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Conservation Measures for Improving Land Use and Land Cover in Dalvoy Lake Environs of Mysore City

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Abstract: ***In recent years of Indian urbanization, the structure of large cities is undergoing rapid land use and land cover changes in lake environs, particularly in Mysore. Mysore is one of the fastest growing tier II cities, located in southern part of Karnataka. The city comprises of several large and small water bodies viz, Karanji Lake, Dalvoy Lake, Kukkarahalli Lake and Devanoor Lake. These lakes play an important role in recharging ground water, regulates microclimate, home for flora and fauna, recreational place for each neighborhood involving in community participation, improve aesthetic of the city and finally influence living condition of the people. Due to rapid transformation of land use and landcover in Mysore has resulted in degradation of water bodies. Dalvoy Lake is one of the major Lakes in Mysore City and it is deteriorating as a result of land use change, growth of industries and urbanization pressures. The total catchment area of Dalvoy Lake is 2165 acres. According to sixth sustainable development goals (clean water and sanitation) targets to protect and restore water-related ecosystems, including wetlands, rivers, and lakes. This paper deals with land use and landcover changes and its analyzing around Dalvoy Lake and its catchment using Remote sensing data and ERDAS imagine software and propose sustainable strategies for environmental improvement and management of the lake.***

Keywords: ***Lake Environs, Land Cover, Land Use, Conservation, Remote Sensing.***

I. INTRODUCTION

In India, the process of Urbaniszation gained momentum with start of Industrial revolution in 1970s followed by globalization in 1990s [1]. The degree of urbanization has increased from 27.7% (2001) to 31.1% (2011) with a decadal increase of 3.3% [2]. Rapid urbanization is the main reason for complex and uncontrolled pattern of urban physical spatial growth and continuous change in Land Use and Land Cover (LULC). Urbanization as resulted in decline of water bodies, arable land, natural vegetation cover, habitat destruction, climate at local, regional and global scales. In most of developing countries like India, urbanization is referred as dynamic process for the growth of urban population resulting in landuse and landcover (LULC) changes. The spatial characteristics of Land use and Land cover (LULC) are useful in understanding the various impact of human activity on the overall ecological condition of the urban environment. Currently water bodies are under varying degree of environmental degradation due to the various anthropogenic activities and encroached due to urban expansion [3].

II. BACKGROUND OF MYSORE

Mysore is located in southern part of Karnataka with an altitude of 770m above mean sea level. It is one of the fastest growing tier II cities, with a population of 8.87 lakhs as per census 2011 and covers an area of 155 km^2. The city has grown considerably with respect to demography and spatially since its formation [4]. The main contribution to city growth is establishment of Information Technology (IT) hubs, industries and associated infrastructure due to liberalization in 1990s. Mysore is recognized for its tree lined boulevard, majestic buildings, water bodies and well laid gardens. But currently Mysore is undergoing extensive and often unplanned urban expansion resulting in loss of green spaces, degradation and encroachment of lakes. Naturally undulating terrain and valley of Mysore has lent perfectly for development of lakes.

III. DALVOY LAKE

Dalvoy Lake (fig1) is one of the major water bodies located in south of Mysore adjacent to Nanjangud road. It was constructed during period of Maharaja in 19th century for irrigation, drinking and for other related purpose. The total catchment area of Dalvoy Lake is 2615acres covering Shettykere, Dalvoy series, Gudumadanahally pickup and marshy pickup**.** [5] Topography of the catchment area slopes from north to south with an average terrain slope of 3% to 5%. Total catchment area consists of 18 numbers of drains, comprising of 25km of drain length. The main contributors of runoff can be seen at foot hills of Chamundi hills, which is part of catchment area. Agricultural practices were seen at the southeastern side of the lake. Stormwater, industrial and domestic sewage enters the lake from various inlets.

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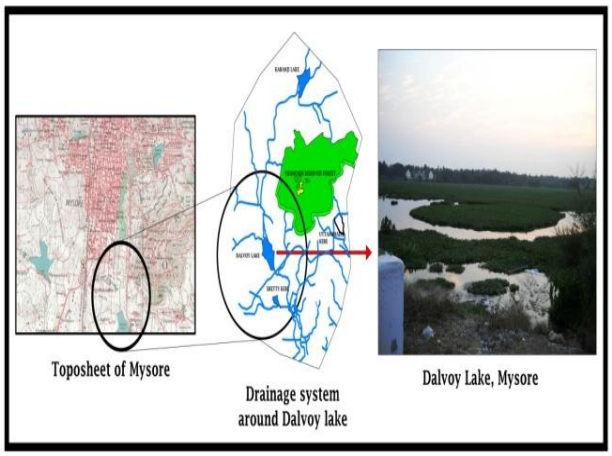

Figure 1: Dalvoy Lake

IV. METHODOLOGY

Methodology involves qualitative and quantitative data from various primary and secondary sources. Multi resolution remote sensing data of Landsat for period of 1998, 2006 and 2012 were used from USGS earth explorer. The topographic map to a scale 1:50,000 of Survey of India were made use of. Landuse map of 2009 of Mysore Urban Development Authority was employed for Land use analysis. Figure 2 illustrates methodology involved.

Remote sensing (RS) is an effective tool to detect and quantify the impact of spatial and temporal Land use and Land cover (LULC) changes. Various period of LULC is taken for comparative analysis. LULC change is analyzed by considering 2.5 Km radius around Dalvoy Lake covering an area of 1968.99 Ha. Earth Resources Data Analysis System (ERDAS) software contains robust support of both vector data and raster data processing, which is used for image processing. Gaussian maximum likelihood classifier (GMLC) is used since pixel with maximum likelihood is classified in corresponding class.

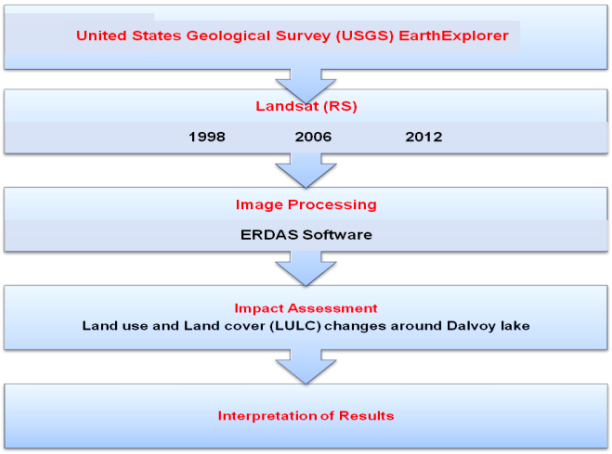

Figure 2 Methodology

In order to identify and obtain the valuable information viz. classes and features, various image processing techniques are adopted. ERDAS EMAGINE 9.1 software is used.

During classification of landuse and landcover different categories to include Built-up, Vegetation, Water Bodies and others are taken into consideration. These Identified LULC layers were created. Classification schemes involve in categorizing and organizing information. Proper organization and categorization of information that can be extracted from image data can be achieved through classification schemes. After analyzing the information sources, 4 types of LULC extraction are done namely Built-up, Vegetation, Water bodies and others.

After analyzing and validating the field information, Built up layer includes roads, bridges, residential, commercial and industrial areas etc., Water body layer includes lakes and drains etc., Vegetation layer includes forestland, plantation etc., Other layer includes land with/ without scrub, barren and agricultural land, mapping of Land cover classes are done from digital remotely sensed data through digital image classification and interpretation.

Dalvoy Lake is under process of degradation mainly due to rapid change of LULC. National Lake Conservation Plan (NLCP) guidelines act as driving tool for environmental improvement of Lake. [6]

V. RESULTS AND DISCUSSION

The contrast and clarity of the LULC image made it possible to broadly classify the study area into built-up area, vegetation, water bodies and others (open space, barren land, etc) (see table 1. Table 2 illustrates Temporal Landuse and Land cover (LULC) changes.

Table 1: Land use and Land cover around Dalvoy Lake

Land use	Built up, urban	Vegetation	Water body	Others
Year	***%***	***%***	***%***	***%***
1998	38	36	2	24
2006	42.5	34.5	1.8	21.2
2012	51.3	28	1.7	19

Table 2: Temporal Land use and Land cover around Dalvoy Lake in hectare

Land use	Built up, urban	Vegetation	Water body	Others
Year	***Ha***	***Ha***	***Ha***	***Ha***
1998	748.42	708.83	48.56	463.18
2006	834.20	676.14	47.34	409.75
2012	997.43	559.02	47.28	364.03

Source: Extracted from the Raster Image

The built up percentage is increased from 38 % (1998) to 42.5% (2006) to 51.3% (2012) due to different phases of economic growth like public sector, industries, offshoot of private sector.

Percentage of vegetation is declined to 24.75% from 1998 to 2012 due to conversion into residential layouts, industrial activity, transport and communication infrastructure. Fig 3 illustrates graphical representation of LULC changes around Dalvoy Lake and Fig.4 illustrates temporal dynamics during 1998, 2006 and 2012 around Dalvoy Lake.

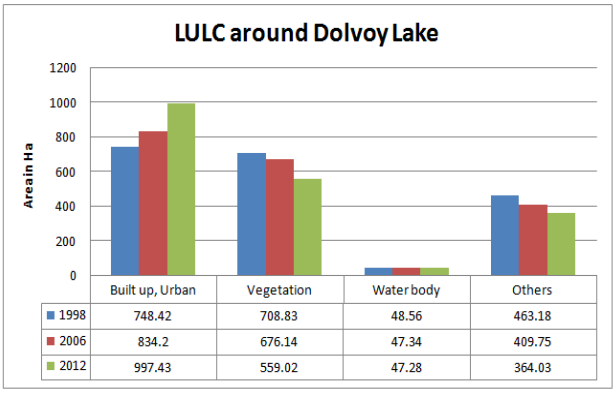

Figure 3: LULC changes around Dalvoy Lake

Area of Dalvoy lake is decreased from 48.56 Ha (1998) to 47.34 (2006) to 47.28 (2012) due to anthropogenic activity of land filling/dumping. The change of Land use and Land cover (LULC) around Dalvoy Lake from 1998 to 2012 has enhanced by various pollutants being discharged from different landuse. Encroachment of lake bed has contributed to low storage level. Dumping of building debris has altered the physical, chemical as well as biological integrity of the ecosystem. This has led to water pollution and silt formation finally affecting water holding capacity of lake.

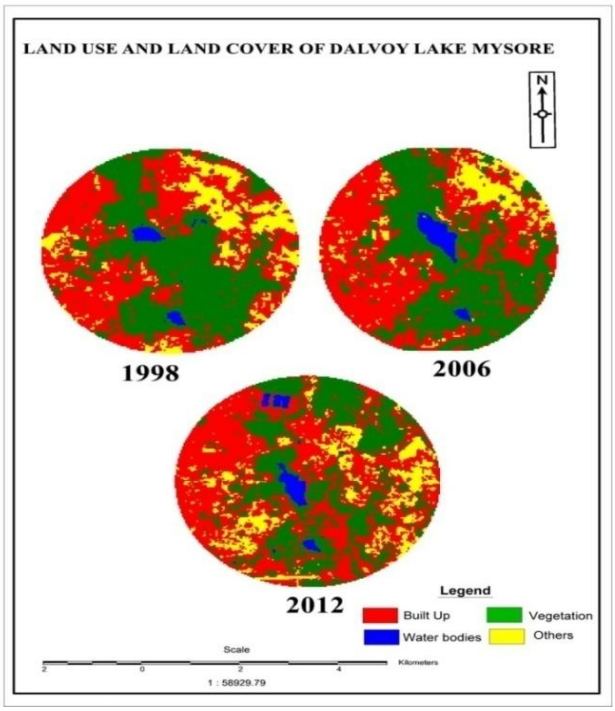

Figure 4: Temporal dynamics Dalvoy Lake in different period

Growth of water hyacinth and consumption of water by weeds have also reduced water holding capacity. The Dalvoy Lake is encroached under urban expansion and shrinked due to eutrophication process. Figure 5 illustrates impact of LULC around Dalvoy Lake. Various socio economic, natural and anthropogenic factors are responsible for ecological degradation and shrinking of Dalvoy Lake.

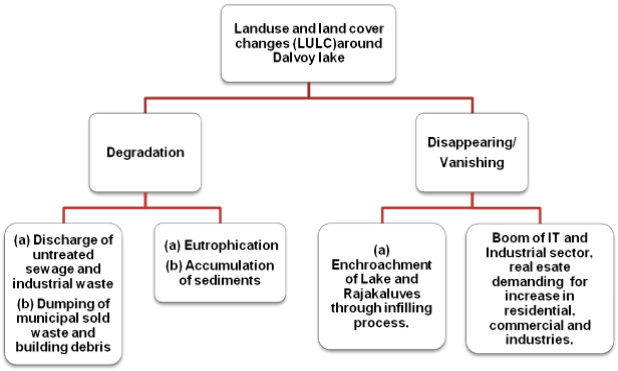

Figure 5: Impact of LULC in Dalvoy Lake Area

(A) ***Discharge of Polluted water into Dalvoy Lake:*** Dumping of building debris and discharge of untreated domestic sewage, industrial effluents into lake has contributed to low water quality resulting in loss of flora and fauna, pungent smell and finally aesthetics of the lake and its environs is lost. Figure 6 illustrates entry of pollutants and impact of different landuse on Dalvoy Lake.

Figure 6 Land use around Dalvoy Lake

Discharge of untreated domestic and industrial effluents into Dalvoy Lake pollutes the lake and contaminates ground water as well. Percentage of built-up area has increased around Dalvoy Lake due to growth of industrial sector, residential layouts namely JP Nagar and Siddalingeshwara layout, traffic and transportation infrastructure etc. Change of Land use and Land cover are the main contributors for pollution. Each land use contributes to different amount of pollution like (a) industries - discharge of heavy metals and detergents, (b) agriculture- use of harmful fertilizers, (c) commercial and residential units. Table 3 illustrates analysis of pollutants entering from various inlets into the lake.

Table 3: Environmental Problems of Dalvoy Lake

Drain No	Analysis	Problems
Inlet 1	Drain No 6A connects outlet of Karanji lake and Mysore zoo carries storm water and its surrounding area and finally joins Dalvoy lake. Drain No 6A2 carries domestic sewage from Curzon park and palace. Drain No 6A5 carries domestic sewage from ooty road to sewage treatment plant.	1. Contaminated lake water and dumping of solid waste around the lake bed has resulted in breeding place for mosquitoes. 2. Water hyacinth, aquatic weeds, algal blooms, Unhygienic foreshore condition is observed in Dalvoy Lake. .
Inlet 2	Drain No 6A6 carries domestic sewage from Jayanagar-Krishnamurthypura- Vidyaranyapuram,-Vishwesharnagar – STP- Dalvoy Lake. Drain No 6A7 carries domestic and industrial waste from Sandal factory (Industrial suburb near JP. Nagar) and finally connects Dalvoy lake. Drain 6A8 carries domestic sewage from Manandawadi road and Visveshwar Nagar. Natural valley at Manandawadi carries industrial waste from concrete manufacturing block.	
Inlet 3	Drain from JP Nagar carries Storm water and domestic sewage into the lake.	
Inlet 4	Drain carries domestic sewage from North east layouts of Dalvoy Lake.	

(B) ***Health Hazards*:** Contaminated lake water and dumping of solid waste around the lake bed has resulted in breeding place for mosquitoes causing malaria, breathing problems etc for people around the Dalvoy lake and environs.

(C) ***Flora and Fauna*:** Healthy climate in the city was due to contribution of variety of rich fauna and flora around the lake. Due to loss of spread area has adversely affected the flora and fauna. Polluted water in lake has affected the terrestrial ecosystem. Aquatic eco-system has disappeared mainly due to reduced oxygen level.

VI. PROPOSALS

Due to inflow of untreated domestic, industrial sewage and dumping of solid waste around Dalvoy Lake etc. as resulted in contamination of lake water. Water quality of Dalvoy Lake has been reduced drastically due to change of Landuse and Landcover. Action plan and management plan is required to prevent lake from degradation. The conservation strategies for improving the quality of lake water are:

1. Control of pollution of point and non point source:

Treatment of sewage from catchment area provides substantial improvement in Dalvoy lake environment and also improves the living condition of community and their environs. Some of the effective management tools are:

(a) Intercepting, diverting and treating the pollution loads before it enters into lake.

(b) The sewage and sullage from the catchment should be stopped at a source point, treatement shall be taken up to the acceptable standards and only then to be allowed to enter the lake. More capacity STPs should be installed.

(c) Remodeling of storm water drainage and removing blockages in storm water drain improves the water quality, increase the storage capacity and also prevents from flooding.

2. In-Lake Treatment:

(a) Installation of Aerator:

Installation of areators: Presently Dalvoy lake is in the state of eutrophic. Aerators plays a key role in improving water quality as well as reduce mosquito activity through continuous circulation of water in lake. Installing Surface and deep (diffuers) aerators improves the dissolved oxygen level for aquatic life which leads to healthier habitat for fish and other aquatic life. Figure 6 shows proposed location of aeration system in Dalvoy Lake.

(b) **De-silting and De-weeding of Dalvoy Lake:** Enhances aquatic ecosysytem and increase storage capacity of lake.

(c) **Riparian Zone Management:** Riparian buffer plays a key role in protecting the storm water drains from impact of adjacent landuse, also improves the water quality of lake [7].

(d) **Fencing of lake:** Fencing is required in order to prevent the entry of cattle and encroachment.

3. ***Recreational Activities*:** Community participation around Dalvoy Lake is encouraged through recreational activities like open gym, jogging track, park axis etc. Bund is to be created throughout the perimeter of lake. To strengthen the bund and to prevent soil erosion around the lake can be achieved by Revetment technology.

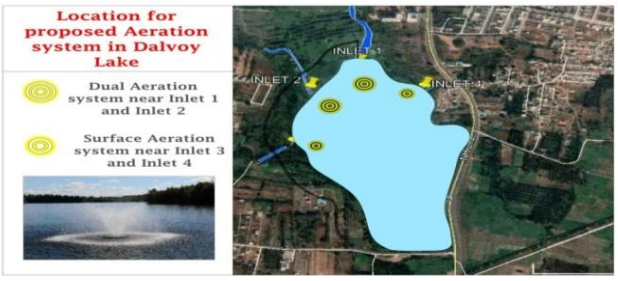

Figure 7: Proposed Aerators in Dalvoy Lake

VII. CONCLUSION

Increase of built-up area from 748.42 Ha (1998) to 834.20 Ha (2006) to 997.43 (2012) is mainly due to growth of public sector, industries, offshoot of private sector, demand for residential units, traffic and transportation. Impact of landuse and land cover changes around Dalvoy Lake as resulted in entry of domestic and industrial sewage, area of the lake is decreased due to encroachments, dumping of solid waste, growth of weeds etc. There should be long term preventative approach which shall be directed for preventing the causes of lake degradation. National Lake Conservation Plan (NLCP) guidelines act as driving tool for environmental improvement of Dalvoy Lake. Sustainable management of Dalvoy Lake like Control of pollution, In lake treatment, Recreational activities will result in environmental sustainability and well being of the residents around the lake and its environs, leads in community participation, improves aesthetics, increase flora and fauna.

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