Eco. Env. & Cons. 28 (1) : 2022; pp. (390-397)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i01.059

Assessment of Anthropogenic Stress on Surinsar Wetland using Geospatial Tools

S. Sharma and G. Kumar

Department of Geography, University of Jammu, J&K. 180 006, India

(Received 3 June, 2021; Accepted 30 June, 2021)

ABSTRACT

Surinsar Wetland, a Ramsar Site is situated in the lower Shiwalik region about 35 kms from Jammu city of India. Various anthropogenic causes have put immense pressure on this wetland. Unplanned growth and environmental degradation has led to the decrease of the spread of clear water. The present study highlights the various threats being faced by this wetland due to human activities. The study aimed to examine the land-use land-covers (LULC) changes and degradation of wetland in order to form a baseline for future conservation actions using geospatial tools. The Landsat data has been used for LULC classification around the buffer of the wetland and then the change detection technique was used to quantify the LULC change in GIS environment. During the present course of investigation, it was observed that Surinsar wetland is under stress of diverse type of anthropogenic pressure. The result shows a drastic change in LULC during 10 years (from 2008 to 2018). Degradation in wetland is primarily due to encroachment, agricultural, forestry and other land use activities in the catchment contributing nutrients to the wetland and leading to cultural eutrophication of the wetland.

Key words : *Geospatial, Surinsar, Wetland, Conservation, Encroachment*

Introduction

Wetlands are the unique body of water reflecting many characteristics of surrounding watershed and climate. Wetland ecosystems are the main contributors for the nation's wildlife bio-diversity, productivity and economy (Stanley, 2004). Wetlands are generally distinguished from other water bodies or landforms based on their water level and on the type of plants that thrive within them. Specifically, wetlands are characterized as having a water table that stands at or near the land surface for a long enough period each year to support aquatic plants (Venkataraman, 2008). Wetlands provide many important services to human society, but at the same time ecologically sensitive and adaptive systems (Turner *et al.*, 2000). Wetlands are especially beneficial under extreme drought or flood conditions for their ability to retain water, reduce runoff, filter sediments and provide water purification (Hartig *et al.*, 1997). They play a key role in pollution elimination and flood control, serve as breeding and nursery grounds for many species of fish and wildlife and help maintain ground water supplies and quality (Koc, 2008). Wetlands also act as pollution assimilation agents for nitrate pollution created by upstream agriculture (Rai, 2008). Man's dependence and association with the wetlands has been started since the beginning of civilization. The increasing world population and over-exploitation of wetland resources demand for human habitation and permanent change of landscape could be identified as the

([1]Researcher, [2]Lecturer (Bhaderwah Campus)

inherited problems during the past few decades (Sarma and Saikia, 2008). Due to anthropogenic concerned threat problems and improper management, these wetlands are reducing in number and area size day by day. People use these wetlands for various purposes like irrigation, catching of fishes/aquaculture, and washing of clothes, bathing animals and also as waste lands for dumping (Kumari and Lal, 2008).

Surinsar Wetland—a precious ecological heritage of Jammu region is oval in contour with a deep notch towards its northwest. The water from wetland is currently being used for many purposes including irrigation of agricultural fields around the wetland, domestic uses such as bathing, washing and recreation purposes. Also wetland is receiving significant pollution load and dissolved constituents from catchment area, drainage basin, agricultural fields, and forest area and wildlife sanctuary in the vicinity. The wetland presently is under tremendous biotic pressure, facing deforestation in its catchment area and the general neglect due to increased human and cattle population in the catchment along with increase in tourist influx which has resulted in changes in its physical, chemical and biological characteristics (Slathia and Dutta, 2013). Owing to poor management and increasing human habitation near and around are also being facing major impacts and anthropogenic threats. The unplanned growth and environmental degradation has led to the decrease of the spread of clear water. The decay of the vegetation has added to the creation and increase in the dry land mass deteriorating the general health of the wetland body. The present study has been done to highlight the various threats being faced by this wetland due to human activities.

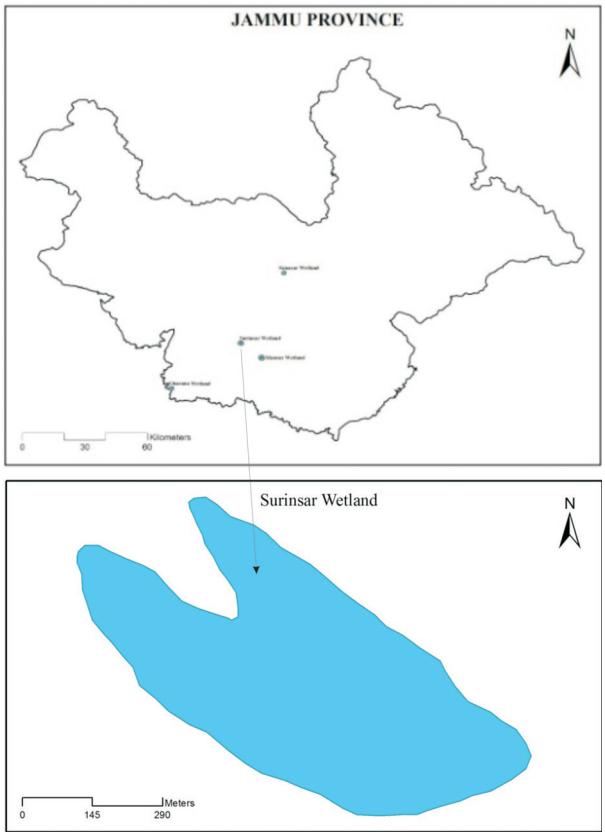
Study Area

Surinsar wetland is about 2.8 km in circumference at an altitude of 605 meters. above mean sea level lies between 32p 46 16 N latitudes and 75p 02 28 E longitudes. The wetland is situated in the lower Shiwalik region about 35 kilometers from Jammu city of India and 16 km from Mansar wetland. The communication link between Jammu-Surinsar, Surinsar-Mansar runs through sandy mountainous region (Slathia and Dutta, 2013).

Datasets and Methods

In the Present study both field and laboratory based work was undertaken in order to generate the necessary data. For the assessment of anthropogenic impact a buffer of five kilometers has been created around of Surinsar wetland.

Map 1. Location map of Surinsar Wetland



Source: Jammu and Kashmir Administrative Atlas 2011, Toposheet

Changes in Land use: The major land use in the study area was recognized as agriculture, barren land, moderate dense forest, open forest, river, settlement and water body. Supervised Landuse classification is being done by using ERDAS IMAGINE 9.2 software. Change detection analysis is being done to see changes in land use dynamics over time using Landsat data of two different time period (2008 and 2018). Finally, the output is presented through maps prepared by Arc GIS 10.5.

Analysis of water and sediments samples: The sampling was done manually using a water sampler. Random sediment samples were collected from the littoral regions of the wetlands. The necessary data of water and sediment samples were carried out in the laboratory.

pH: pH of water sample was determined with the

Data type	Data production	Scale	Source
Landsat image	28-Nov-2008	30mtrs	USGS GloVis
Landsat image	10-Dec-2018	30mtrs	USGS GloVis

help of a portable field pH meter (Hanna).

TDS: Electrical Conductivity and TDS were measured by Century water/ soil analyser kit, CMK 731

Dissolved Oxygen: Dissolved Oxygen was determined by Sodium Azide Modification of Winkler's Method.

Nitrogen: Available nitrogen content of bottom sediments was determined by Alkaline permanganate method.

Phosphorus: Available phosphorus content of sediment samples was determined by 0.5 N Sodium bicarbonate (pH 8.5).

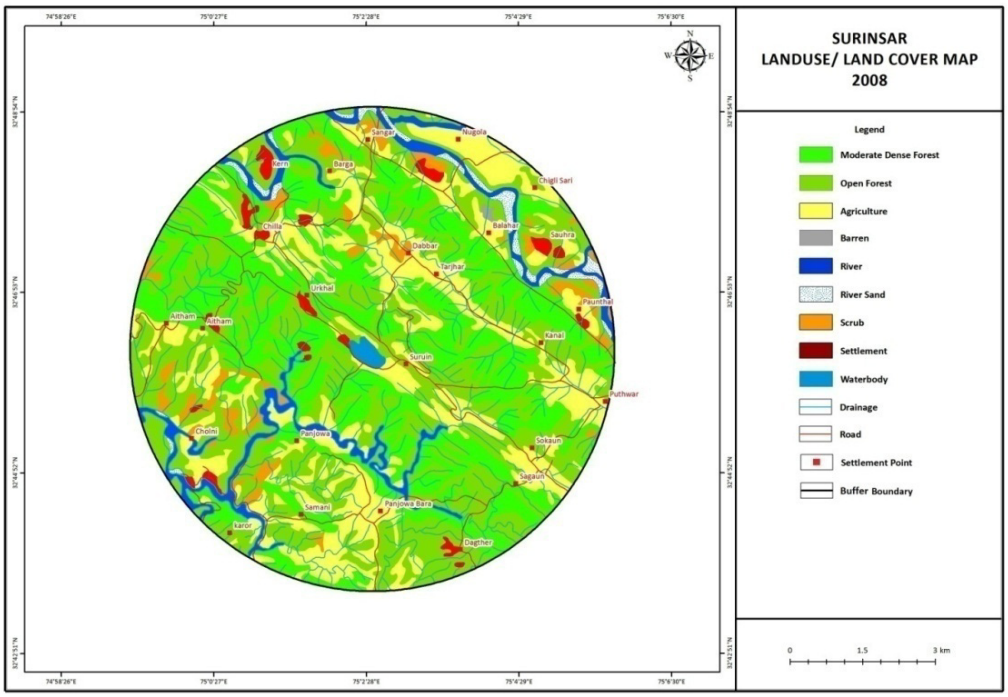
Measurement of solid and liquid waste: The direct waste analysis (Hoang, 2005), which is one of the most commonly used methods, involving direct examination of the waste characteristics – weight and composition and existing waste management practices has been used for the present analysis.

Results and Discussion

Criticalities faced by Surinsar Wetland

Surinsar wetland is under tremendous biotic pressure due to increased human and cattle population in the catchment along with increase in tourist influx, which has resulted in changes in its physical, chemical and biological characteristics. Environmental degradation of this wetland either directly from domestic discharges and encroachments or indirectly due to excessive deforestation, indiscriminate use of chemical fertilizers, insecticides and pesticides in the catchment etc. has gradient potential for introducing enduring changes in their ecological structure and functions. With rapid increasing population and development, Surinsar wetland is being threatened in two principle ways: a) through direct conversion of wetland both planned or unplanned, leading to acute problems associated with polluted drainage, direct habitat loss,

Map 2. Land Use Land Cover Map of Surinsar Wetland



Source: Generated from Land Sat Satellite Image, November, 2008

overexploitation of wetland plants and animals. b) Through the watershed related impacts of development, including increased demands for water, increasing diffuse and non-point source pollution.

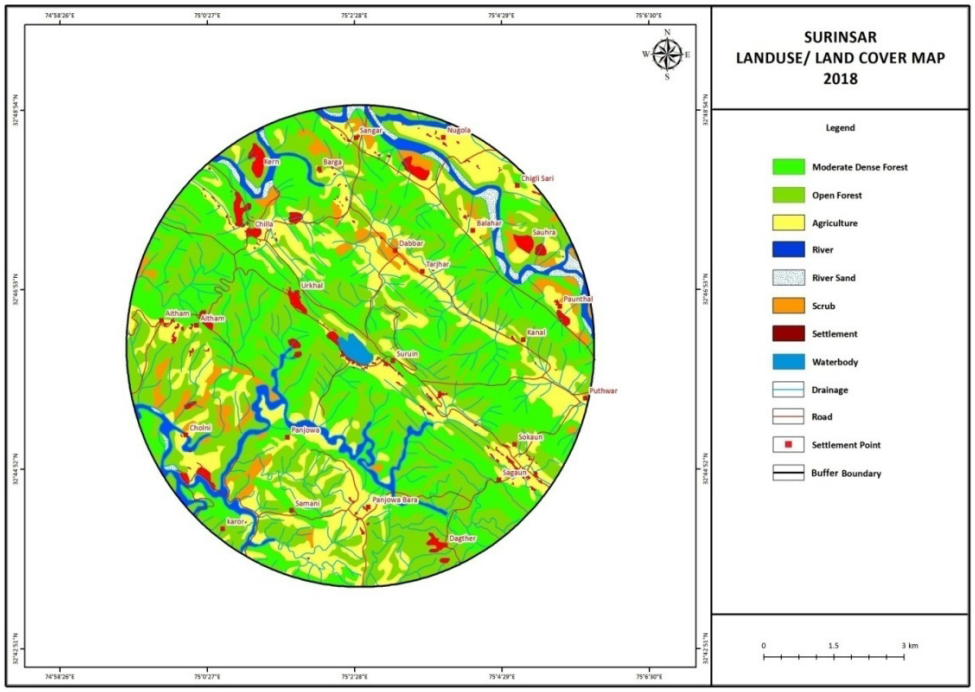
Perusal of table 1 shows the Impact of anthropogenic activities on water body, forest area, agriculture and fringe area around Surinsar wetland over a period of ten years, i.e. (between 2008 and 2018) 39.97 hectare of forest area cleared, 13.8 hectare area encroached and 4.18 hectare area increased under agricultural activities. However water body area remains same. The analysis has revealed that Cutting of trees in the adjoining areas of wetlands for agriculture purposes or for timber extraction causes denudation, thus enhancing the silting process. Surinsar wetland is religious and tourist destination and is surrounded by temples, parks and recreational area. Although some of the area is well planned but majority of the surrounding areas has organic growth encroaching up to the wetland. No proper buffer area between the water body and the built mass leads to Encroachment on the Wetland Fringe Area. Increased agricultural practices in the catchment areas deteriorate quality of water. Inappropriate development in and around wetlands may affect the ecological character of wetlands. Construction activities – have led to deforestation, habitat destruction, filling of natural tanks and reservoirs conversion of lands for agriculture, overgrazing etc. In short, in Surinsar wetland increasing demand of grey infrastructure had started overshadowing the natural infrastructure.

Table 1. Impact of anthropogenic activities on area of water body, forest area, agriculture and fringe area around Surinsar wetland

Categories	Area (in ha) 2008	Area (in ha) 2018	Status
Deforestation (Area under forest)	5044.70	5004.73	39.97 ha forest area cleared
Encroachment	123.05	136.85	13.8 ha area encroached
Agricultural activities	1875.98	1880.16	4.18 ha area increased under agricultural activities
Water body area	28.25	28.25	Water body area remain same

Source: Computed from Landsat images of 2008 and 2018.

Map 3. Land Use Land Cover Map of Surinsar Wetland



Source: Generated from Land Sat Satellite Image, December, 2018

Table 2 depicted the Impact of human induced activities on water quality and eutrophication status of Surinsar wetland. During the present period of investigation i.e. from 2015 to 2018, value of pH decreased by 0.3% but within acceptable limits of BIS criteria. TDS increased by 11 ppm but within acceptable limits of BIS criteria. DO shows decrease of 0.1 mg/l in its level but it is less then acceptable limits, which is matter of great concern. The value for available nitrogen content of sediment increased by 0.52% and the value of available phosphorus also increased by 0.02% clearly gives indication of eutrophication in near future.

The analysis reveals that religious ritual waste and idols immersions lead to severe threats. Surinsar wetland is famous religious tourist destination with tourist coming throughout the year for performing various religious rituals. Pilgrims arrive to perform ritual bathing ceremonies in the wetland every year. Some religious sects come here to perform the ritual first haircut of their sons. Agriculture-over use of fertilizer and poisonous pesticides reaches wetland through runoff from fields which deteriorates the quality of water. The various land use activities in the catchment area of Surinsar wetland contribute nutrients to the water bodies and lead to cultural eutrophication. The large quantity of excreta dropped by the livestock, agricultural runoff and chemical detergents enter into the water bodies leading to an increase inorganic content in the water causing eutrophication which is detrimental to the living fauna residing in or near water bodies.

The above mentioned Table shows annual composition of solid waste generated by human induced activities around Surinsar wetland. It is evident from Table that Religious ritual waste and idols immersion is most dominant source of the solid waste, i.e. 53.3 per cent. Residual of cremation ground is the second dominant source of solid waste, which accounts for 20 per cent. Fruit and Vegetable waste constitutes 6.66 per cent of total waste. Paper wrappers and Cattle and agriculture waste constitutes 5 per cent each of total solid waste generated. Glass and Metal waste includes tin and aluminum containers and other metallic bottles of different consumption items and constitutes 1.66 per cent of the total waste generated by shops and houses. Leftover food also accounts for 1.66 per cent of the total waste. The singe use plastics, including polythene carry bags, bottles etc., constitute 6.66 per cent of the total waste and are most visible sources of environmental pollution in the study area.

The analysis reveals that in spite of multifarious uses, Surinsar wetland is under tremendous pressure due to either directly or indirectly in the form of

Table 3. Annual Composition of Solid Waste Generated by Human Induced Activities around Surinsar Wetlands, 2018 (in %)

Material Category	Percentage of Solid Waste Generated
Fruit and Vegetable waste	6.66
Leftover food	1.66
Cattle and agriculture waste	5.00
Metal and Glass	1.66
Paper wrappers	5.00
Single use plastic	6.66
Religious ritual waste and idols immersion	53.3
Residual of cremation ground	20.0
Total	100

Source: Based on Field Survey, 2018

Table 2. Impact of Human Induced Activities on Water Quality and Eutrophication Status of Surinsar Wetland

Parameters	Unit of measurement	2015	2018	Status	
Water Quality	pH	Unit	8.3	8.0	Decrease in pH but within acceptable limits
	TDS	Ppm	132.5	143.5	Increase in TDS but within acceptable limits
	DO	mg/l	4.7	4.6	Decrease in DO but less then acceptable limits, which is matter of concern
Eutrophication	Nitrogen	%	1.37	1.89	Increase in nitrogen level gives indication of eutrophication in near future
	Phosphorus	%	0.17	0.19	Increase in nitrogen level gives indication of eutrophication in near future

Source: Sample results, Central Water Commission, Jammu and SKUAST-J (2015 and 2018)

solid waste arising out of the houses, restaurants, market area etc. solid wastes include fruit and vegetable wastes, agricultural waste, animal excreta. Domestication of animals and agriculture is the main occupation of the inhabitants of the area. The study has indicated that per capita number of animal in the vicinity is more and their waste in the form of dung is disposed off in the open or is applied in the fields as manure which is adding to the organic load of wetland thereby contributing to the pollution. Shops around the wetland offer eatables to the visitors in the polythene bags and tins. The leftover are thrown by the visitors on the bank of this wetland which ultimately find their way into the wetland leading to water pollution and consequently, harming of ecosystem. Religious ritual waste and idols immersions lead to severe threats. Surinsar wetland is famous religious tourist destination with tourist coming throughout the year for performing various religious rituals. Pilgrims arrive to perform ritual bathing ceremonies in the wetland each year. Some religious sects come here to perform the ritual first haircut of their sons. The outer boundary area of Surinsar wetland is used for cremation purpose. This also leads to pollution of wetland thereby disturbing the ecology of wetland rendering it unfit for utilization as habitat for vertebrates especially turtle, migratory as well as resident aquatic birds. These entire practices shows anthropogenic pressure on wetland, increase pollution load in wetland and further degrade its water quality.

It is evident from Table 4 that there is considerable variation in the generation of liquid waste from different accommodation categories. The magnitude of liquid waste generation is enormous in Agriculture Runoff i.e. 73.3 per cent of liquid waste/day. However, Domestic Sewage Water generates 11.6 per cent of liquid waste/day while bathing and Washing Practices on Ghats share 8.33 per cent of liquid waste/day. Chemical Detergents shares only 6.66 per cent of liquid waste/day as compared to other categories.

Table 4. Daily Liquid Waste Generated By Anthropogenic Activities at Surinsar Wetland, 2018 (In %)

Material Category	Percentage of Liquid Waste Generated
Domestic Sewage Water	11.6
Chemical Detergents	6.66
Agricultural Runoff	73.3
Bathing and Washing Practices on Ghats	8.33
Total	100

Source: Based on Field Survey, 2018

The analysis revealed that domestic sewage drains from market area and habitations adjacent to wetland enter into the water and deteriorate water quality of the wetland. Cultivation of land around wetland coupled with use of fertilizers add nutrients into water through agricultural runoff carrying organic manure as well as chemical fertilizers and toxic pesticides in wetland, thereby, adding organic and inorganic matter in wetland water and posing water pollution and eutrophication problem which is detrimental to the living fauna residing in or near

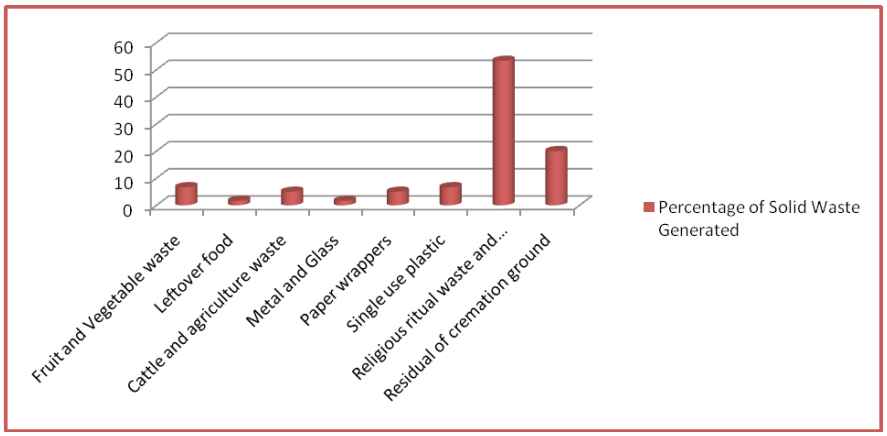


Fig. 1. Annual Composition of Solid Waste Generated by Human Induced Activities around Surinsar Wetland, 2018 (in %)
Source: Based on Field Survey, 2018

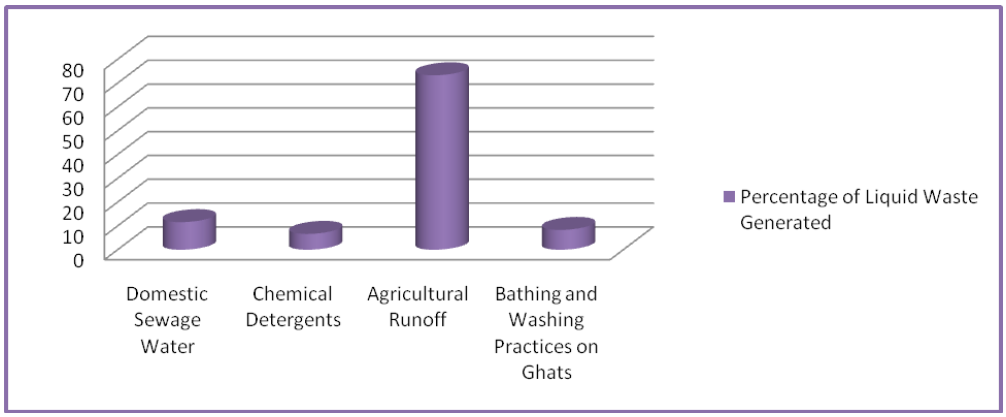


Fig. 2. Daily Liquid Waste Generated by Anthropogenic Activities at Surinsar Wetland, 2018 (in %)
Source: Source: Based on field survey, 2018

water body. Bathing and washing practices causes pollutants and make this wetland unsuitable for feeding and swimming of fish and bird fauna. It also results in mass killing due to the spread of diseases and unhygienic conditions. Addition of detergents and soaps used for washing and bathing causes nutrient enrichment accelerating algal blooming and increased BOD in wetland that can be highly detrimental to wetland water quality and severely limit the use of wetland, thereby putting bad effects on human health and aquatic biota.

Conclusion

The impact of anthropogenic activities on forest area, fringe area, agriculture and water body in and around Surinsar wetland over a period of ten years i.e. (between 2008 and 2018) clearly shows that maximum area under forest decreases in buffer zone of wetland, i.e. 39.97 hectare. If we talk about encroachment, 13.8 hectare area has been encroached. Agricultural activities increased by 4.18 hectare in buffer zone of wetland. Finally water body area of Surinsar wetland shows no sign of increase or decrease. The impact of human induced activities on water quality and eutrophication status of Surinsar wetland clearly gives indication of eutrophication in near future due to increase in nitrogen and phosphorous content of the sediments. The annual composition of solid waste generated by human induced activities around Surinsar wetland clearly depict that religious ritual waste and idols immersion is most dominant source of the solid waste, i.e. 53.3 per cent. There is considerable variation in the generation of liquid waste from different accommodation categories by anthropogenic activities at Surinsar wetland. The magnitude of liquid waste generation is enormous in Agriculture Runoff i.e. 73.3 per cent of liquid waste/day. However, Chemical Detergents shares only 6.66 per cent of liquid waste/day as compared to other categories. The information generated from the analysis gives a clear picture depicting the threats of intense anthropogenic pressure on Surinsar wetland**.** Therefore regular monitoring and assessment of wetland is very important for proper conservation and management purposes.

References

A.P.H.A. 1985. *Standard Methods for the Examination of Water*. 17th edition, American Public Health Association, Washington D.C.

Ahmed, S.A. and Ali, M. 2004. Partnership for solid waste management in developing countries: linking theories to realities. *Habitat International.* 28 : 467-479.

Akram, J., Khanday, M.Y. and Rais, S. 2011. Watershed Prioritization Using Morphometric and Land use/ Land cover Parameters: A Remote Sensing and GIS based Approach, *Journal Geological Society of India*. 78: 63-75.

Allen, M.J. and Barnes, M.R. 1985. The causes of deforestation in developing countries. *Annals of the Association of American Geographers.* 75(2) : 163-184.

Badar, Bazigha and Ramshoo, S. A. 2008. Assessing the Pollution Load of Dal Lake Using Geospatial, Tools. *Proceedings of Taal 2007: The 12th World Lake Conference:* 668-669.

Goudie, A. 2000. *The Human Impact on the Natural Environment.* Blackwell publishers ltd. 108 Cowley road Oxford OX4 1JF UK.

Hartig, E.K., Grozev, O. and Rosenzweig, C. 1997. Climate change, Agriculture and Wetlands in Eastern Europe: vulnerability, adaptation and policy. *Clim. Change.* 36 : 107-121.

Hoang, P.C. 2005. Audit of Solid Wastes from Hotels and Composting Trial in HaLong City, Vietnam. M.Eng. thesis, Department of Civil Engineering, University of Toronto, Toronto. (Available at www. utoronto.ca/waste-econ/res-pub.html)

Kaur, P. and Malaviya, P. 2018. Human Impacts on Gharana Wetland (Reserve), Jammu (J&K, India). *International Journal of Science and Research.* 7(6): 1058-1061.

Koc, C. 2008. The Influence of Drainage Projects on Environmental and Wetland Ecology. *Environ. Prog.* 27(3) : 353-364.

Kotwal, D., Kumar, S. and Sahi, D. N. 2009. Impact of various anthropogenic activities on migratory avifauna of Lake Mansar. *J. Adv. Zool.* 3(1): 10-15.

Kumari, V. and Biharilal, B. 2008. Need of Conservation of Wetlands- A Case Study of Bidar district tanks in Karnataka state. *The 12th World Lake Conference*: 1695-1698.

Rai, S.P., Kumar, V., Singh, O., Kumar, B. and Jain, S.K. 2006. Bathymetry, Sedimentation Rate and Physico-Chemical Characteristics of Mansar Lake in the Himalayan Foothills, J&K, India. *J. GSI.* 67 : 211-220.

Rai, V. 2008. Modelling a Wetland System- The Case of Keoladeo National Park (KNP), India. *Ecol Modell,* 210 : 247-252.

Sarma, S.K. and Saikia, M. 2008. Utilization of Wetland Resources by Rural People of Nagaon district, Assam. *Indian Journal of Traditional Knowledge.* 9(1) : 145-151.

Shinde S.S., Kamtikar V.N., Muley S.P. and Nimbalkar R.K. 2011. Studies on phvsico-chemical parameters of water and zooptanktons diversity in Kham rtver, Aurangabad District (MS, India). *Bioscience Discovery*. 02 (2): 207-213.

Shrestha, S. and Kazama, F. 2007. Assessment of surface water quality using multivariate statistical techniques: A case study of the Fuji river basin, Japan. *Environ. Model. Softw*. 22: 464-475.

Slathia, D. and Dutta, S.P.S. 2013. Hydrobiological Study of a Subtropical Shiwalik Lake, Jammu, J&K (India) *International Journal of Chemical, Environmental & Biological Sciences (IJCEBS)* 1(1): 143.

Stanley, O.D. 2004. Wetland Ecosystems and Coastal Habitat Diversity in Gujarat, India. *Journal of Coastal Development*. (2) : 49-64.

Turner, R.K., Van den Bergh, J.C.J.M., Soderqvist, T., Barendregt, A., Van der Straaten, J., Maltby, E., Van lerland, E.C. 2000. Ecological-Economic Analysis of Wetlands: Scientific Integration for Management and Policy. *Ecology Econ.* 35 : 7-23.

Venkataraman, K. 2008. Coastal and Marine wetlands in India. *The 12th World Lake Conference,* 392-400.

Zeng, H., Sui, D.Z. and Wu, X.B. 2005. Human disturbances on landscapes in protected areas: A case study of the Woo long nature reserve. *Ecological Research*. 20 : 487-496.