



Environmental Impacts and Land Use Land Cover Map in Lower Paunglaung Hydropower Project

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Abstract: Large dams, though necessary for national growth, adversely affect the life-support strategy of a large number of people living in the submergence zone and the hinterland of the reservoir. With the help of GISbased techniques and land-use/land-cover map prepared with the help of satellite remote sensing tools, it is estimated that the watershed and reservoir areas are 317 km² and 18 km². The Lower Paunglaung Dam is located at 19 ° 47' 17" north latitude and 96 ° 19' 59" east longitudes in Mandalay Division boundary area in Myanmar. It was started in 1998 and commissioned in 2005. It is an installed capacity of 140 MW and 434 GWh annual generation. The flow accumulation, flow direction and drainage network and watershed were generated from DEM using ArcGIS software and land use/ land cover maps using ENVI package. And the environmental impacts are mostly forest land and wildlife and species in the reservoir area. The water was tested at the water and sanitation department (water laboratory), Mandalay (Myanmar). From the water quality analysis, it is clear that the quality of water is good. Low BOD levels indicate the absence of organic pollution source.

Keywords: Lower Paunglaung Dam, AIS Package, Topographic Map, Satellite Image, Environmental Impact, Land Use Land Cover And Water Quality Analysis.

I. INTRODUCTION

Myanmar's largely rural population relies heavily on rivers and streams for their livelihoods and culture. These are under serious threat from dam development. To construct a dam, it needs to manage the river, stream and inland for the benefits of human lives. On the other hand, it can make many environmental and social problems by constructing man-made structures. It requires studying the Environmental Impacts Assessment (EIA) before the constructing of these reservoirs. While dams provide significant benefits to our society, their impacts on the surroundings include socioeconomic impacts and environmental concerns. In order to predict environmental impacts of any development activity and to provide an opportunity to militate against negative impacts and enhances positive impacts, the environmental impacts assessment (EIA) procedure was developed in the 1970s. EIA is a management tool for planners and decision makers and complements other project studies on engineering and economics. Environmental assessment is now accepted as an essential part of development planning and management. It should become as familiar and important as economic analysis in project evaluation. The aim of any EIA should be to facilitate sustainable development. Beneficial environmental effects are maximized; while adverse effects are avoided to the greatest extent possible [1]. Dams have positive and negative effects on environment. The social effects of dams in their surroundings are important because dams have large long term effects on the communities that live in the land used for the project; their magnitude in a

balance between the benefits and damages of a dam project is large [2]. Watersheds can be delineated from a DEM by computing the flow direction and using it in the Watershed function. The Watershed function uses a raster of flow direction to determine contributing area [3]. Land use change is one of the main boundary conditions which influence many hydrologic processes. The effect of land use changes on river flow is one of the most important environmental problems of our time. Expanding cities due to economic growth and population growth both often come at the expenses of increased risk of flooding and decreased quality and quantity of water [4].

II. MATERIALS, METHOD AND DATA SOURCES

A. Materials

The characteristics of Lower Paunglaung Hydropower Project are described in Table I.

TABLE I: CHARACTERISTIC OF LOWER PAUNGLAUNG DAM

Item no	Item	Character
1	River	Paunglaung
2	Purpose	Irrigation and energy
3	Dam	Rocked-filled dam
4	Dam height	131m (430ft)
5	Dam Length	945m (3100ft)
6	Maximum water level	EL-190 m

7	Minimum water level	EL-160 m
8	Water surface area	18 km ²
9	Storage capacity	560000Acre-ft
10	Dead storage capacity	280000Acre-ft
11	Install capacity	280MW
12	Annual generation	911GWh

B. Method

The environmental impacts are evaluated using topographic maps (linch map) in GIS package. The categories of the environmental impacts are classified by the supervised and unsupervised classification method with satellite images. The satellite images of Landsat (2000) are used for the study area. A false colour composite of the ASTER image is generated and geo-referenced based on the Universal Transverse Mercator 1984 and Zone 47. The rectified images are then interpreted in the ENVI 4.2 software using the method of unsupervised classification [5]. The water at downstream of Lower Paunglaung dam is analyzed.

C. Data source

The data sources of this project are described in Table II.

TABLE II: DATA SOURCES FOR LAND USE LAND COVER MAP

Type	Index	Published date
Topographic (One-inch map)	94_A_05	March 1945
	94_A_06	April 1945
	94_A_09	February 1945
	94_A_10	July 1945
Satellite image (Landsat)	P133/ r046	30.12.1999

III. LOCATION OF THE STUDY AREA

Lower Paunglaung Hydropower project is located at 19 ° 47' 17" north latitude and 96° 19' 59" east longitude, a boundary area between Mandalay Division and Shan state in Myanmar. It is located on the Paunglaung River, the upper reach of Sittaung River. The Paunglaung river flows from its source in Western Shan state through the south west plateaus into the join Sittaung. The dam is at the southern end of the Paunglaung Valley, the only fertile plain along the river. It was started in 1998 and commission in 2005. It is an underground power station with an installed capacity of 280 MW and 911 GWh annual generation. It aims to meet water demand for irrigation and to generate the hydropower. Part of the water is diverted to the already existing Yezin reservoir, to be used for irrigation. The location map is shown in Fig 1.

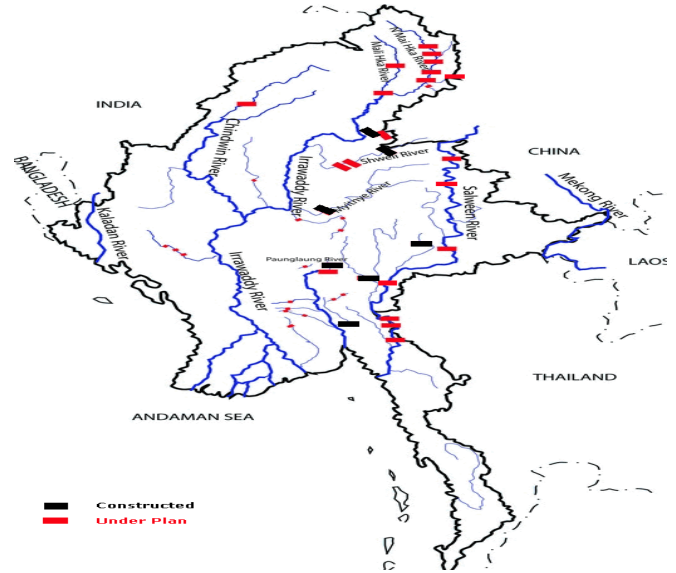


Fig.1. Location map for the study area.

IV. ENVIRONMENTAL IMPACTS

The impacts of dams vary substantially from one geographical location to another and are dependent on the exact design and the way a dam is operated, as well as the ecological character of the riverine ecosystem and the socioeconomic context. Every dam has specific characteristics and, consequently, the scale and nature of environmental changes are highly site-specific and often very difficult to predict accurately [6]. Animal and plant life are impacted significantly by the dam construction. As

TABLE III: ENVIRONMENTAL IMPACTS DUE TO RESERVOIR OR DAM

Upstream area	Downstream area
-Loss of forest: loss of biomass, habitats, wildlife, exploitable forest products, loss of productive land and timber stands	-Change in the water flow regime: low flows become larger and small flows smaller (with a possible significant fluctuation during the day depending on power operations).
-Loss of protected area	-Dam will represent a barrier to fishes for spawning and for navigation.
-Change in the river flow regime: impacts on wildlife and fishes	-More availability of water may enhance the possibility of developing irrigation schemes and navigation.
-Submergence of vegetation	
-Possible induced seismicity	
-Possible induced landslides	

mentioned earlier the large scale flooding destroys a large area of habitat for animals and destroys an equally large number of plants. If the region was forested prior to the construction of the dam, the timber is harvested before the

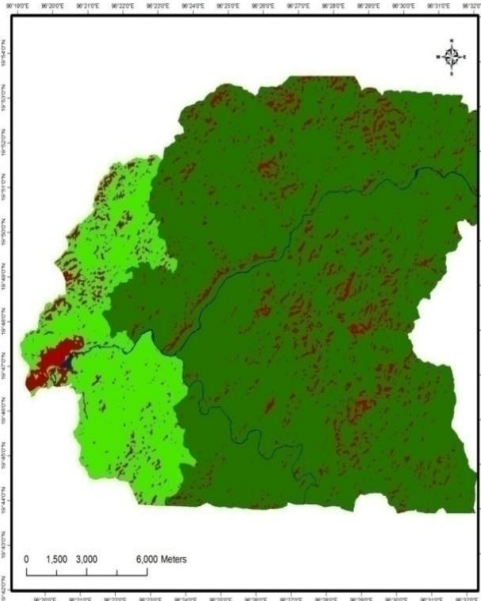
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flooding begins. Reservoirs that in the future will be used for recreation such as boating or fishing tend to be completely cleared of trees. The impact of tree removal is more logging equipment around the dam site which of course increases roads and pollutants into the region. Some of biological impacts are flora, fauna, fishery, water-borne diseases aquatic –nuisance and water quality. The environmental impacts are shown in Table III.

V. LAND USE LAND COVER ANALYSIS

A. Land Use Land Cover in Watershed Area

For the purpose of flood analysis, it is necessary to reclassify the land use categories. Land use such as urban, housing, public facilities, schools can be considered the same and can be grouped into one group and classified into urban or built-up land, as well as rivers, lakes, ponds and swamps can be grouped into another, that is classified into water. In this study, the land cover is classified as forest land, water body and deforestation land by using remote sensing and GIS software whereas the urban area is not included in the reservoir area. Based on information from local inhabitants, deforestation, water body, open forest and dense forest land are the major land use and land cover classes, depending on their level of ground cover during the study periods. There was no population in the Lower Paunglaung Watershed area. Using ArcGIS tool a reclassification map for the Lower Paunglaung watershed is defined in Fig 2.



Source; Map derived from landsat image (2000)

Fig.2. Land use land cover map of watershed area.

Analysis of the 2000 satellite image revealed that dense forest land constituted the largest proportion of land in Lower Paunglaung with a value of 74% (Fig.3), followed by open forest land which accounts for 17%. Water body occupies the least class with just 0.6% of the total area. Also, deforestation area seems to be practiced moderately, nearly 9% of the total classes.

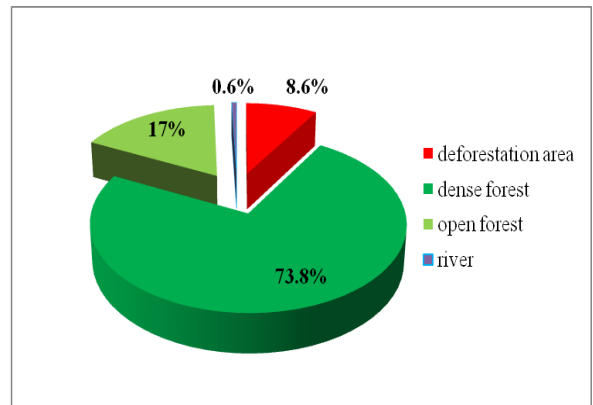
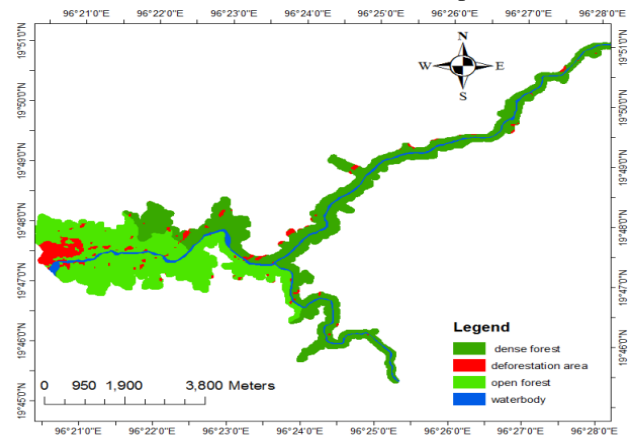


Fig.3. Percent of different classes in watershed area.

B. Land Use Land Cover within Reservoir Area

In the analysis of the 2000 satellite image, the study area contains in the forest land and a little of water body before constructing Lower Paunglaung Dam. Based on the satellite image (2000), it is classified into the major classes of dense forest, open forest, water body and deforestation land in the study area. There are dense forest (8.83 km²), open forest (7.18 km²), deforestation area (1.04 km²) and water body (1.21 km²). According to the GIS map analysis, the submerged area contains mostly the forest land such as open forest and dense forest. There was no built-up area in the



Source; Map derived from landsat image (2000)

Fig.4. Land use land cover map of reservoir area.

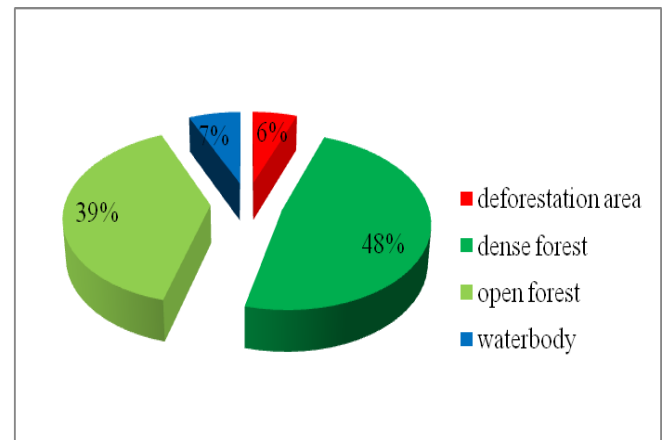


Fig.5. Percent of different classes in reservoir.

impounded area by constructing Lower Paunglaung reservoir. The map of land use land cover within reservoir area is shown in Fig.4 and 5.

VI. WATER QUALITY ANALYSIS

The environmental impact such as water quality is analyzed. The water quality is an important consideration for all water resource development (WRD) projects as it affects all aspect of water use – for humans, animals, crops, and even industries. Construction of a project does not degrade

TABLE IV: WATER RESULTS FOR UPSTREAM (26.9.2012)

Characteristics	Units	Actual Value	W.H.O standard
D.O	mg/l	6.20	-
B.O.D	mg/l	8.20	-
pH value	Scale	6.80	6.5-9.2
Colour	Units	5	50
Turbidity	N.T.U	2.80	25
Conductivity	micromhos	150	-
Calcium as Ca	/cm	19	200
Hardness, total as CaCO ₃	mg/l	64	500
Magnesium as Mg	mg/l	4	150
Chloride as Cl	mg/l	5	600
Total alkalinity as CaCO ₃	mg/l	80	500
Iron, Total as Fe	mg/l	0.01	1.0
Maganese as Mn	mg/l	0.01	0.5
Sulphate as SO ₄	mg/l	< 200	400

TABLE V: WATER RESULTS FOR UPSTREAM (13.12.2012)

Characteristics	Units	Actual Value	W.H.O standard
D.O	mg/l	9.31	-
B.O.D	mg/l	6.80	-
pH value	Scale	6.80	6.5-9.2
Colour	Units	50	50
Turbidity	N.T.U	5.80	25
Conductivity	micromhos/cm	120	-
Calcium as Ca	mg/l	10	200
Hardness, total as CaCO ₃	mg/l	40	500
Magnesium as Mg	mg/l	4	150
Chloride as Cl	mg/l	6	600
Total alkalinity as CaCO ₃	mg/l	60	500
Iron, Total as Fe	mg/l	0.2	1.0
Maganese as Mn	mg/l	0.05	0.5
Sulphate as SO ₄	mg/l	< 200	400

TABLE VI: WATER RESULTS FOR DOWNSTREAM (26.9.2012)

Characteristics	Units	Actual Value	W.H.O standard
D.O	mg/l	5.20	-
B.O.D	mg/l	7.44	-
pH value	Scale	6.8	6.5-9.2
Colour	Units	20	50
Turbidity	N.T.U	11	25
Conductivity	micromhos/cm	210	-
Calcium as Ca	mg/l	32	200
Hardness, total as CaCO ₃	mg/l	100	500
Magnesium as Mg	mg/l	5	150
Chloride as Cl	mg/l	6	600
Total alkalinity as CaCO ₃	mg/l	120	500
Iron, Total as Fe	mg/l	0.02	1.0
Maganese as Mn	mg/l	0.02	0.5
Sulphate as SO ₄	mg/l	< 200	400

the quality of water- the reckless and indiscriminate use of fertilizers, pesticides, and disposal without proper treatment does that. Building a dam over a river deprives the downstream land of nutrients normally brought by the river in the form of silt. After the construction of dam, river flow is stored in the reservoir and this alters the supply of fresh water to the downstream area. The purposes of the project are to generate the hydropower and irrigate the agriculture. The water sample at upstream and downstream are collected at two times. And then, the water was tested at the water and sanitation department (water laboratory), Mandalay. The results at upstream and downstream of the reservoir are shown in Table IV, V, VI and VII.

TABLE VII: WATER RESULTS FOR DOWNSTREAM (13.12.2012)

Characteristics	Units	Actual Value	W.H.O standard
D.O	mg/l	9.80	-
B.O.D	mg/l	3.80	-
pH value	Scale	6.80	6.5-9.2
Colour	Units	10	50
Turbidity	N.T.U	4.89	25
Conductivity	micromhos/cm	180	-
Calcium as Ca	mg/l	27	200
Hardness, total as CaCO ₃	mg/l	80	500
Magnesium as Mg	mg/l	3	150
Chloride as Cl	mg/l	6	600
Total alkalinity as CaCO ₃	mg/l	100	500
Iron, Total as Fe	mg/l	0.02	1.0
Maganese as Mn	mg/l	0.02	0.5
Sulphate as SO ₄	mg/l	< 200	400

The study area has low population density, with low irrigation intensity. There are no major sources of organic

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pollution in the catchment area. From the water quality analysis, it is clear that the quality of water is good. Low BOD levels indicate the absence of organic pollution source.

VII. COMPARISON OF LAND USE LAND COVER IN WATERSHED AND RESERVOIR AREAS

The land use land cover of Lower Paunglaung watershed and reservoir areas in 2000 are divided into three classes according to the topographic maps and satellite images. The reservoir area is approximately 18 km² at the maximum water level whereas the watershed area of Lower Paunglaung project is 317 km². The comparison of the land use land cover within watershed and reservoir areas are describe in Table VII.

TABLE VIII: LAND USE LAND COVER IN WAERSHED AND RESERVOIR AREAS

Land use land cover categories	Watershed area (km ²)	Reservoir area (km ²)
Dense forest	233.98	8.83
Open forest	53.90	7.18
Deforestation area	27.25	1.04
Water body	2.08	1.21
Total	317.20	18

VIII. CONCLUSION

The environmental impacts are analyzed using topographic maps (one inch map) and satellite images. The water sample at upstream and downstream are collected at two times. And the water quality is tested at the water and sanitation department (water laboratory), Mandalay. There are no major sources of organic pollution in the catchment area. Therefore, Low BOD levels indicate the absence of organic pollution source. The land use land cover categories of the study area are classified using satellite image (Landsat 2000 image) by the method of unsupervised classification. The total reservoir (or) flooded area around the dam site is about 18 km² while the watershed area of the project is 317 km². The environmental impacts are loss of forest land, damage of drainage pattern, loss of wildlife such as flora and fauna within the watershed area and reservoir area or Lower Paunglaung hydropower project.

IX. ACKNOWLEDGMENT

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