National Hydropower Company" [15] and the electricity generated through this project is purchased by Nepal Electricity Authority (NEA).

3.4. Methodology

After the approval of Scoping and TOR documents from the concerned agency of the Government of Nepal, EIA study was carried out. During the study, information on the baseline conditions of the project area were collected and compiled. Impact identification was made following the methods given in National Environmental Impact Guidelines, 1993 and particularly the following methods were adopted [16]:

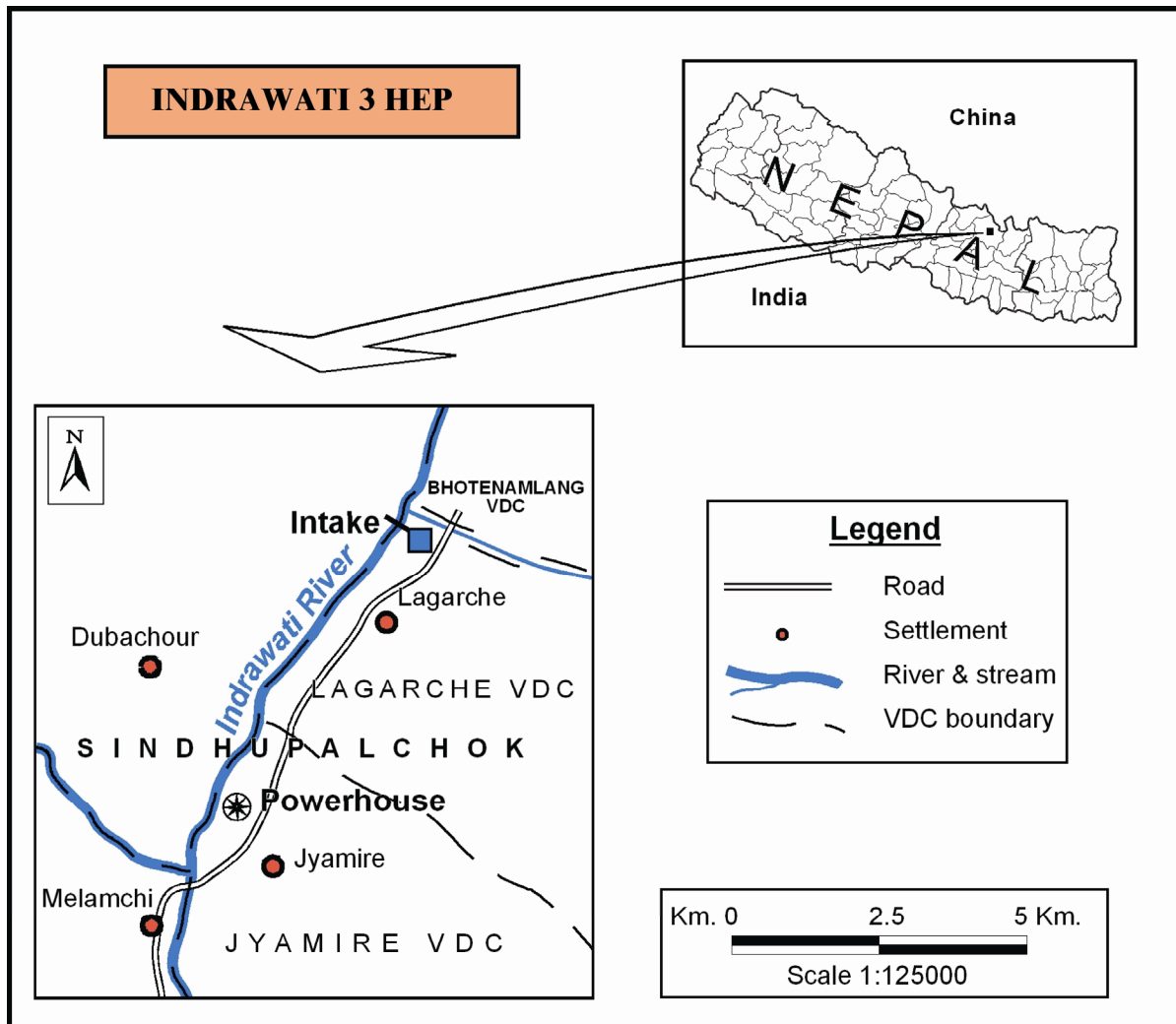


Figure 1. Location of indrawati 3 hydropower project, Nepal.

- The use of structured questionnaires,
- Interaction Matrices; Simple Matrices and Leopold Matrix,
- Use of GIS,
- Overlay techniques,
- Impact Networks,
- Task—specific Computer Models, and
- Ranking and weighting methods.

The second stage of the process predicting the impact in terms of magnitude, extent and duration of each impact identified. This was carried out through the intensive interactions among professional experts, stakeholders, and local people. A series of meetings were held for impact prediction and finally they were accepted by all.

Importance Weighing is the most structured approach to impact rating. It permits direct transformation of a

sum of impact magnitude, extent, and duration into impact significance. Importance weightings of the resources likely to be affected were determined by organizing a workshop or a meeting to discuss at which representatives of the local people, local agencies, NGO stakeholders and the technical experts involved in EIA study have participated. A series of steps were followed by each participant/organizer as given by Rau and Wooten [8] while conducting meetings for the determination of weighting. Total scores of prediction were multiplied by importance weighting which resulted in developing a framework for determining the impact significance.

Thus, determination of significance provided the impact framework which contributed in the following:

- Categorization of impacts into most detrimental and most beneficial,
- Prioritization of impacts for which major resources

and efforts can be allocated for minimizing the effects of highly detrimental impacts and enhancing the benefits from highly beneficial ones, and

- Dropping down the insignificant impacts of project implementation [6].

4. Results and Discussion

4.1. Identification of Environmental Impacts

Indrawati-3 Hydropower project constitute the construction of a water diversion weir, headrace tunnel, powerhouse, and other ancillary infrastructures. In the process of project construction and operation, the following adverse and beneficial impacts were likely to occur.

Physical Impacts (Adverse and Beneficial)

Micro-climate and air quality
Topography, land use, and stability
Surface erosion
Disposal of excavated materials
Hydrology and Sedimentation
Water Quality/Pollution
Solid Waste
Noise and Vibration

Impacts on Biological resources

Loss of forest cover
Increase in felling of trees
Exploitation of NTFP
Impact on Biodiversity
Impact on Rare Endangered and threatened species
Impact on fish migration
Effect on Riparian Habitat
Downstream effect

Impacts on Socio-Economy and Cultural Resources

Impacts in agricultural land
Women and Child Labor
Culture and Religion
Public Health
Occupational Health and Safety
Law and Order
Impact on local Life Style
Increase Pressure on Local Services
Increased local Employment
Increase in Local Trade
Improvement in Road Condition
Rural Electrification
Industrialization
Promotion in Eco-tourism

4.2. Predicting Anticipated Impacts

Based on the list above, the impacts were predicted. Each impact was predicted in terms of magnitude, extent, and duration. In predicting the impacts, ranking methods as

given in National Environmental Impact Assessment Guidelines [11] and Canadian Federal Environmental Assessment Review [10] were followed. As specified earlier, a series of meetings were held with the participation of professional experts, stakeholders, affected people, and beneficiaries. In the preliminary meeting, a list of anticipated impacts was prepared and presented. The meeting was attended by all the experts involved in the EIA study. Each impact was discussed and predicted in terms of magnitude, extent, and duration. Based on the outcome of the preliminary meeting a Framework of Impact Prediction (FIP) was developed and presented in following meeting. A confirmation meeting was held immediately upon the finalization of FIP. The opinions and expressions of local people, local authorities, NGOs, and other stakeholders present in the meeting were recorded. The final meeting of experts made the necessary modifications to the predictions. The prediction made for the anticipated impacts of Indrawati-3 Hydropower Project are given in the **Table 2**:

4.3. Ranking of the Predicted Impact

Each of predicted impact is categorized into magnitude extent and duration. Further, on the basis of severity, impacts are classified as high (H), moderate (Mo) and low (Mi) under magnitude, in which (H) is irreversible, and (Mo) and (Lo) are reversible. Under the extent, impact are classified as site specific (Sp), local (L) and regional (R). Similarly under duration, impacts were classified into short term (St), medium term (Mt) and long term (Lo). Each of the categories were the translated into numerical value as given in National EIA guidelines (1993). The total numerical values were summed up to a maximum of 140 and minimum up to 35 (**Table 3**).

4.4. Determining Importance Weighting

Importance weighting is a structured approach to impact rating and permit a direct transformation of sum of impact magnitude, extent and duration into impact significance. Weighting can be determined by organizing a workshop or a meeting represented by local people, local agencies, NGOs stakeholders and the experts involved in EIA study.

The meeting held on 25 January, 2002 assigned importance value to the resources to be affected. An interaction table was prepared where resources anticipated to be affected were listed in the vertical column and the importance weighting was marked in the horizontal column, indicating the degree of importance from 1 - 3 where 1 stands for the least importance and 3 indicates the highest importance. **Table 4** provides the overall

Table 2. Impact prediction in terms of magnitude, extent and duration.

Impacts	Magnitude			Extent			Duration		
	H	Mo	Mi	R	L	Sp	Lt	Mt	St
Physical Environment									
Micro-climate and air quality	-	-	Mi	-	-	Sp	-	-	St
Topography, land use and stability	-	Mo	-	-	L	-	-	-	St
Disposal of excavated materials	-	Mo	-	-	L	-	-	Mt	-
Hydrology and Sedimentation	-	-	Mi	-	L	-	-	Mt	-
Water Quality/Pollution	-	Mo	-	-	L	-	-	-	St
Solid Waste	-	-	Mi	-	-	Sp	-	-	St
Noise and Vibration	-	Mo	-	-	L	-	-	-	St
Biological Environment									
Loss of forest cover	-	Mo	-	-	L	-	-	Mt	-
Impact on Biodiversity	-	Mo	-	-	L	-	-	-	St
Impact on Rare Endangered and threatened species	-	Mo	-	-	L	-	-	Mt	-
Impact on fish migration	-	-	Mi	-	L	-	-	Mt	-
Effect on Riparian Habitat	-	-	Mi	-	L	-	-	Mt	-
Downstream effects	-	Mo	-	-	L	-	-	Mt	-
Socio-economic/Cultural Impact									
Loss of agricultural land	H	-	-	-	L	-	-	Mt	-
Women and Child Labor	-	Mo	-	-	-	Sp	-	-	St
Culture and Religions	-	Mo	-	-	L	-	-	-	St
Public Health	-	Mo	-	-	L	-	-	Mt	-
Occupational Health and Safety	-	Mo	-	-	-	Sp	-	-	St
Law and Order	-	-	Mi	-	-	Sp	-	-	St
Impact on local Life Style	-	Mo	-	-	L	-	-	-	St
Increase Pressure on Local Services	-	Mo	-	-	L	-	-	-	St
Increased local Employment	-	Mo	-	R	-	-	-	Mt	-
Increase in Local Trade	-	Mo	-	R	-	-	-	Mt	-
Improvement in Road Condition	-	Mo	-	R	-	-	-	Mt	-
Rural Electrification	-	Mo	-	R	-	-	Lt	-	-
Promotion in Eco-tourism	-	Mo	-	R	-	-	Lt	-	-
Decrease in Dependence on Fuel wood	-	Mo	-	-	-	-	Lt	-	-

H = High, Mo = Moderate, Mi = Minor, R = Regional, L = Local, Sp = Site Specific, Lt = Long Term, Mt = Medium Term, St = Short Term (National Planning Commission, GON and IUCN-The World Conservation Union, 1993).

framework for assigning importance. The individual ranking of importance was then divided by the total score of importance value which provided the importance weighting of each resource to be affected by project implementation.

4.5. Determination of Significance of Predicted Impacts in the Context of Indrawati-3 Hydropower Project

The total score of numeral value of prediction of each impact (Table 3) was multiplied by importance weighting

given in (Table 4). The product gives the relative impact of significance (Table 5). The higher the product, the more effects are associated with it. The impacts were then categorized and prioritized to invest greater efforts and resources for mitigating significant detrimental effects, while dropping down less significant effects.

4.6. The Prioritization of Impacts for Designing Effective Mitigation Measures

Table 5 provides a framework for impacts prioritization for designing an effective mitigation measures. Based on

Table 3. The predicted impacts translated into numerical ranking as given by National Planning Commission, GON and IUCN-The World Conservation Union, 1993. [11]

Impacts	Magnitude			Extent			Duration			Total
	H	Mo	Mi	R	L	Sp	Lt	Mt	St	
Physical Environment										
Micro-climate and air quality	-	-	10	-	-	10	-	-	5	25
Topography, land use and stability	-	20	-	-	20	-	-	-	5	45
Disposal of excavated materials	-	20	-	-	20	-	-	10	-	50
Hydrology and Sedimentation	-	-	10	-	20	-	-	10	-	40
Water Quality/Pollution	-	20	-	-	20	-	-	-	5	45
Solid Waste	-	-	10	-	-	10	-	-	5	25
Noise and Vibration	-	20	-	-	20	-	-	-	5	45
Biological Environment										
Loss of forest cover	-	20	-	-	20	-	-	10	-	50
Impact on Biodiversity	-	-	10	-	-	10	-	10	-	30
Impact on Rare Endangered and threatened species	-	20	-	-	20	-	-	10	-	50
Impact on fish migration	-	-	10	-	20	-	-	10	-	40
Effects on Riparian Habitat	-	-	10	-	20	-	-	10	-	40
Downstream effects	-	20	-	-	20	-	-	10	-	50
Socio-economic/Cultural Impact										
Loss of Agriculture land	60	-	-	-	20	-	-	10	-	90
Women and Child Labor	-	20	-	-	-	10	-	-	5	35
Culture and Religions	-	20	-	-	20	-	-	-	5	45
Public Health	-	20	-	-	20	-	-	10	-	50
Occupational Health and Safety	-	20	-	-	-	10	-	-	5	35
Law and Order	-	-	10	-	-	10	-	-	5	25
Impact on local Life Style	-	20	-	-	20	-	-	-	5	45
Increased on Pressure on Local Services	-	20	-	-	20	-	-	-	5	45
Increased local Employment	-	20	-	60	-	-	-	10	-	90
Increase in Local Trade	-	20	-	60	-	-	-	10	-	90
Improvement in Road Condition	-	20	-	60	-	-	-	10	-	90
Rural Electrification improvement	-	20	-	60	-	-	20	-	-	100
Promotion in Eco-tourism	-	20	-	60	-	-	20	-	-	100
Decrease in Dependence on Fuel wood	-	20	-	-	20	-	20	-	-	60

Source: National Hydropower Company Pvt, 2002; The values have been assigned as per the values given in National Environmental Impact Assessment Guidelines (NPC Government of Nepal and IUCN, 1993).

Table 4. Importance weighting as decided by expert group (Extracted from EIA of Indrawati-3 Hydropower Project).

Impacts	Importance Value				
	1	2	3	Total	Importance Weighting
Physical Environment					
Micro-climate and air quality	√			1	0.01960
Geology and topography		√		2	0.03921
Hydrology and Sedimentation		√		2	0.03921
Water Quality	√			1	0.01960
Solid Waste	√			1	0.01960
Tranquility of the area		√		2	0.03921
Biological Environment					
Forest cover		√		2	0.03921
NTF	√			1	0.01960
Cultivated land	√			1	0.01960
Wild Life Habitat		√		2	0.03921
Rare Endangered and threatened species			√	3	0.05882
Fish species		√		2	0.03921
Riparian Habitat	√			1	0.01960
Socio-economic/Cultural Impact					
Land property			√	3	0.05882
Women and Child		√		2	0.03921
Culture and Religions		√		2	0.03921
Occupational Health and Safety		√		2	0.02489
Law and Order	√			1	0.01960
Local Services		√		2	0.03921
Employment			√	3	0.05882
Water Use	√			1	0.01960
Local Trade		√		2	0.03921
Road Condition	√			1	0.01960
Rural Electrification			√	3	0.05882
Industrialization			√	3	0.05882
Eco-tourism		√		2	0.03921
Total				51	1.000

Note: 1 = least importance, 2 = moderate importance and 3 = most important.

Table 5. Impact significance and prioritization for mitigation prescription.

Predicted Impacts	Total Score from Ranking (Table 3)		Importance Weighting (Table 4)	Significant Values	Impact Prioritization (1 = top priority)	
Physical Environment						
Micro-climate and air quality	25	M U L T I P L I C A T I O N O F Y	0.01960	0.490	18	
Topography, land use and stability	45		0.03921	1.764	9	
Disposal of excavated materials	50		0.03921	1.960	8	
Hydrology and Sedimentation	40		0.01960	0.784	15	
Water Quality/Pollution	45		0.01960	0.882	14	
Solid Waste	25		0.03921	0.980	13	
Noise and Vibration	45		0.03921	1.764	9	
Biological Environment						
Loss of forest cover	50		0.01960	0.980	13	
Impact in Biodiversity	30		0.01960	0.588	17	
Impact on Rare Endangered and threatened species	50		0.03921	1.960	8	
Impact on fish migration	40		0.05882	2.352	7	
Effect on Riparian Habitat	40		0.03921	1.568	10	
Downstream effects	50		0.05882	2.941	5	
Socio-economic/Cultural Impact						
Loss of Agriculture land	90	I M P O R T A N C E W E I G H T I N G	0.05882	5.293	2	
Women and Child Labor	35		0.03921	1.372	11	
Culture and Religions	45		0.03921	1.764	9	
Occupational Health Hazardous and Safety	35		0.01960	0.686	16	
Law and Order	25		0.03921	0.980	13	
Impact on local Life Style	45		0.05882	2.646	6	
Increase Pressure on Local Services	45		0.01960	0.882	14	
Increased in local Employment	90		0.03921	3.528	4	
Increase in Local Trade	90		0.01960	1.521	10	
Improvement in Road Condition	90		0.05882	5.293	2	
Rural Electrification	100		0.05882	5.882	1	
Promotion in Eco-tourism	100		0.03921	3.921	3	
Decrease in Dependence on Fuel wood	60			0.01960	1.176	12

Source: National Hydropower Company Pvt, 2002.

priority and severity the predicted impacts were classified into following three categories:

Impacts having significant adverse/beneficial effects

- Rural Electrification—beneficial
- Local employment—beneficial
- Promotion in Ecotourism—beneficial
- Loss of Agricultural land—adverse
- Disposal of excavated materials—adverse
- Decrease in dependence on fuel wood—beneficial
- Promotion of ecotourism—beneficial
- Loss of forest cover/forest biomass—adverse
- Impact on rare/endangered/endemic species of plants and animals downstream effects—adverse
- Topography, land use and stability—adverse
- Noise and vibration—adverse
- Habitat encroachment—adverse
- Effects on culture and religious—adverse
- Hydrology and sedimentation—adverse
- Impact on fish migration—adverse

Impacts with Moderate/Adverse/Beneficial Effects

- Occupational health hazards—adverse
- Women and child labor—adverse
- Exploitation of NTFP—adverse
- Impacts on life style—adverse
- Water quality / pollution—adverse
- Effects on riparian habitat—adverse
- Impacts with Less Significant Adverse/Beneficial Effects**
- Improvement in road condition—beneficial
- Law and order—adverse
- Micro-climate and air quality—adverse
- Solid waste—adverse

5. Conclusions

The entire process as outlined above for the identification of significant impacts is a subjective exercises involving mostly judgment values of experts, stakeholders, project affected and beneficiaries and other concerned people of the local area. But for those parameters of environment, whose national and international standards or

norms are available, the values anticipated from the study can be compared and the thresholds can be determined. For example, air and water quality and noise level can be compared against national quality standards. For impacts, whose severity is not quantifiable such as social issues, this process of quantification, would be most appropriate, since it involves the project affected stakeholders of project areas. The authors believe that the impact predicted and quantified through this method would likely to be more closer to the reality of the local area, since it involves the local people likely to be affected by the project implementation [14].

Determination of significance provides the impact framework on categorization of impacts into most detrimental and most beneficial ones and prioritizes the impacts for which major resources and efforts can be allocated for reducing highly detrimental effects and enhancing benefits from highly beneficial impacts [6]. All scores are relative and computation methods are based on subjective judgment value. Therefore, it does not have any scientific foundation [8]. However, in the process of EIA of a development project, many impacts are usually identified; some of them are significantly detrimental or beneficial but most of them are insignificant in terms of their severity, albeit, they are equally treated and wrongly predicted. In such circumstances, the project proponent faces dilemma as to where to place more resources and efforts in order to minimize the detrimental effects or to enhance beneficial effects of project implementation. Therefore, categorization of impacts in terms of severity is more desirable [14] for:

- Designing the most effective mitigation measures investing adequate amount of time, money and efforts, to minimize the most significant adverse impacts,
- Paying less attention and efforts on moderate and less significant impacts,
- Providing a coherent linkage among the various issues addressed in EIA report,
- Providing specific monitoring and auditing linkage to the specific impacts and mitigation measures proposed, and above all, concentrating more on highly significant impacts, thus, avoiding the insignificant ones.

Furthermore, the quantification of impacts and their categorization is important because the decision makers usually require a strong basis to make a decision on the proposed project implementation. It would be rather difficult for project proponent to convince the decision maker through descriptive narration; but quantification of the description is likely to ease the decision makers to grasp the essence of the issues to be decided particularly in developing country.

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