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Application of Remote Sensing and GIS in Wet Land Management Issues and Challenges

-A Case Study

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Abstract: The practise of maintaining the ecosystem of wetlands is known as wetland management. Wetlands are a vital source of food, water, and income for the local population. So, it is crucial to keep them healthy and productive. In order to maintain the wetland's health and productivity, it is requisite to make sure that operations are carried out in a sustainable manner. There are many challenges in managing wetlands, which include the potential for pollution from agricultural and industrial activities, as well as from nearby urban areas. To create successful strategies for sustainable living solutions, it is crucial to comprehend the difficulties in managing wetlands. "Wetlands are among the most effective systems for supporting life and have great socioeconomic and ecological significance for humanity"(Kundu, N., Bhattacharya, M. And Mukherjee, A. 1977). They are of significant importance for the survival of natural biodiversity. They contribute significantly to the improvement of water quality, sediment control, oxygen production, nutrient recycling, flood control, recharging of aquifers, ground water outflow, coastal protection, and stabilisation of local climatic conditions by virtue of their natural functioning. "Wetlands play a crucial, irreplaceable role in the functioning of the environment. India's wetlands are home to a wide variety of flora and fauna, many of which are threatened"(Jose C. Samuel B.K., Mukherjee and Das D.C. 1986). Hence it is a monumental task to manage and conserve these wetlands effectively. To understand the importance of wetland Srinagar Sub-Urban area has selected as case study. In the study area, many of the wetlands have lost their original quality and have been changed into altered ecosystems. Srinagar has grown into the Jhelum flood plain as a result of constant development in the swampy natural area. "Illegal building, careless business ventures, urbanisation, and anthropogenic pressure severely harmed the wetlands, which had a negative effect on the research region in the form of disastrous flood" (Malik,P.K. (2004). Rivers were converted into four-lane highways, while wetlands were filled in to create malls and colonies. It demonstrates that the catastrophe in Srinagar, which occurred in September 2014, was long in coming. In addition to safeguarding current water bodies and reclaiming and restoring wetlands, it is crucial to develop an effective conservation strategy and management plan to prevent future disasters of a similar nature.
Key Word: Wet Land,Management,Ecosystem

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Introduction: In most developing nations, urbanisation is happening at an accelerated rate. India also experiences rapid growth of population and urban expansion, which has raised severe concerns among environmental experts because of the conversion of wetlands, vegetation, and productive agricultural land into urban areas. "Wetlands are internationally recognised important ecosystems, which are diverse in terms of habitat, biota, distribution, functions and uses"(FAO 1996). Wetland eco-system is considered highly fragile which may be easily disturbed by too much of natural as well as human interference. So, the wetland in urban areas have been drawing keen attention from all sectors in the last few years due to their importance in respect of storm water storage, restoring the ground water table, ecological balance, aqua culture, beautification and tourism. "Wetlands can store excess rain water and control sudden run off rate by acting as buffer regions and thereby help in controlling flood" .(Amin A., Singh, SK., (2012).They have also a significant role in ground water recharge and discharge and thus help in making ground water available for human consumption. "They may sustain a stunning concentration of various aquatic plant and animal species, wild animals, and avifauna, greatly aiding in the preservation of ecological diversity"(Kumar R, Saxena R, and Mukherjee 1999). A portion of the population also relies on them for their livelihood through fishing, the cultivation of commercial plants, and the collection of other species that can be sold.

A study has been conducted to create a data base for the wetland using remotely sensed satellite data on a scale of 1:50,000, taking into account the recent eco-degradation of the wetland in the Srinagar area due to increased human interference, such as encroachments and other biotic and abiotic factors. With a 69,678 hectare area, Srinagar is one of the well-known valley towns in the Indian union territory Jammu and Kashmir. "The presence of marsh along the valley's undulating surface and channels, some of which are perpetual in nature while others are seasonal or transitory, favours the development of numerous small low lying areas and natural depressions"(Moore I.D. and Grayson R.B. (1991). The majority of wetlands are on the brink of extinction or are being encroached upon.

The study provides an inventory of the wetlands and highlights the various varieties, along with the condition of aquatic plants in the wetlands. The maps and data tables created in this way are anticipated to be helpful when planning for effective management of the wetlands in the Srinagar area. In the current study, an effort has also been made to assess the wetland's changes and potential causes for those changes in order to comprehend the main problems and challenges within Srinagar town's urban environment using a visual interpretation of remotely sensed satellite imagery supplemented with field data.

The Study area is spotted with numerous perennial and seasonal water bodies playing a vital role in controlling the water regime of the area. "If properly managed, the wetland can be a source of immense wealth for this locality leading to enrichment of the quality environment" (Saha, S.K.

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and Pande, L.M. (1993) . "A scientific wetland survey and the creation of a wetland data base are necessary prerequisites for any type of management" (Burrough P.A. 1996). Today's instruments and methods for wetland mapping and monitoring include a wide range of methods. In the specific context of our wetlands, IRS (Indian Remote Sensing Satellite)/Landsat (American Satellite) data is very helpful in giving current wetland information for their effective management due to its synoptic, multi-spectral, and repeating coverage. "Remote sensing (RS) and Geographical Information System (GIS) techniques provide new tools for advanced land use management. In order to improve urban life in the Srinagar town region, the study's findings will be helpful in developing plans for the conservation and development of these wetlands" (Fazal, S and Amin, A., 2011).

Advantages and Need of Sustainable Living Solutions:

The need for sustainable living options is growing as Srinagar's suburbs continue to grow in population. The necessity for efficient wetland management is increasingly more critical as the population expands. Our urban environment needs wetlands to be healthy because they benefit the surrounding communities in many ways. They serve as organic filters, cleaning the air, purifying water supplies, and giving wildlife important habitat. With the growing population, there is an urgent demand for sustainable living options in the suburbs of Srinagar. "Wetlands are crucial for supplying clean water, wildlife habitats, and recreational opportunities. To maintain a healthy and productive environment, it is essential to make sure that these wetland habitats are appropriately managed"(De Mers, M.N. 1997). The local government may contribute to the preservation and protection of these wetlands for future generations by developing appropriate management plans. "Local governments can reduce the likelihood of flooding and water pollution, save water resources, and enhance the general standard of living in the area by managing wetland resources effectively"(Encyclopaedic Directory of environment, 1988). Wetland management can also lessen the chance of soil erosion and raise the calibre of nearby water sources. In order to guarantee that the local population has access to clean and safe water for drinking, bathing, and cooking, this is crucial. The suburbs of Srinagar must adopt sustainable living practises to preserve the environment and maintain their economic viability. "Wetland management is essential to this effort since it aids in preserving and protecting the local natural resources hence it is requisite to develop an efficient management plans and maintaining the wetlands"(FAO ,1995).

Study Area: The study area is restricted to Srinagar suburbs, which lies between 33^{o}59'14" N and 34^{o}12'37" N latitude and 74^{o}41'06" E and 74^{o}57'27" E longitude, covering an area of 69,678 hectare. The river Jhelum is a major river flowing through the heart of town (Figure 1)..

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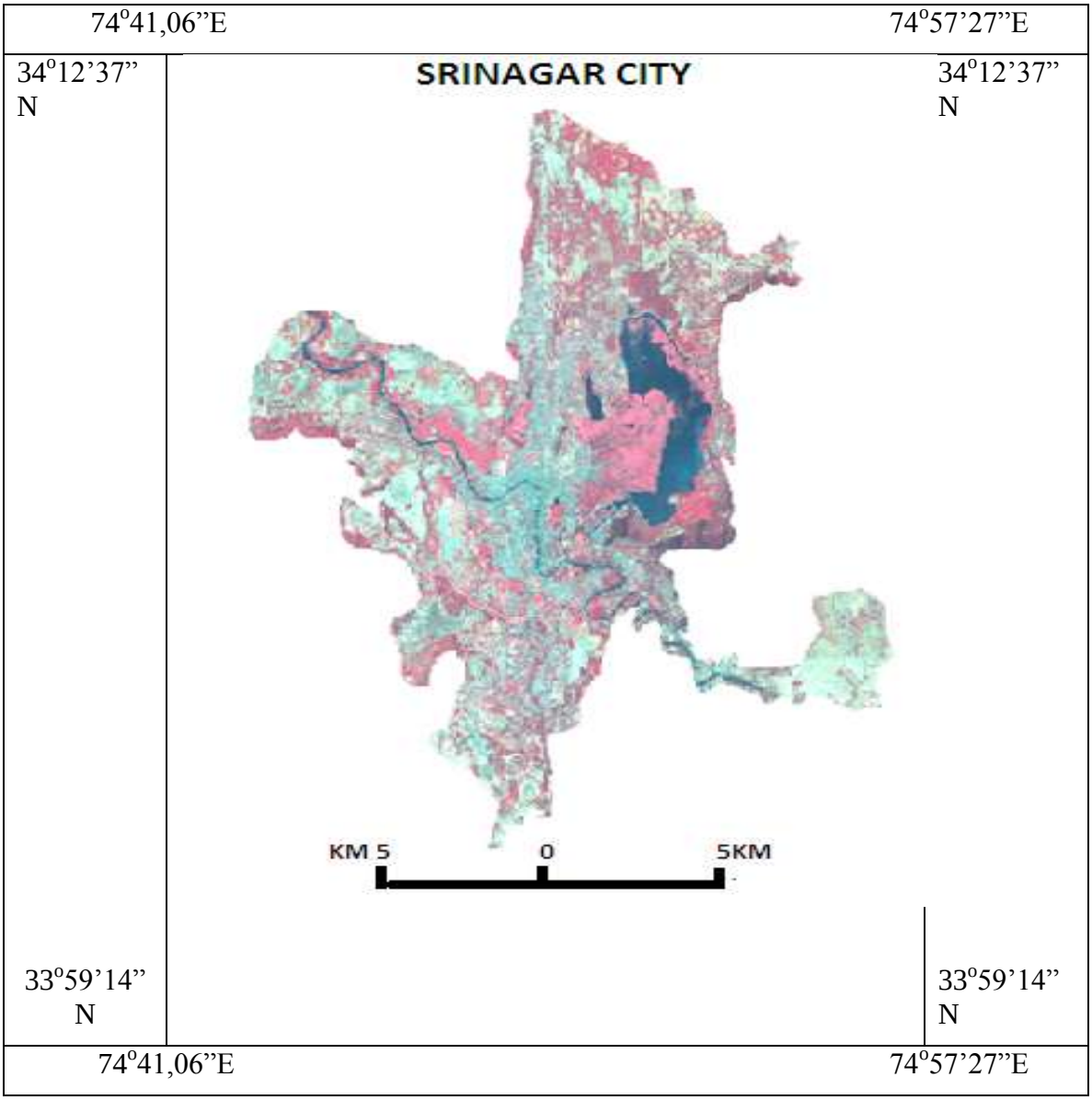
The study area represents one of the, ecologically fragile, tectonically unstable and one of the densely populated mountain ecosystems. The overall landscape is hilly with a moderate gradient. The research region has an average elevation of 1,580 metres above mean sea level and a general slope to the south-west. It serves as the main hub for trade, commerce, politics, socio-culture, and administration. Teak-dominated forests are typical on the adjacent hill slopes.



Source: Field Survey

Figure-1

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In general the soil in and around the study area are alluvial fertile soils rich in humus. In the previous 50 years, its population has expanded more than five times, from 2, 55,679 in 1951 to 1.62 million in 2021. Urban social change stimulated economic growth, which in turn transformed the land. The town's demographic structure and composition are eventually impacted by the steady influx of rural residents from the surrounding area towards this urban centre. Present study is confined to the master plan area of Srinagar.

Strategies for Achieving Sustainable Living Solutions – Benefits of Proper Management

"The wetlands in the outskirts of Srinagar have been under a lot of stress recently as a result of urbanisation. Population growth in the region has led to increased pollution and the deterioration of the wetlands" (Saha, S.K., Kudrat, M. and Bhan, S.K. ,1991). The survival of the local environment and biodiversity depends on proper management of the wetlands. In the suburbs of Srinagar, there are numerous methods for achieving sustainable living options. These include:

- **Restoration and conservation:** Restoring and conserving wetlands can lessen the effects of human activity and raise the standard of water supplies. By building the appropriate infrastructure, such as water supply, sewage treatment, and drainage systems, wetlands can be restored and conserved.
- **Wetland management plans:** The effective management of wetlands depends on a well-developed management strategy. "Plans for wetlands preservation, protection, and restoration should be included. Also, it ought to have methods to improve biodiversity as well as to monitor and manage water pollution"(Socio-economic profile of Jammu and Kashmir ,2008).
- **Public awareness:** For the management of wetlands to be successful, public education is necessary. Individuals should be informed about sustainable practises and the significance of protecting wetlands. Campaigns for public awareness should include events like seminars, workshops, and educational initiatives.
- **Stakeholder participation:** It's crucial to involve stakeholders in the management of wetlands. The decision-making process should engage stakeholders, and their suggestions ought to be taken into account. By doing this, the management strategy will be guaranteed to be thorough and efficient.

Proper management of the wetlands in Srinagar suburbs can bring about numerous benefits. These benefits include:

- **Protection of biodiversity:** Many species of plants and animals call the wetlands in the suburbs of Srinagar home. The sustainability of the local environment can be ensured by careful management of the wetlands, which can aid in preserving this biodiversity.
- **Improved water quality:** The area's water quality can be raised by managing the wetlands properly. Water can be used for different reasons, including irrigation and home consumption, while pollution levels can be decreased.
- **Reduced flooding:** Wetlands can serve as a flood protection barrier. The risk of flooding in the area can be decreased with proper management of the wetlands..

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- **Economic benefits:** The wetlands can have a positive impact on the economy by supplying local communities with jobs and tourism-related resources. These economic advantages can be increased with the help of effective wetlands management.

Current Issues and Challenges in Wetland Management of Srinagar Suburbs:

Due to urbanisation, agricultural development, and climate change, the wetlands in Srinagar Suburbs are extremely vulnerable. An essential ecosystem for maintaining biodiversity and controlling water flow is the wetland environment. Unfortunately, due to inadequate management and control, wetlands in Srinagar Suburbs are degrading at an alarming rate. The following are the main problems and difficulties with managing wetlands in Srinagar's suburbs:

- **Absence of a regulatory framework:** Wetlands in Srinagar Suburbs are not currently covered by any laws or regulations. Wetlands have been used unchecked for urban, industrial, and agricultural growth as a result of this lack of oversight**.**
- **Pollution:** Industrial and urban trash are frequently dumped in wetlands, causing water pollution and the devastation of wetland ecosystems..
- **Biodiversity loss:** Due to the devastation of wetland habitats, many plant, animal, and fish species are now gone or in danger of going extinct.
- **Overexploitation:** The ecosystem surrounding wetlands has been destroyed as a result of the overexploitation of wetlands for a variety of purposes, which has caused a rapid drop in the wetland's water level.
- **Lack of knowledge:** The local populace frequently is not aware of the significance of wetland ecosystems and their role in the development of sustainable living practises.

Data source: The current study attempts to understand, identify, categorise, map, and analyse changes in wetland areas. With these goals in mind, an image interpretation survey was conducted. The present study is based on the primary (Table-1) and auxiliary data listed below.

Table 1
Details of Satellite data Used in the Study

Sr.No.	Data Type	Path/Row	Date of Production	Wavelength	Spatial Resolution(Meter)	Swath(Km.)	Source
1	IRS – ID LISS - III FCC	92/46	10-10-2010	0.52-0.590.62-0.680.77-0.861.55-1.70	23.5	142	NRSA
2	IRS-ID PAN	92/46	10-10-2010	0.5-0.75	5.8	70	NRSA

Source: (i) Satellite data, (ii) Ancillary data: S.O.I. Toposheet (1:50,000 scale) No. 43J/16, (iii). Field data and GPS Data, (iv). Reports and maps from the notified town area committee .

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Methodology: Using IRS-1D-LISS III and IRS-ID-PAN data, a visual analysis technique was used to map distinct wetland categories at a scale of 1:50000. Two points in time, 1980 and 2010, were used to produce the spatial data, which were then analysed in GIS. The base map was created using the Survey of India's topographical sheet No. 43J/16, which highlights notable features such as rivers, streams, large settlements, and roads, among others. Using a town planning map of Srinagar city from 1980 at a scale of 1:15,000, the research area's early date land use and land cover were prepared. Similarly, IRS-1D LISS III + PAN 2010 combined satellite imagery was used to determine the land use and land cover for the later date. This imagery was obtained from the National Remote Sensing Agency in Hyderabad; India. The data were created using the World Geo-coded System (UTM WGS 84) projection parameters and the zone 43 of the Universal Transverse Mercator (UTM) coordinate system. With the use of the Earth Resource Data Analysis System (ERDAS) Imagine 9.0 software, both photos were first geo-corrected and geo-referenced. Also, SOI toposheet No. 43J/16 was geo-referenced and given a similar projection and datum in order to aid in the interpretation process. The area of interest was extracted by sub-setting the image, which was created by stacking satellite images into several bands to create a false colour composite. "Using Arc info.GIS software, different wetland types were recognised and defined from FCC of satellite imageries based on tone texture colour pattern location association, etc. and prior field knowledge. Based on visual interpretation, the presence of aquatic vegetation was recorded by FCC for each wetland where it was found"(Space application Centre,1998). The presence of aquatic vegetation was indicated by a patch of red colour with fine texture in or around it, or both. The intensity of the red colour and its extent revealed the various levels of aquatic vegetation, including those that were fully or partially vegetated, only at the edges, inland, or in wetland areas. The town planning map was subset to extract the area of interest. Using Arc-GIS 9.3 software, the photos were decoded and then converted into polygons that represented various land use/land cover categories in a GIS context. The field GPS readings were used to identify the ground control sites. Both paved and unpaved road centrelines were digitalized at the time of map production. The data was divided into four major land use and land cover groups using the Level 1 categorization system, covering a total area of 69,678 hectares in the Srinagar suburbs. Every polygon that represented a specific class was quantified and depicted on corresponding maps, along with the trend and pattern of urban expansion. After gathering background data on the wetland, such as its name, socioeconomic significance, general physiographic of the area, land use/land cover of the surrounding area, and water distribution of the wetland in various seasons of the year, final maps were created. In addition, the study performed a land transformation analysis by superimposing these two land use/cover maps from different historical periods in a GIS setting. The goal was to develop a matrix that showed the transitions between the different types of classified land use/cover.

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Result and Discussion: The outcome shows how the spatial distribution of urban wet land has changed through time. 4 categories of land use/cover were assigned to Srinagar's 69,678 hectares (Figure-2). These classes consist of Built-up areas include residential areas, parks, gardens, playgrounds, agricultural plantations and orchards, barren terrain, marshes, and parks and open spaces (marshy land, water body) Table 2 provides a full explanation and distribution of the land use/land cover types. The table indicate that there is a considerable change in the wetland area.

.Table 2
Land Use/ Land Cover of Srinagar City
1980-2010

Sr.No.	Land Use/ Cover Classes	Category	Total Area In Hectare			
			1980		2010	
			Total Area	Percentage area	Total Area	Percentage area
1	Built up area		**5191**	**7.45**	**20307**	**29.14**
		Residential area	4780	6.86	19199	27.55
		Parks, Garden and Play Grounds and others	411	0.59	1108	1.59
2	Agriculture		**49716**	**71.35**	**42511**	**61.01**
		Agriculture	42818	61.45	32617	46.81
		Plantation/Orchard	3763	5.40	7790	11.18
		Barren	1603	2.3	1428	2.05
		Fallow Land	1533	2.2	676	0.97
3	Forest	Forest	**1345**	**1.93**	**453**	**0.65**
4	Wetland		**13426**	**19.27**	**6407**	**09.20**
		Water body	8474	12.17	5017	7.20
		Marshy	4947	7.1	1394	2.0
	Total		**69678**	**100**	**69678**	**100**

Source: Town Planning Map of Srinagar City 1980 on 1:50,000 scale and IRS-ID LISS III + PAN 2010 Merged Satellite Imagery of Srinagar City.

i. Agricultural land: Land classified as plantation/orchard, bare, and fallow land are included in this category. A total of 42,511 hectares (61.01%) was used for agricultural purposes in 2010, down from 49,716 hectares (71.35 %) in 1980. The main crop grown as paddy whose area has shrunk as a result of individuals switching from primary to secondary & tertiary occupations and the growth of the built up area. The predominant paddy-growing regions were identified as being in the hilly west, south, and north-eastern regions.

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Vegetable gardens and floating gardens were mostly seen in Khushalsar .Wet Land in the north and the western portions of Dal Lake. The world's best quality saffron is grown on the renowned Karewas in the southeast of the city, which is an outstanding land use feature of Kashmir. Apart from the city centre, the plantation/orchard class comprises willow plantations as well as apple, cherry, almond, and walnut orchards. The total area included in this class was 3,763 hectares (5.40%) in 1980, and it climbed to 7,790 hectares (11.18% of the research area overall) in 2010. (Figure-3).A sizable amount of the study area's land was found to be covered in orchards in the north; minor patches were also found in the study area's southwest and southern ends.

Similar to this, little patches of willow planting were seen across the study region. Along the western banks of the Jhelum River, there was a sizable region covered in willow plantations. Willow plantations were also spotted in the east along the foothills of the Zabarwan Mountains and in the Lokut Dal area, where boatmen had converted a marshy area into a willow plantation area. By substituting horticulture operations for agricultural cultivation, a sizable portion of the economy is now dependent on these orchards.

The amount of fallow land declined from 1,533 hectares (2.2%) in 1980 to 676 hectares (0.97%) in 2010. On the northern part of the city, at Zakura and Tailbal, fallow ground was visible. Moreover, a sizable chunk of undeveloped land was seen in the city's west and northwest, particularly in Ahmad Nagar. The area has shrunk, and numerous awareness campaigns and technological advancement are to blame.

The naked exposed rocks and some quarrying areas are included in the term "barren land." The total area included in this category was 1,603 hectares (2.3%) in 1980, but it fell to 1,428 hectares (2.05%) in 2010. This lesson has been held in the study area's rugged terrain, specifically on the slopes of Koh-i-Maran and Koh-i-Sulaiman. Similar patches were mapped in the northwest, at the Khanmou quarrying site in the southeast, and in the hilly regions of Alestang and New Theed. Due to the increased demand for property from the expanding population, the area has decreased as other built-up classes have seized previously uninhabited territory.

ii. Urban Built up land: These areas comprise those used for institutional, commercial, industrial, and residential uses. According to the research, there has been a rise in the total area falling under this category, going from 5,191 hectares (7.45%) in 1980 to 20,307 hectares (29.14%) in 2010. This increase is linked to the rising demand for land brought on by the expansion of both the population and the economy. Along the highways, there has been a general tendency of expansion. Zainakot, Malura, Parimpora, and Bemina in the west, Soura and Ahmad Nagar in the northern end, and Magarmal Bagh in the southwest of the city are among the locations where unplanned residential development occurred throughout the research period.

In Lal bazar in the north, Chanapora, Natipora, Bhagat Barzulla, Rawalpora in the south, and Bemina in the west, the planned residential neighbourhood came into life. In 1980, unplanned

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residential development was largely confined to the central region on the east and west banks of the Jhelum River. Boulevard, Karan Nagar, Habba Kadal, Residency Road, Polo View, Court road, Kokar Bazaar, Maisuma, Wazir Bagh, Shaheed Gunj, and Dal Gate were all noted to have commercial areas; all are situated in or near the city centre, or Lal Chowk (CBD). Other commercial locations beyond the city centre include the fruit mandi region at Parimpora in the west and the Hazratbal neighbourhood next to Dal Lake.Industrial areas includes; Bagh-i-Ali mardan Khan light industrial area, Khrew and Khanmou cement manufacturing industrial area in southeast of the city.

Other sites, such as different parks and playgrounds, play a significant role in the culture of the city. The total area of land classified in this category was 411 hectares (0.59%) in 1980 and 1,108 hectares (1.59%) in 2010. Because the city is a popular tourist destination and the amount and quality of green areas in the city are clear signs of sustainable urban development, the total area falling under this class rose despite urban expansion. The famous Mughal gardens are among the parks, gardens, and play areas, along with others like Shalimar Bagh, Harwan Garden, Nishat Bagh, Botanical Garden, Tulip Garden, Zabarwan Park, Golf Course, Polo Ground, Nehru Park, Cricket Pavilion, Sher-i-Kashmir Park, and Iqbal Park, among others.

Land Cover Change in the Study Area

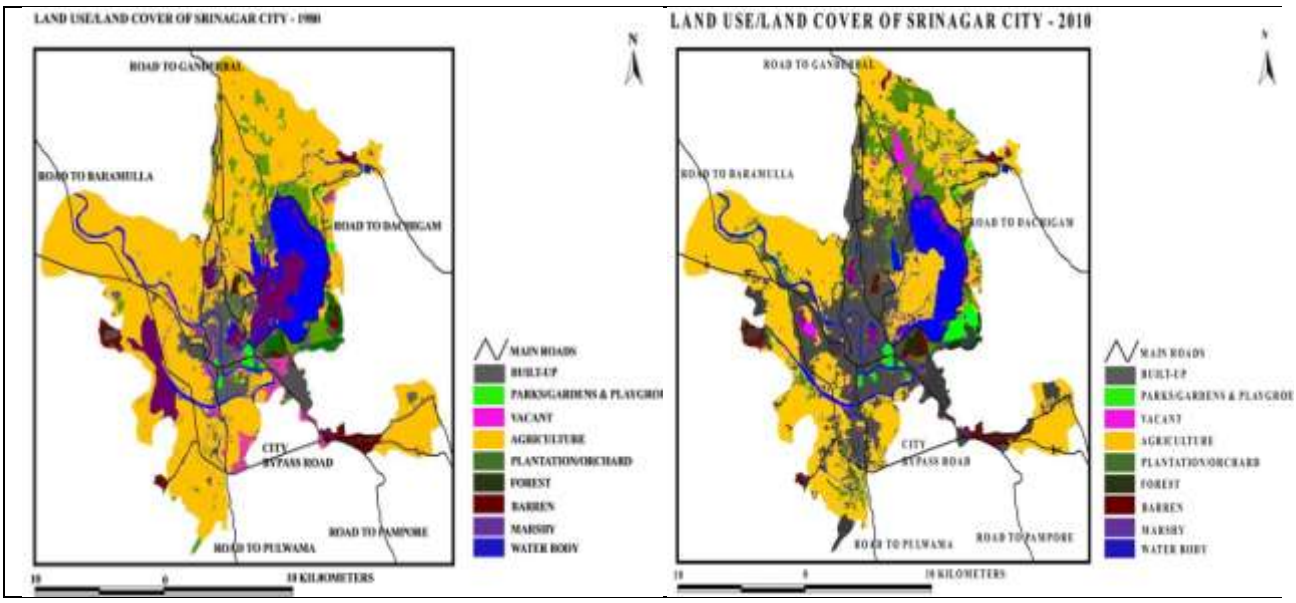

Figure- 2

iii. Forest Land: This type of land cover covered 1,345 hectares (1.93%) in 1980, but it only covered 453 hectares (0.65%) in 2010, demonstrating that there was significant urbanisation during that time period at the expense of the woods. An increase in anthropogenic pressure has

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resulted in a decline in forest cover. Poor people who were unable to obtain land on the plains cleared the forest regions in the foothills and made a living there by cutting down trees.

iv. Water Bodies: The city's rivers, lakes, and water reservoirs fall under the category of water bodies. Wetland class is the most vulnerable land use/land cover type in Srinagar city, out of all the land use/land cover classes. There were 6,407 hectares (9.20%) in this category overall in 2010 compared to 13,426 hectares (19.27%) in 1980. Nearly all water bodies have diminished during the research period due to anthropogenic pressure. Included in this study's observations of the city's existing water bodies are the Dal Lake, Nigeen Lake, River Jhelum, Brarinambal, Tailbal Nallah, and Harwan Water Reservoir. (Figure-4)

Land Trans Formation in the Study Area (1980-2010)	Spatial Change in Wetlands of Srinagar (1980-2010)

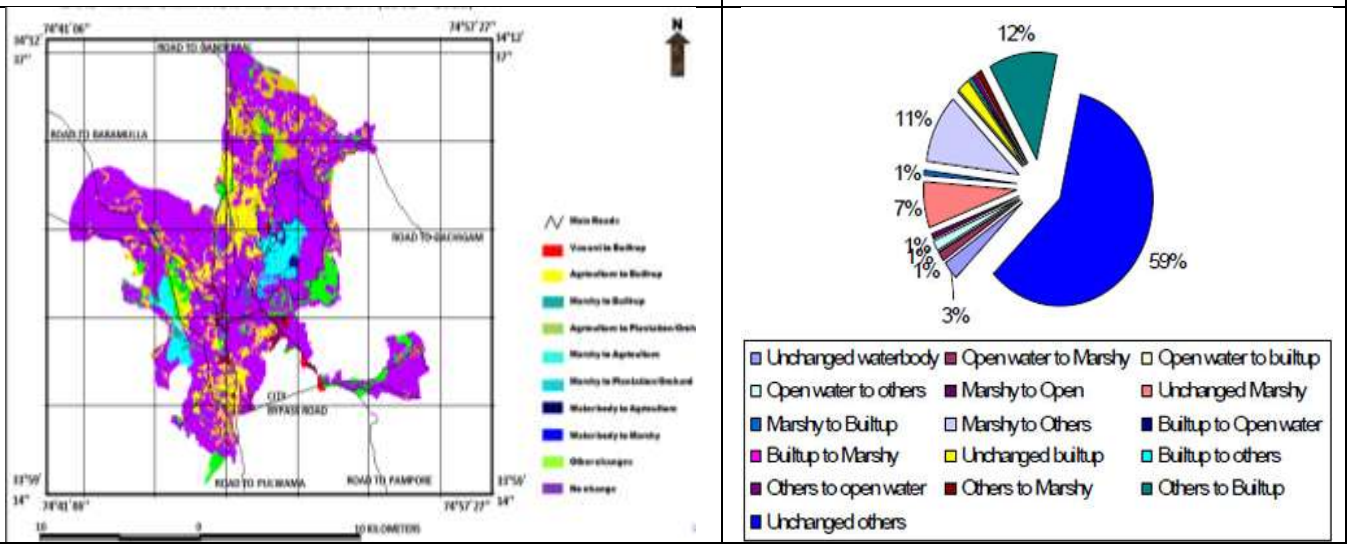

Figure-3

Possible Solutions for Improving Wetland Management in Srinagar Suburbs

Many steps can be taken to improve wetland management in Srinagar Suburbs. Promoting wise land use is one of the key solutions. "The value of wetlands and the ecosystems they support can be brought to the attention of the public by local authorities. Public awareness campaigns, workshops, and seminars can be used to accomplish this. Also, local government should take action to prevent wetlands from being harmed by human activity"(Space Application Centre, 1993). This can be accomplished by offering incentives to encourage individuals to refrain from actions that endanger wetlands. The local government can also enact rules and legislation to safeguard wetlands from any human activities that might negatively impact them. The size of the wetlands in Srinagar Suburbs should also be increased, according to local authorities. This can be accomplished by re-establishing wetlands in locations where humans have encroached. By doing

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this, the area's ability to hold more water will rise, helping to keep the water levels in the area stable. Also, local government bodies should take action to lessen pollution in wetlands. This can be accomplished by enacting waste disposal rules and promoting the adoption of environmentally friendly garbage disposal techniques. Additionally, local government should oppose the use of fossil fuels and encourage the use of renewable energy sources. Thirdly, "local government should take action to improve the wetlands' biodiversity. This can be achieved by implementing policies that promote the expansion of local species in wetlands. The wetlands should also be adequately safeguarded by local authorities from any activity that can upset the ecosystem's natural equilibrium. Local government may guarantee that the wetlands in Srinagar Suburbs are managed in a sustainable way by taking the aforementioned actions. This will assist the region in striking a balance between the economy, society, and environment"(Suresh R., Das G. and Singh J.K. 2002).

Issues and challenges: One of the Kashmir valley's most damaged ecosystems is the wetland. The Jhelum, Madhumati, Erin, and other streams that enter the lake routinely deposit significant amounts of silt, which is the main problem with the wetland. A major weed infestation is caused by the constant addition of plant nutrients and raw sewage to the nutrient pool. The dense weed mats inhibit other species that are key food sources for many fish and bird species because they block light from reaching the deeper water column. The breeding habitats of several fish species have been severely impacted by encroachment into the periphery as well as by vegetation within the lake body. Large expanses of wetlands were transformed for agriculture and other human uses as a result of the development of science and technology, which accelerated the exploitation of natural resources and favoured land-based growth. Strangely, marshes have a reputation for being barren places full of illness, hardship, and danger. These habitats were drained, filled, despoiled, and degraded for commercial benefit because of their negative effects, which were emphasised while neglecting their significance. The fact that these wetlands support the local community living in and around them is a significant feature of them. On the other hand, the local residents have a significant impact on the wetlands in terms of managing the health of the environment. Aquaculture, leisure, and tourism are just a few of the various and expanding economic activities supported by wetlands. Urbanization and anthropogenic pressure are the main dangers. The latest calamity in September 2014 and the seriousness of the topic both stem from decreasing wetlands. As a number of the wetlands in the study region have either ceased to exist or are in a derelict state, these water bodies have been under major threat. Therefore, it is believed that it is crucial to preserve these wetlands in the research area and safeguard their distinctive biodiversity.

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Cartosat Image of Pre and Post-Flood and Wetland Status

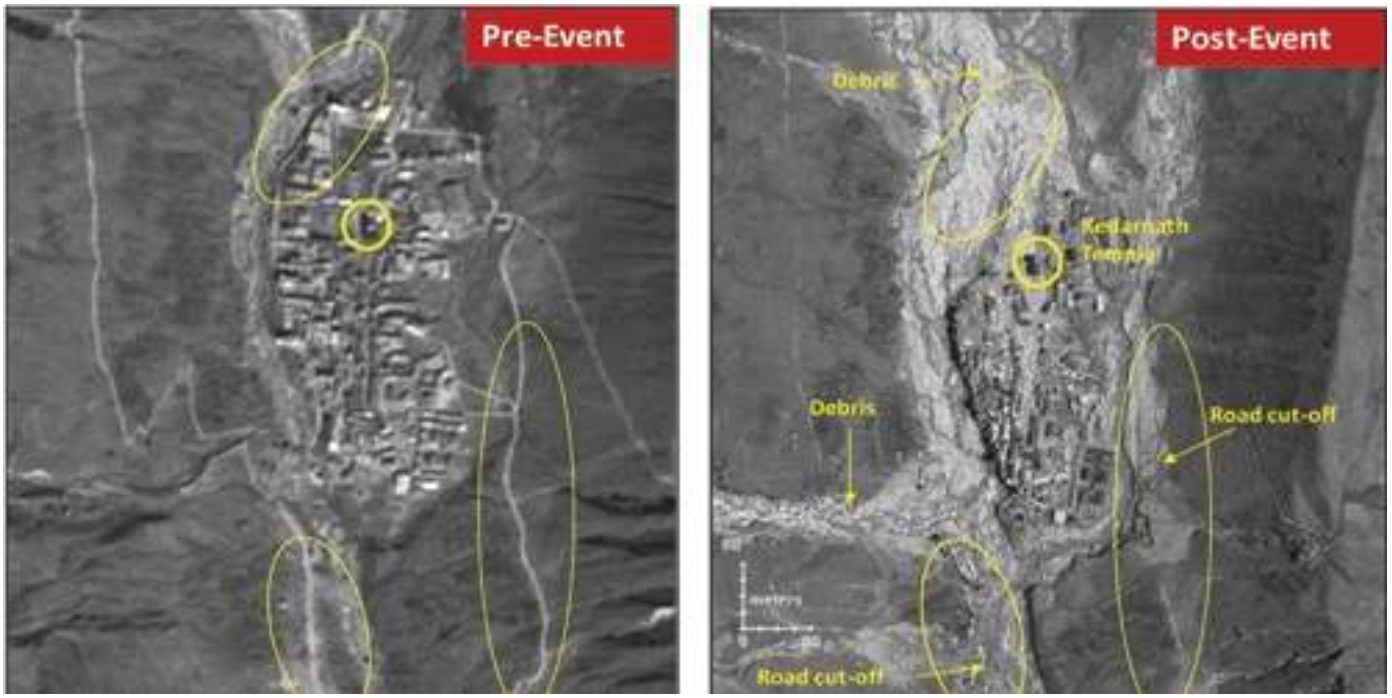

Figure-4

The government, NGOs, aid organisations, local institutions, and local people may all play an equal role in the integrated management of some selected wetlands since it is not possible to take action on all wetlands. A comprehensive strategy involving the people's active participation in participatory programmes is required for the conservation of resources and management of the environment. The local people and the biota, who are frequently stakeholders in development initiatives, should be taken into account. Ecosystem management cannot be done effectively, and practises for preservation and conservation may fail. The management programmes should use economically sensible strategies that serve as incentives for resource conservation and sustainable use in these areas. Cooperation between stakeholders in the fields of science, technology, and socioeconomics should be promoted, as should the adoption of policies that prevent or at least mitigate harmful effects on biodiversity.

Conclusion and Recommendation: In order to maintain the viability of the regional ecosystem, appropriate management of the wetlands in the suburbs of Srinagar is crucial. The area may be efficiently managed and the advantages of good management can be obtained via the execution of various methods and public awareness initiatives. As a result, it is advised to periodically survey the wetlands in the town area using high resolution remotely sensed satellite data and to

create a detailed database of the wetland using a geographic information system (GIS) that includes information on the wetland's hydrologic characteristics, aquatic flora and fauna, including avifauna, water quality parameters, and all other relevant information. This will enable sorting out of strategic action plan for efficient management of the wet land of the area.

It is crucial to find sustainable living options for managing wetlands in the suburbs of Srinagar to protect the area's fragile ecosystem. We have learned how crucial it is to comprehend the state of the environment, create an efficient management strategy, and put it into action. Wetlands in the Srinagar suburbs can be protected and managed effectively and sustainably by developing an appropriate management plan. We have talked about how crucial wetland management is to the local communities' ability to receive a range of services and advantages. Wetlands offer a variety of benefits, including carbon sequestration, sediment trapping, water storage, and flood control. Also, they are crucial for maintaining biodiversity and serving as habitat for a range of animals.

We have also talked about the role that sustainable practises can play in wetland management. These procedures include lowering the quantity of contaminants that enter the wetlands, enhancing water quality, and keeping an eye out for risks to the wetlands. We have also looked at the significance of community involvement in wetland management and the function of local communities in preserving wetlands. We've talked about the possibility for future sustainable living options in the suburbs of Srinagar. Wetlands in the area can be preserved and protected if an appropriate management plan is developed and the required actions are taken. We can lessen the effects of climate change and work to give Srinagar residents a more resilient and healthy environment by implementing sustainable practises.

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