

The Degree of Success in Environmental Mitigation Measures of Development Projects in Sri Lanka with Special Reference to Peraru Water Supply and Sanitation Project

Y.B.M. Asmi¹ and T.K. Weerasinghe²

¹*Centre for Environmental Studies and Sustainable Development, The Open University of Sri Lanka, Nawala, Nugegoda. E-mail: asmiyazeen@gmail.com*

²*Faculty of Natural Sciences, The Open University of Sri Lanka, Nawala, Nugegoda. E-mail: tkwee@ou.ac.lk*

ABSTRACT

Human life and element of nature is well connected. Man-made activities can destroy the natural system which sustains the human life. In many parts of the world, economic development projects directed at improving levels of material comfort have had unintended detrimental effects on people and natural resources. Water, land, and air have been degraded to the point where they can no longer sustain existing levels of development and quality of life. Economic development in developing countries has been focused on immediate economic gains environmental protection has not been a priority because the economic losses from environmental degradation often occur long after the economic benefits of development have been realized.

Environmental Management Plans (EMP) are used in development projects to mitigate the anticipated impacts due the project intervention. EMP is monitored periodically using performance indicators shown in the Environmental Monitoring Plan (EMoP). As per National Environmental Act, all the mega development activities must have an EMP. Some development projects effectively implement the EMP but there are cases that the implementation is not being practiced as per the EMP. This study assessed how effectively EMP was implemented in Per Aru Water Supply and Sanitation Project. A structured interview guideline was used to collect and obtain information from the target group. The study analysed impact and mitigation on key environmental factors such as air, water, land, fauna and flora.

Throughout the study, it was found that the implementation of EMP was successful. Project had planted around 176,972 plants for removing 1600 trees; Followed enough mitigation measures riprap and turfing to control the erosion in the bund; less mobile species were translocated to similar habitat area; no degradation occurred to the water body surrounding the project area; however project had failed to take enough mitigation measures on dust, translocating the flora and releasing the environmental flow. It is recommended to release the environmental flow, form a grievance redress mechanism to solve environmental related peoples' complains and grievances, improve the community consultation, increase the project approving agencies monitoring on the implementation of EMP, and control the invasive plants *Muntingia calabura* (Jam fruit tree). Further, recommended to donor agencies to evaluate the successfulness of the implemented EMP after project completion.

Key words: environmental impact, environmental management plan, environmental monitoring plan, mitigation measures

1 Introduction

National Water Supply and Drainage Board wanted to get 12,000 m³/d of water by constructing a reservoir across the Per Aru River for the sole use of drinking water to cater the water supply demand in urban areas of Vavuniya district. It is hoped to capture the runoff flow during the Maha Season by this attempt and then store it, treat it using water treatment plant and distribute to the urban areas. Due to this construction some of the paddy, high and forest lands were inundated under the reservoir.

Unregulated and unplanned economic growth can have the opposite effect on environment. Pressure on the environment may be increased, environmental degradation may occur at greater rates, and the sustainability of ecological and economic systems may be compromised (Lohani *et al.*, 1997).

Above facts reveal that the reason for high significant impacts on environment is due to lack or no prior environmental management plan for the development projects which emphasizes me to carry out a research study to assess the degree of success in environmental mitigation measures taken in development projects in Sri Lanka by giving special reference to a case study of Per Aru water supply and sanitation project in Vavuniya District, Sri Lanka. The objective was to evaluate the effectiveness of environmental management plan (EMP) implemented throughout the project in implementation stage by taking mitigation measures and propose recommendations to improve the effectiveness of the EMP. This study is the first of its kind was conducted in the Per Aru water supply and sanitation project. Therefore, the results of this study are valuable for understanding the effectiveness of environmental management plan (EMP) implemented and areas for improvement.

1.1 Study Area

The construction of reservoir across Per Aru for drinking water purposes to the Vavuniya Divisional Secretariat area located in Sastrikoolamkulam Grama Niladhari Division in Vavuniya Division (Fig. 1 and Fig 2). The Vavuniya District falls within the Dry Zone of Sri Lanka where tropical dry climate is prevalent. The area receives somewhat low rainfall throughout the year. The annual rainfall in the District varies from 1000 – 1500 mm, and experiences heavy rains from North East monsoonal season during October to December. In comparison, amount of rainfall receive during the rest of the months is considerably low. Topography ranges from 0 - 125 m and 125 – 750 m from the average mean sea level (amsl). The terrain is generally undulating. (EIA, 2012a).

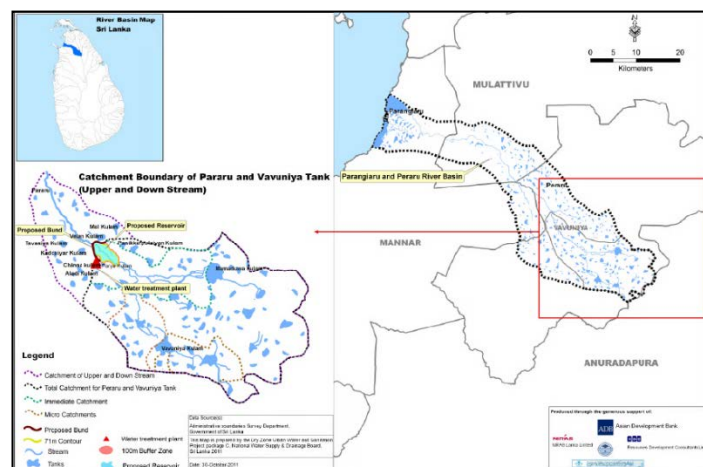


Fig. 1: Project Area (Source: EIA, 2012a)

Per Aru reservoir and surface water intake is one of the subproject in Vavuniya district under Dry Zone Urban Water and Sanitation Project (DZUWSP). Per Aru reservoir was built across Per Aru river with an earth dam having a length of about 3 km. The bund has a maximum height of 10 m. The dam is store and pump raw water to the water treatment plant for purification, storage and distribution.



Fig 2: Location of the proposed reservoir (Source: EIA, 2012b)

2 Methodology

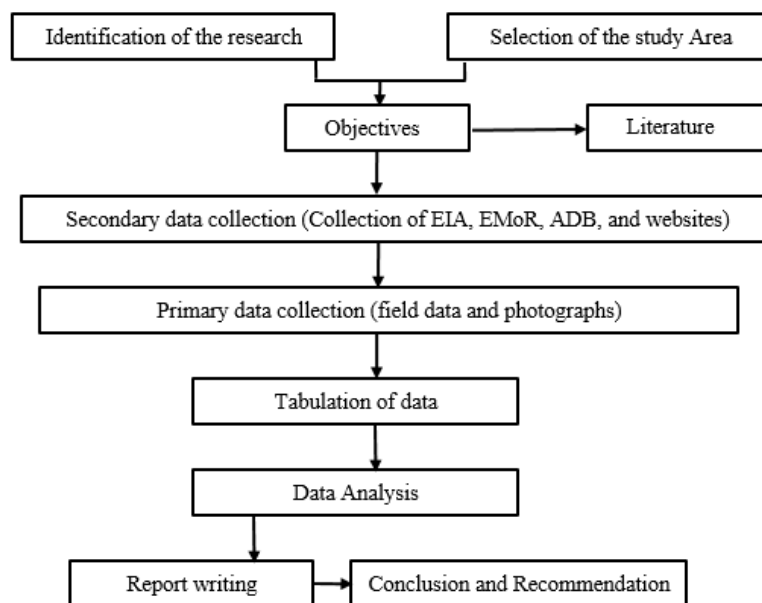


Fig. 3: Flow chart of methodology

The study was conducted using different approaches to gather data/information. The secondary data was collected from EIA, EMoR, websites and other desk and field studies. The primary data was collected from the project management units (PMU), contractor, departments, institutions, and international organizations (Fig. 3). The data were collected during March to December, 2018 on intermittent time intervals.

Following methods were used to analyze the above objectives:

- Desk study of Environmental Impact Assessment/Environmental Management Plan.
- Focus group meetings with project PMU staff, consultants, ADB staff and stakeholders
- Reviewing semiannual environmental monitoring report of the project implementing agency
- Reviewing, Acts, Regulations and Ordinances
- Direct field observation
- Past monitoring studies commissioned by PMU
- Thirty individual households were interviewed in order get the accurate responses for the questionnaire. Fifteen of each in upstream and down stream were interviewed.

3 Key Findings/Results

3.1 Impacts on soil and topography

3.1.1 Impact of cleared area for reservoir construction

The study reported by ADB, (2018a) on ecology of this project area have shown that large number of trees had been felled outside the project boundary. Such activities would have been taken place during the timber extraction that was carried out under the Per aru project affected area. To avoid such activities in future, boundaries of forest clearing areas shall be clearly demarcated with permanent boundary poles visible to forest cleaning staff. Moreover, the project should hold awareness programs to contractor's staff about forest boundaries and to arrange close supervision during the forest clearing activity. Forest Department, the agency responsible for managing these forest reserves, shall closely monitor the timber extraction process to ensure that only the identified trees are being removed.

3.1.2 Impact on Vegetation

It was noted a total of 1600 mature trees namely *Kumbuk (Genera terminalia Arjina)*, *Palu (Manikara hexandra)*, *Weera (Drypetes sepiaria)* and other few were removed. EIA identified a total of 1559 mature trees to be removed in the same species. The project had taken a steps to plant a total of 295,000 plants at 162.16 ha . Based on the available survival records only 60% of 176,972⁶ plants are surviving (Fig 4). The study reported by IUCN, (2007) on the Moragahakanda Agricultural Development Project indicated that survival of transplanted species was 84%.

⁶ After the project completion in September 2016, there were no maintenance for the planted plants. Researcher couldn't take the survival of plants during the field study as the area with full of bushes and scrub. There is no access to the area. The data used here is from the contractor's invoice in January 2016. The planted plants are composition of upper canopy and under story.

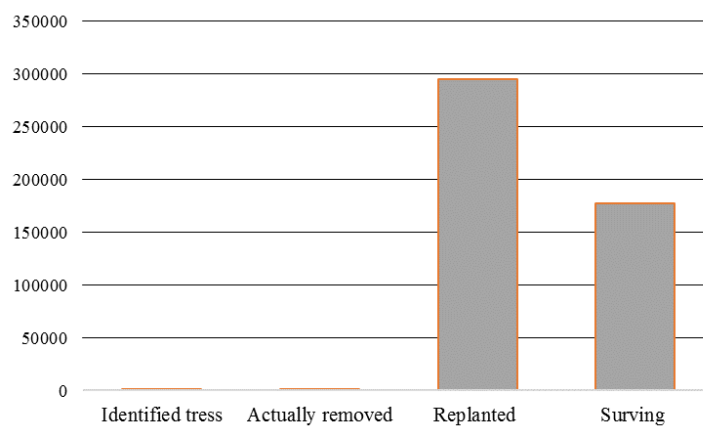


Fig 4: Comparison of removed and planted trees

According to Subhendu *et al.*, (2018), Maithon Dam construction in India had cleared 18km² of forest area. But no measures have been taken for deforestation and replanting. However famous Moragahakanda Mega Irrigation Project in Sri Lanka has also completed the reforestation of about 1,365 ha in the immediate catchment of Amban Ganga Basin for flooding around 3,035 ha (Diana, 2018).

It was noted that the forest enrichment programme, which is the mitigation measure proposed in the EIA to enhance the overall carrying capacity of the area for species that would compensate for the loss of forest that taken place under the project has been completed successfully.

3.1.3 Impact on Soil erosion by clearance of vegetation

Wickramasinghe *et al.*, (1988) observed that the annual erosivity in the dry zone region is higher than that in the upcountry mainly due to high percentage of erosive rainfall, which occur in the low country dry zone. The work reported by Dharmasena (2003) indicated that the reduction of forest cover from half to less than quarter in Sri Lanka during last fifty years more than anything else gives the most clear historical evidence of soil erosion. This is primarily due to colonization and rice land development under major irrigation schemes and opening of new lands for chena cultivation in the dry and intermediate zones.

It is observed in this study the removal of trees, notably uprooting of the large trees had disturb the surface topsoil which activity made the surface soil vulnerable to erosion. However, the trees uprooting was carried out only within the reservoir area and soil material within the reservoir bed was used for the dam construction. The dam construction was preceded by uprooting. As a result, the eroded soil were deposited within the reservoir area as a silt.

Soil erosion may take place along the bund slopes by forming runnels. Figure 5 shows cascade type drainage lines constructed along the bund slopes to drain out the surface water collected over the bund surface during heavy rains. The impact has been reduced by turfing in the downstream slope and providing the riprap protection on the upstream section (Fig 5 and Fig 6). The project staff confirmed that some turbidity was observed in the downstream during the rainy season. During the monsoon rains, land clearing cannot be avoided and soil erosion take place during the construction period. Soil erosion along the bund slopes were taken place before placing riprap protection and turfing until roots of turf are firmly grown .

Household survey for this study in the village indicates that permanent sedimentation has not been experienced at the downstream of the Per Aru since construction completion and the impact of soil erosion is no longer exist. The increased turbidity level has not disturbed to any aquatic lives as there were no death of fish or any aquatic lives observed by the villagers during the interview. It was found that water quality testing has not been carried out during the rainy days/period.



Fig 5: Riprap protection in the bund



Fig 6: Turfing protection in the bund

3.1.4 Impact on surface and sub-surface hydrology

The work reported by Subhendu *et al.*, (2018) indicated that the downstream of dam were naturally endowed with water resources and sub-surface aquifers were naturally rich with water due to regular flow of the river. The dam as a barrier made over the river has disturbed this natural supply of water, as water below the dam has been artificially and totally stopped.

It was observed during the study that the trees closer to the dam at the downstream are dying which may be due to the water level dropped (Fig 7). Around ten trees were affected at the downstream. This impact was not anticipated and as a result no mitigation measures had been proposed in the EIA and subsequent monitoring reports. This study recommends investigating this impact by an ecologist to find out the root cause and to propose mitigations measures.



Fig 7: Dying trees

3.2 Management of Ecological Impacts

3.2.1 Impacts on flora

The EIA identified a total number of 279 plant species including 11 endemic, 6 nationally threatened and three nationally near threatened species. Majority of the plant species recorded were herbaceous

species (95) followed by trees species (92), climbers (63), shrubs (25) and epiphytes (4). About 4 % of the recoded plant species were endemic to the country and about 87 % of the recorded plant species were native to Sri Lanka while the remaining 9 % of the recoded plant species were exotic to the country (Fig 8 and EIA, 2012b). This indicates that most of these habitats have not had a major human influence during recent times. The study revealed that no mitigation measures have been proposed in the EIA or EMP to protect 11 endemic, 6 nationally threatened and three nationally near threatened species. In order to conserve these floras, the mitigation option of ground rooting, translocating and replanting could have been considered.

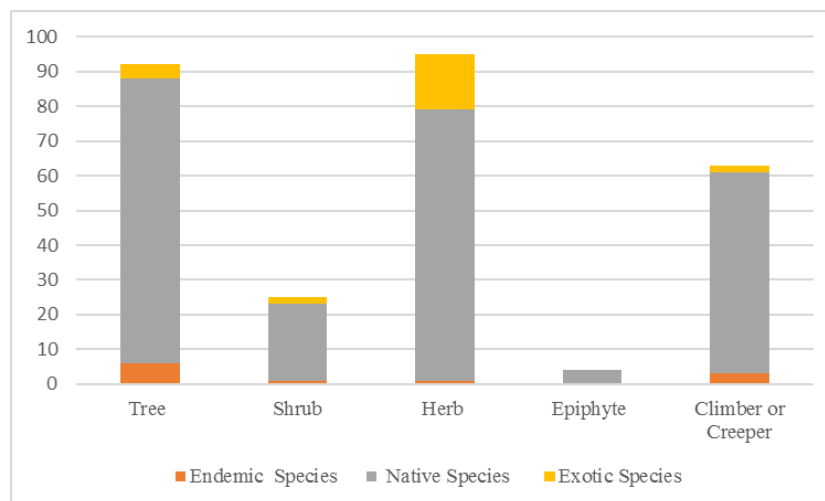


Fig. 4.8: Summary of the plant species according to the plant variety

The work reported by IUCN, (2007) in the Moragahakanda Agriculture Development Project indicated that vulnerable species were collected and transplanted as one of the mitigation activity to conserve the vulnerable species. As a result, a total of 916 plants belonging to 58 species were translocated by considering the status of species, distribution, use value and conservation status.

3.2.2 Impacts on fauna

A total number of 316 faunal species including 28 endemic and 3 proposed endemic were recorded in the EIA for translocation (EIA, 2012b). Three recorded species including one fish species and two land snails are exotic to the country. When large scale deforestation takes place in an area the more mobile species can move away from the area of disturbance to more safe locations. However, less mobile species are not capable of moving out from the area of disturbance on their own and hence will require human assistance in order to reach a safe location. The study revealed that one of the mitigation measures undertaken in order to minimize the impact on less mobile critical species (endemic and threatened species) as well as non- critical species was to relocate them from the project affected areas to protected forest reserves found downstream of the project site that has similar habitat characteristics.

While interviewing the villagers in the upstream reported that crocodiles are migrating to their residence and people are scare to go out in night. There were two crocodile attack in the village. The crocodile migrant is due to water level rise in the upstream. The EMP was not predicted this kind of impact of harmful wild animals. Recommended mitigation measures are community awareness about the wild animal human conflict and distribute ambulance and wild official contact details.

3.2.3 Impact by invasive species

The EIA has anticipated three invasive species in the reservoirs and streams might have spread which were *Salvinia* (*Salvinia molesta*), *water hyacinth* (*Eichhornia crassipes*) and *Mimosa pigra* (*Giant Sensitive plant*). This study revealed that two invasive plant namely *Typha angustifolia* (narrow leaf cattail) and *Muntingia calabura* (Jam fruit tree) are spreading in the reservoir area (Fig. 9).



Fig. 9: Spreading of invasive plants in the reservoir and on road sides.

Jam fruit trees are grown commonly in home gardens, street and listed as potentially invasive as it can spread rapidly in disturbed habitats as that will arise during construction of roads, reservoirs etc., The plant bears a berry that is used as food by many birds species, which functions as seed dispersal agents of this plant. Thus, it can spread rapidly once established (ADB, 2018a). This study recommends to take steps to remove and control the spread of these invasive alien plant species.

3.2.4 Impacts on migratory fish

The construction of dams in rivers causes habitat destruction in both feeding and breeding grounds, which leads to biodiversity loss. Habitat alteration has led to stunted growth, diseases, parasite infestation, and increased mortality. Dams block the natural flow of water, reducing water discharge in the downstream. Flowing water is vital as it cleans interstitial spaces of pebbles, gravel, and boulders and prepares spawning substrate for fish. In the absence of water flow after diversion, the spawning ground is covered by sediment that limits fish recruitment (ADB, 2018b).

A fish ladder was constructed for migrant fishes (Fig. 10). The fish ladder contains a series of interconnected water pooling units. The speed of the water flow has been reduced by providing a mild bed slope, speed breakers alternative at right and left sides, and bedding material with coarse rock media. This enables fish species to move upstream against the water flow.



Fig. 10: Constructed fish ladder

This study revealed that the fish ladder was constructed closer to the spillway since the fish tend to get confused between the spillway and the entrance to the fish ladder and attempts to scale the spillway which causes injury to fish (Fig 11). The construction of fish ladder closer to the spillway might have happened due the late design of fish ladder in the later stage.



Fig 11: Construction of fish ladder closer to the spillway

The study reported by ADB, (2018a) on this project indicated that concrete metal has been used to cover the bottom surface of the fish ladder which tend to get shifted when water is flowing in the ladder creating small pools where fish get trapped when the fish ladder stop operating (Fig 12). These small pools are subjected to high temperature fluctuations and high rate of predation by birds.



Fig. 12: Water pools created by concrete metal

The study has shown that the spillway and the fish ladder are used by villagers as fish can be easily caught at these two locations which would reduce the conservation value of including a fish ladder for the dam.

The work reported by Wasantha, (2018) indicated that Victoria Reservoir and Samanala Reservoir Hydroelectric dams in Sri Lanka do not contain fish ladders, fish ways or fish paths. Therefore, dams across rivers have become barriers for migration of fish.

3.3 Impacts on Hydrology and water quality

3.3.1 Impacts on sub-surface hydrology

The project had changed the water table of the area. While interviewing the people, Seventy three percent of the people living in the study area of the upstream had observed the water level in their well has been increased by 1-2 feet after the reservoir construction and continually having the adequate water in their well in the dry season (March – September) period (Fig 13). But twenty seven percent of the people have not observed any fluctuation or changes in the water table. The people living in the downstream observed the water level in their well has gone down during summer but continually having the water than before the reservoir construction.

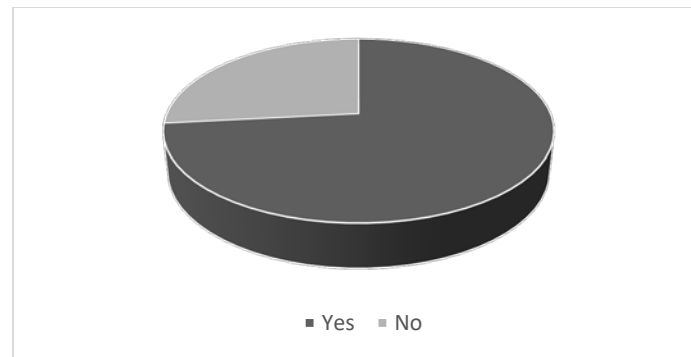


Fig 13: Water table changes

Subhendu *et al.*, (2018) also noted in his study on the Impact of Maithon Dam construction that absence of forest and absence of river, jointly affected the water resource of the area. According to field survey of Subhendu *et al.*, (2018), all the dug-wells and the natural courses of river become dried up in the summer, even the deep tube wells established by the government sometimes fail in the summer due to depth.

3.3.2 Impact on Environmental flow

Peru Aru is not a perennial river. The EIA had recommended to maintain continuous downstream flow throughout the year. The study revealed that the water flow was not stopped during the construction. A diversion canal was constructed during the construction to allow the stream flow without any interruption. This study reveals that operating arrangements have not been performed to release the environmental flow after the construction. People living at the downstream too confirmed that they have not observed any flow of water during the dry spell in the river. The project team believed that the seepage water from the reservoir is enough to meet the environmental flow requirement (Fig 14). The perception of the NWSDB is not justifiable against the concept of the environmental flow. The proposed continuous flow in EIA has not been complied.

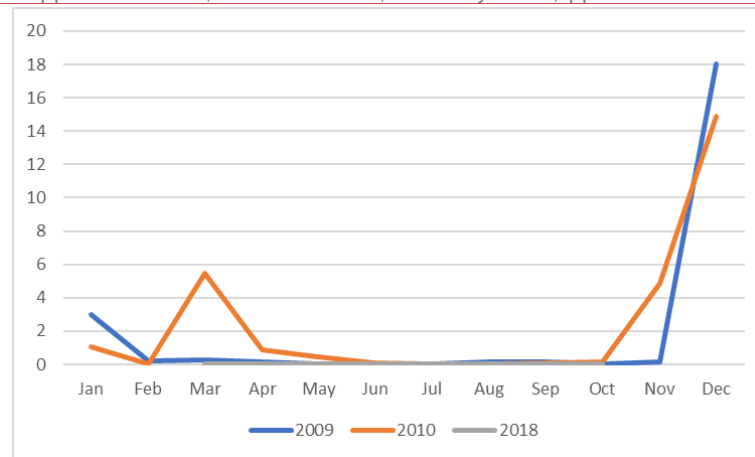


Fig 14: Monthly average stream flow (m³/sec) (EIA, 2012b)

Richter *et al*, (1997) and Gopal, (2013) described that Natural flow regime has its own behavior and flow functions can be violated through flow manipulations. Furthermore, the dependents at the downstream are interlinked with hydrology that is being changing with hydrological alterations such as dam construction and it may leads to unpredictable consequences. King *et al*, (2008) noted that the goal of allocating the EF under above conditions is to restore the downstream natural flow regime to an acceptable level. Considering these importance, EFs and ecological considerations must be taken in to account seriously in development activities.

3.3.3 Impact on water quality

The study revealed that the project started including land clearing, dam construction and intake structure commenced in July 2013 and completed in September 2016. It is known that the project had been implemented for 39 months period. However, the quality of the water was measured only three times March 2015 (no data available), July 2015 and March 2016. As per the EIA the water quality should be measured once in three months during the construction. But the water quality was measured only in three times during the construction period in the downstream closer to the reservoir. The results are compared with the Sri Lankan standard for Drinking water quality of maximum permissible level (SLS 614:1983). It was revealed that the quality of the down stream water was not disturbed due to the project.

3.4 Management of Air Pollution

EMP recommended to measure the quality of the air once in three months. However, the Project Implementation Unit has measured only in two times throughout the project implementation period of 39 months where there should be 13 records (Table 1).

Table 1: Air quality levels recorded at project sites

Location	Sampling date	Time average	Concentration at each sampling location (mg/m³)
----------	---------------	--------------	---

				SO ₂	NO ₂	CO	SPM	PM ₁₀
Ambient Air Quality Standards*				0.120	0.150	10	0.350	0.100
At the entrance to camp site (L1) At bund top	30 Jul 2015	8 hrs.	0.016	0.028	<1			
	29-30 Jul 2015	24 hrs.				0.016	0.036	
	10 Mar 2016	8 hrs.	0.020	0.028	<1			
	9-10 Mar 2016	24 hrs.				0.168	0.038	
	30 Jul 2015	8 hrs.	0.015	0.026	<1			
	29-30 Jul 2015	24 hrs.				0.195	0.057	
	10 Mar 2016	8 hrs.	0.021	0.025	<1			
	9-10 Mar 2016	24 hrs.				0.064	0.230	

Source : EMoR, 2015-2016

*Stipulated under Extraordinary Gazette No. 850/4, December 20, 1994 and Gazette No. 1562/22, August 15, 2008 by the Central Environmental Authority (8 hour average for SO₂, NO₂, CO and 24 hours for PM₁₀)

The study revealed that Except PM₁₀ measurement in March 2016, all measured levels of ambient air quality parameters were within the standard levels stipulated under respective gazette on ambient air quality. However, two records are not enough to make a decision that the Project has followed enough mitigation measures to control the dust.

While interviewing the people, hundred percent of the people stated that the vehicle transporting the material have generated the dust during the construction. It is confirmed based on the above results the contractor had not followed enough mitigation measure such as watering/ water spearing to the ground to control the dust.

3.5 Management of Noise

Lawrence (2011), noted that current estimates suggest many millions of people around the world are seriously affected by (environmental) noise in their communities. The study reported by Kupolati (2010), revealed that civil engineering infrastructure development projects impacted greatly on the environment especially in areas of noise pollution, water pollution, decrease in size of available land, etcetera.

The test studies have shown that the project has not created the large noise and vibration. Sixty seven percent of the people stated that they heard low noise. Twenty seven percent of the people mentioned that they heard moderate noise. Seven percent of the people mentioned that they had heard extreme noise (Fig 15). The respondent composition is within five hundred meters radius in the upstream and downstream.

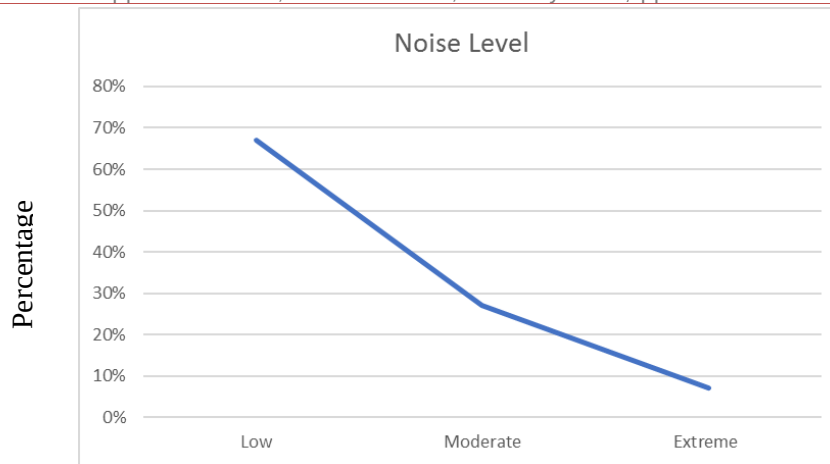


Fig. 15: People heard noise level

Table 2: Noise levels recorded at project sites

Location	Monitoring date	Time	Run Time (min)	Measured noise level Leq (dB)	Residual noise level Leq (dB)	Corrected noise level
At the camp site near staff quarters, 50 m away from batching plant	29 Jul 2015	Day	5	61	49	61
		Night	5	47	40	46
	10 Mar 2016	Day	5	43	40	40
		Night	5	39	36	36
At the dam access road Ch. 0+550m, in front of camp site (NB)	29 Jul 2015	Day	5	49	46	46
		Night	5	49	40	48
	10 Mar 2016	Day	5	50	46	48
		Night	5	43	40	40
At dam construction area (Ch. 1+225)	10 Mar 2016	Day	5	47	43	45
		Night	5	49	40	48
At dam construction area (Ch. 1+800)	29 Jul 2015	Day	5	55	49	54
		Night	5	48	40	47
At the radial gated spill site at Ch. 2+070	29 Jul 2015	Day	5	59	49	59
		Night	5	46	40	45
	10 Mar 2016	Day	5	65	50	65
		Night	5	41	38	38

Source : EMoR, 2015-2016

The maximum permissible noise levels stipulated under Gazette Extraordinary No. 924/12 of 23 May, 1996 under the National Environmental Act (NEA) at boundaries of construction sites are 75 dB(A) during day time and 50 dB(A) during night time. As per the above measurements no boundary location has recorded noise levels above the stipulated noise levels of NEA during day time or night (Table 2).

3.6 Impact on Health

The study revealed that the aspect of Occupational Health and Safety and Community Health and Safety were not considered in the EIA reports. However hundred percent of the people living in the sample study area confirmed that they have not noted any communicable diseases as a result of this project.

The people in the project area were not aware about the health problem due to dust. It was stated by fifty seven percent of the people that they were not aware about the health impact due to dust. Forty seven percent of the people stated that there was no any health impact due to dust raised by the project (Fig 16).

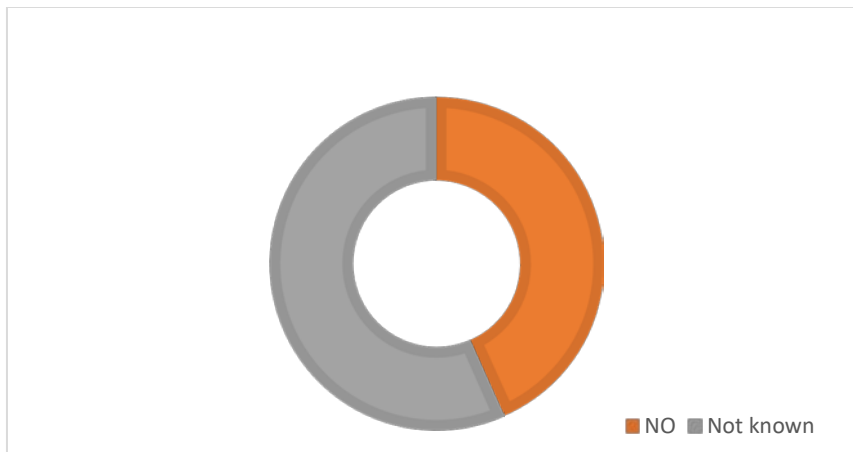


Fig 16: Dust related health problems

The project has followed harmless waste disposal methods. Hundred percent of the People in the study area confirmed that they have not faced any difficulties with solid and liquid waste from the projects.

3.7 Institutional Arrangement for Environmental Management

3.7.1 Incorporating the EMP into the Bid document and budgetary allocation

EMP and EMoP are integral parts of the contract, their implementation is mandatory for contractors. Incorporating the EMP into the Bid document of the Peru Aru reservoir construction project was screened. It was noted that requirement of EMP were included in the Section 6 and Section 8 of the Bid document.

The engineer estimated Rs.35,520,000 for the Environmental Management activities of before, during and after the construction activities. However, the successful bidder quoted Rs. 88,330,000 for the projects Environmental Management and utilized 82,720,000 at the project completion (Fig 17). The 95% of the contractors quoted amount are for the establishment of nurseries, watering and maintaining the reforested area to ensure survival of the plants. The contractor has utilized 96% of the quoted amount for the establishment of nurseries, and watering and maintaining the reforested area to ensure survival of the plants. The contractor's quoted amount is 60% higher than the engineer estimate. The contractor quoted 10% of his total contract amount for EMP obligation while engineers estimated only 5.3% for the EM activities.

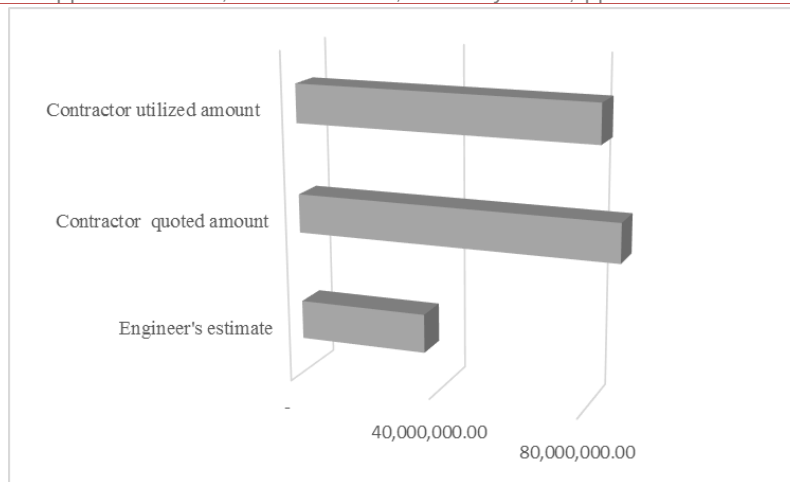


Fig 17: Estimation and actuals for EM

The study revealed that the re-planted plants under the project were to be maintained by the project for a period of two years during the operation and maintenance period. The operation and maintenance are not performed by the project office and no transitional arrangements have been made to maintain the re-forestation. As per the discussion with project staff, a contract was given to Forest Department by the contractor for planting the trees and technical guidance.

3.7.2 Monitoring activities by CEA

The EIA has proposed to monitor the EM activities once in three months. CEA district office monitors the IEE project while head office monitors the EIA projects. As this project is a category A and EIA project, it was monitored by CEA head office. CEA head office officials have filled missions only three times during the entire project period in 2014, 2015 and 2017. CEA noted the reforestation program was not effective, survival of plants were affected by cattle and goat, excavated soil was reused to avoid erosion, roads and other exposed areas were watered using water trucks to mitigate dust generation from constructional activities, all material transporting vehicles had been covered, waste bins were available in camp sites and waste disposal was properly done, poor maintenance of reforestation, translocation of species had been completed prior to start the construction. The above results were validated through the author's findings.

3.8 Impacts on Archaeological Cultural Resources

The requirement and managing the archaeological cultural resources is part of the EIA report. The EIA prepared for this project did not discuss to manage if any accidental discovery of archaeological assets, sites or resources discovered at the sites.

However, the project has prepared an Archaeological Impact Assessment (AIA) as per the Antiquities (Amendment) Act No 24 of 1998, and the implementing regulations published in Gazette Extraordinary No 1152/14 of 4 October 2000 require that an Archaeological Impact Assessment is conducted in relation to every proposed development project with a land area of over 0.25 ha. The purpose of the assessment is to examine whether there are antiquities in the land, to determine the impact of the proposed development and to provide alternative measures if necessary.

The following recommendation by the AIA report had been adequately complied by the contractor and project proponent.

- Since proposed Per Aru reservoir dam is connected to existing Periyakulam ancient tank, no damage can be taken place to the ancient tank.
- According to the reports of archeological investigation carried out in the vicinity of the Parannattakal village, settlement indications are at deep soil strata. Therefore, it is recommended to take fullest care while carrying out deep excavations at the project area and incase of finding any archeological item, it had to be brought to the notice of DG (Archeological) by closing all operations at the particular area.
- Project activities could be carried out in a manner that archeological sensitive areas are being protected at the area where Kapparawalli rock over which conical shape holes are appeared.
- Project activities shall be restricted to the area for which permission has been granted. Approval of the department of archeology to be obtain prior to carrying out any activity outside of the project area related to construction, re-settlement, land allocation for agriculture, laying of piles, and excavation etc.

The only building of historic, cultural or religious significance was the Hindu kovil located in the Periyakulam area (Fig 18). This had been in existence for some time and the incumbent was very concerned that the kovil was not to be relocated. Therefore the kovil was rebuilt at the same premises at a higher elevation (Fig 19).



Fig 18: Old Hindu kovil



Fig 19: Newly Built Kovil

3.9 Challenges in implementing the Environmental Management Activities

The study revealed based on the discussion with ADB and CEA officials that challenging Environmental Management Activities are too many agencies involve for monitoring Eg. FD, DWL, CEA; EM activities after the project completion were not properly implemented; On time submission of Environmental Monitoring report by project implementing agency; The submitted reports are lacking with the latest details; Project implementing agencies and contract are not giving the priority; Lack of commitment by project implementing agency to monitor the EMP; Lack of commitment by the contractor in implementing the EMP; Lack of understanding in wearing the PPT by workers; Lack of funds to implement post construction of EMP; Contractor are having Lack of awareness about EMP; and Contractor and project implementing agencies are not having enough skilled staff for the implementation of EMP.

3.10 Community consultation

It is widely accepted that the benefits of stakeholder involvement in environmental management include development that delivers more environmental and social benefits and avoids conflict (Donnelly *et al.*, 1998), there is no tradition of consultation and participation in many developing countries (Lee, 2000). Indeed, the notion of public participation in decision making is revolutionary in

many developing countries (Wilbanks *et al.*, 1993). Fifteen years of EIA experience in the Philippines has shown that many problems associated with the EIA process are traceable to a lack of adequate communication and understanding (Lohani *et al.*, 1997). It was noted that developing countries generally have weak requirements for consultation and public participation, but that as community involvement is becoming more widely recognized as an important element of the success of the environmental management process (Wood, 2003).

EIA has mentioned that a large number of representatives representing both government, nongovernment, private sector and farmer community who enthusiastically participated in the public consultations. However, it was noted no any such evidence photos or signatures of the attendees were attached to the EIA.

3.11 Measuring the degree of Success

Table 3: Measuring the degree of Success

Criterion	Weight (%)	Description/Justification	Rating Description	Rating Value	Score
1. Relevance	25	The proposed mitigation measures relevant. The EMP has covered the mitigation activities for important source of impacts. (Eg; reforestation, waste management, erosion and safeguarding the less mobile species).	Relevant	2	0.50
2. Effectiveness	25	The mitigation measures mentioned in the EMP is effectively followed. Except for dust the mitigation measures for cutting trees, water pollution, waste management, air pollution and noise were adequately practiced and impact were reduced.	Effective	2	0.50
3. Efficiency	25	Contract has spent more money for reforestation program. However there was no allocation to maintaining the plant. Also EMP mentioned to spray water to control the dust which was not highly practiced.	Efficient	2	0.50
4. Sustainability	25	There is no allocation or assigned responsibility to maintain the planted trees.	Less than likely sustainable	1	0.25
Total					1.75
Overall Assessment (weighted average of above criteria)	Successful: Overall weighted average is greater than or equal to 1.75 and less than 2.50. Based on the studies and results the implementation of EMP is Successful				

4 Conclusion and Discussion

There is a lack of trained human resources and of financial resources that often leads to the preparation of inadequate and irrelevant EIA reports as a result the poor EMP are prepared. The EMP are prepared based on the professional experience and judgment.

The project had removed valuable trees of 1600 from the project area. However the financial value of those removed trees, lost benefits in terms of environmental and social were not measured/assessed in the EIA reports.

The fish ladder constructed in Peruaru project was the first fish ladder constructed to a reservoir project in Sri Lanka. Without having historic information about the functionality, subsequent problems, shortcomings of such a structure, fish ladder mouth and spillway would have been placed close to each other. This study recommends NWSDB to invite research institutions and universities to study the associated activities of this fish ladder for their future research studies.

Species translocation as a conservation measure in development projects is carried out to ensure the survival of species whose habitat would be affected by the project activities and regardless to their conservation status. The multi-species translocation programme carried out for Per aru reservoir project is reported as the second such instance where large scale species translocation was undertaken as a mitigation measure for a development project, the first instance being the multi-species translocation had been carried out for Moragahakanda project.

Root bowling options were not considered by the project because of the less survival rate and cost. Small plant has a longer life span than a root bowled plant.

There is lack of attention paid by the NWSDB on the concept of eflow. As a result NWSDB is not discharging the eflow. It would be a serious problem in the future.

As recommended in the EIA, no fence was erected around the reservoir. Migratory animals through the area are free to access reservoir at the upper catchment to fulfil their water needs. This will reduce wild animal movements to the downstream human settlements.

Thus, the overall conclusion that can be reached based on the findings that the main environmental safeguards implemented namely translocation of critical species to safe locations, establishment of a fish ladder to facilitate free passage of fish across the dam of the Per aru reservoir, waste management, air pollution and Nosie water quality have been successful.

5 Recommendations

5.1 Water Quality: EIA should recommend measuring the water quality specially turbidity level and the color during the monsoon rains for similar type of project. Because the impact to the water due to the project activity in the area is very high.

The hospital wastewaters are to be released at the downstream. There is no mechanism or proposal to measure the treated water quality before discharging in to the stream. This study recommends that the officials must take necessary steps to measure the water quality before discharging and to plant Reed plants at the area where discharging water is accumulated, because such plants absorb substantial amount of Ammonia.

5.2 Environmental Flow: NWSDB has not released the environmental flow as per the NEA and EIA recommendation of the project. The matter was not raised by any parties after the project completion, other than ADB. Therefore, it is recommended to monitor as raised by the ADB, irrigation department and Department of Agriculture to ensure the e-flow. As per the EIA, one species (*Labeo dussumieri*)

recorded in the river require triggering flows for breeding and the 14 species of dragon flies may also require triggering flows for mounting while over bank flows will be required to maintain the structure of the riverine forest. Therefore, it is recommended to do further studies on the survival of the above species as there were no e-flow after the project completion. Also this study recommends to do the study on the total requirement of e-flow by compiling social and vegetation water use and release e-flow by maintaining e-flow records.

5.3 Flora Species Conservation: Mitigation measures were proposed and executed only for affected fauna in the project area. However there are no mitigation measures were proposed in the EIA for 11 endemic, six nationally threatened and three nationally near threatened flora species. It is recommended to include the mitigation measures in the Environmental Management Plan for future projects. Ex. Translocate/Replant such species. There is no maintenance for the planted plants. The community engagement for maintaining the plant could be considered, by compensating them by cash for the future projects. Also planted trees must be maintained for minimum five years. The environmental safeguard budget shall be adjusted accordingly. There is unidentified removal of trees by the forest department during the forest clear. It is recommended for future projects to demarcate right of the way clearly by fixing visible permanent boundary poles, and to conduct awareness program for the field staff including tree removing crew before starting tree removal exercise. The newly planted treed should be tacked and marked with geographical coordinate to monitor the survival rate. This helps to differentiate with existing habitats.

5.4 Forest Habitat Conservation: As the accessibility to the area has been improved with the construction of new roads more people are now engaged in fuel wood collection in the forest habitats. Further, improvement of infrastructure has led to replacement of bicycles that were used for transport of fuel wood with motorcycles and tractors, which has increased the amount that can be transported at a given time. Therefore, there is a significant change in the rate of removal of fuel wood form forest habitats. By evaluating the possibility, it is recommended fuel wood use in the area such as establishment of community forests, encouraging people to switch to different energy source such as kerosene or LP gas should be explored. Further the awareness programs can be conducted to the community to protect the forest.

5.5 Fish Ladder : The spillway and the fish ladder should be strictly maintained as a no fishing zone as fish are easily captured by the villagers at these two locations which would reduce the conservation value of including a fish ladder for the dam. The construction of fish ladder mouth closer to the spillway might have happened due the lack of historic information about the functionality, subsequent problems, shortcomings. It is recommended to design the fish ladder for this kind of project at the beginning. Also it is recommended to extend the length of the fish ladder further down. The flow speed in the fish ladder should be kept at a minimum level which will facilitate make it easier for the fish to travel upstream in the fish ladder without becoming fatigued. It is advisable to use small boulders instead of small concrete metal in the bottom surface of the fish leader which will prevent this situation from arising as well as make it easier for fish to move through the fish ladder. Fish hatcheries can be considered as an option. Fish hatcheries try to compensate for fish stocks affected by dams

5.6 Air Quality : The EMP didn't record the quality of the air in the project area before the project comment or during EMP preparation. The comparisons have been made with the standard levels stipulated in the gazettes on ambient air quality. It is recommended to take Air quality of the area during the EMP preparation for future development project. Construction work involving excavation

of soil should not be done at the peak of dry and windy season in order to avoid excessive release of dust into the atmosphere thereby increasing suspended particulates above threshold limit

5.7 Community Health and Safety : Higher percent of the people are not aware about the health impact due to the dust. It is recommended to issue the EIA summary to the people who live in the area. As a result people could monitor and inform to project staff to follow the proper mitigation measures to control the dust generated by the heavy vehicle movement. There are crocodile attacks due to water level rise in the upstream. The EMP must include the mitigation measures for such problem. The people in the surrounding area must be educated how to respond when the crocodiles are moving the human settlement areas. Eg; Share the contact details of wild life department etc.

5.8 Invasive Plants: *Muntingia calabura* (Jam fruit tree) is an invasive trees which can be seen in all the street and gardens in Sri Lanka. The forest department should take necessary steps to control the Jam tree.

5.9 Grievance Redress Mechanism : It is recommended to established a multi-tiered grievance redress mechanism to resolve environment-related grievances and complaints.

5.10 Archeological site management: The EIA prepared for this project did not discuss on how to manage if any accidental discovery of archeological assets, sites or resources discover at the sites. However recommendation for the archeological should be included in the EIA.

5.11 Reporting Requirement : Donor agencies evaluate the successfulness of the implemented development project. There is no post evaluation on the degree of success in environmental mitigation measures that has been implemented before, during and after construction. Donor agencies should take steps to do the post evaluation on the implemented EMP.

REFERENCES

- [1] Asian Development Bank (ADB), (2018a). TA-9050 REG: Strengthening Capacities to Design and Implement Smart Urban Infrastructure - The Small Towns and Rural Arid Areas Water Supply and Sanitation Project, Final Report.
- [2] Asian Development Bank (ADB), (2018b). Impacts of Dams on Fish in the Rivers of Nepal, 44-46pp.
- [3] Dharmasena, P.B., (2003). Soil erosion and conservation – A case study in the dry zone of Sri Lanka. Tropical Agricultural Research and Extension, 6, 2003. p 128-131.
- [4] Diana, V. (2018). Daily Financial Times, Moragahakanda Mega Irrigation Project to boost rice production, <http://www.ft.lk/agriculture/Moragahakanda-Mega-Irrigation-Project-to-boost-rice-production/31-647321> (Accessed 29 April 2019)
- [5] Donnelly, A., Dalal-Clayton, B. and Hughes, R. (1998), A Directory of Impact Assessment Guidelines, London, International Institute for Environment and Development, 2nd edition
- [6] Environmental Impact Assessment (EIA), (2012a). Environmental Impact Assessment on the Proposed Surface Water Extraction from a Reservoir Across Per Aru, Vavuniya District. May 2012 <https://www.adb.org/projects/documents/dry-zone-urban-water-supply-and-sanitation-project-proposed-surface-water-extract>
- [7] Environmental Impact Assessment (EIA), (2012b). Environmental Impact Assessment on the Proposed Surface Water Extraction from a Reservoir Across Per Aru, Vavuniya District. November 2012.

- [8] Environmental Monitoring Reports (EMoR), (2015-2016), Semi Annual Environmental Monitoring Reports.
- [9] Gopal, B. (2013). Environmental flows: An introduction for water resource managers. National Institute of Ecology, New Delhi.
- [10] IUCN, (2007). Biodiversity assessment of the Moragahakanda agriculture development project. Support to implement EIA recommendations of the Moragahakanda Agricultural Development Project (MADP) and Kalu Ganga Reservoir and Agricultural Extension Project (KR&AEP)
- [11] King. J.M., Tharme, R.E. and Villiers, M.S. (2008). Environmental Flow Assessment for Rivers: Manual for the Building Block Methodology. Water Research Commission, Republic of South Africa.
- [12] Kupolati. W.K., (2010). Environmental Impact Assessment of Civil Engineering Infrastructure Development Projects. OIDA International Journal of Sustainable Development 02:04 (2010) 57-66, Available at <http://www.ssrn.com/link/OIDA-Intl-Journal-Sustainable-Dev.html>
- [13] Lawrence. S.F, (2011). Guidelines for Community Noise Impact Assessment and Mitigation. I-INCE Publication Number: 11-1
- [14] Lee, N. (2000). 'Integrating appraisals and decision making', in N. Lee and C. George (eds.) Environmental Assessment in Developing and Transitional Countries, Chichester, John Wiley and Sons
- [15] Lohani, B., Evans.J,W., Ludwig.H., Everitt.R.R., Richard A. Carpenter, and Tu.S.L., (1997). Environmental Impact Assessment for Developing Countries in Asia. Volume 1 – Overview, 1-13 pp.
- [16] Richter, B.D., Baumgartner, J.V.B., Wigington, R. and Braun, D.P. (1997). How much water does a river need?. Fresh water Biology.
- [17] Subhendu, G., Sumanta, B. and Chumki, M., (2018). Impact of Maithon Dam – A Micro Level Study on Salanpur Block of Paschim Bardhaman District, West Bengal, International Journal of Computational Engineering Research (IJCER), Volume 08
- [18] Wasantha, S.W., (2018). The Island newspaper article, Fish Ladders to preserve Sri Lankan Culture. Available from: http://www.island.lk/index.php?page_cat=article-details&page=article-details&code_title=189880. (Accessed 16 Feb 2019)
- [19] Wickramasinghe, L.A. and Premalal. R, (1988) Development of a rainstorm erosivity map for Sri Lanka. Proc. of the 5th International Soil Conservation Conference. (Ed.) Sanam Rimwanich. Bangkok, Thailand
- [20] Wilbanks, T. J., Hunsaker, D. B., Jr., Petric, C. H., and Wright, S. B. (1993). 'Potential to transfer the US NEPA experience in developing countries', in S. G. Hildebrand and J B Cannon (eds.) Environmental Analysis: the NEPA Experience, Lewis, Boca Raton, FL.
- [21] Wood, C. (2003). Environmental Impact Assessment in Developing Countries: An Overview, EIA Centre, School of Planning and Landscape, University of Manchester, Manchester M13 9PL.