Study of the Ecological impact of sewage-irrigated vegetable farming of Calcutta Metropolis using Remote Sensing & GIS

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Abstract

The East Kolkata Wetland (EKW) area, a Ramsar site, which is known as the kidney of the mega city Kolkata consists of different types of land use pattern including sewage fed fisheries and garbage farming. An estimated amount of approximately 250 gallons of sewage and 2700 ton of garbage per day are discharged into the EKW. This paper is attempted to show how to monitor the land use charge in EKW area receiving city sewage and garbage from the city using the space borne optical data like LISS III and IKONOS data. This database will be used for development of the interpretation protocol for microwave data like PALSAR.

1. Introduction:

The East Kolkata Wetlands are well known over the world for their multiple uses. The resource recovery system, developed by the local people through ages using wastewater from the city, is the largest in the world and unique of its type. In the process, it treats the wastewater and has saved the city of Kolkata from constructing and maintaining mammoth wastewater treatment plant. The multifunctional wetland ecosystem is comprises 254 sewage fed fisheries, agricultural field, solid waste farms and some built up areas in addition to the wetland. A large part of wetland happens to be the world's largest wastewater fed aquaculture system and the goods and services offered by this wetland include, in addition to fisheries, water treatment, provision of habitat to waterfowl and a large amount of biodiversity.

In August 2002, 12,500 ha of the East Kolkata Wetland area has been included in the 'List' maintained under the Ramsar Bureau established under the Article 8 of the Ramsar Convention, that has given this wetland the recognition of a "Wetland of International Importance". But this EKW is undergoing a continuous threat of rapid land use change due to increased need for housing and economic development in the city. So need of the time is to take steps for conservation and management of the EKW area by stopping these conversions attempt as a part of conservation and management of the EKW GIS and Remote Sensing can play a very important rule in this respect.

2. Objectives:

The objective of this paper is to create a spatial database of sewage flow system of Calcutta Metropolis in GIS Environment using space borne data which will be used later to monitor the change in the sewage flow over the seasons, crop status in the sewage fed farms and condition of sewage fed fishery ponds and modeling the nutrient cycle and toxicity in food chain using ALOS AVINIR-II data.

3. Study Area:

The study area is East Kolkata Wetlands located along the Kolkata city in the state of West Bengal, India. Kolkata Metropolis is one of thelargest urban agglomerations in the country with a population of 14.72 million and a density of 7950 persons/km². The study area is located along the eastern part of the Kolkata city and some part overlapped with the city. The East Kolkata Wetlands comprises of Kolkata Municipal Corporation and the Bidhananagar municipal Corporation and the Panchayat Area. The weather of the city is quite humid with variation from 50% to 85% and typical temperature variation from 4²/₂ C to 8⁰C.

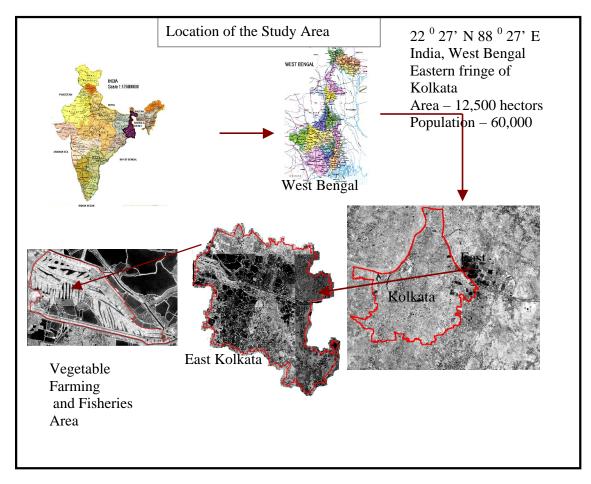


Figure 1: Location of the Study Area

The rainy season lasts from June to October and brings moderate rainfall averaging 160.5cm.

4. Methodology:

High-resolution satellite data of the concerned area is procured. Here CARTOSAT-PAN and Multi-Spectral data are used resolution of which is 1metreX1metre in PAN and 4meter X 4meter in Multi-spectral. Cadastral Maps of the area is collected and geographically referenced with the satellite data. For this purpose image to image registering process is used. The boundary was demarcated with the help of satellite data, cadastral map and ground truth data. Plot level boundary is delineated from the cadastral map and overlaid on satellite image. From this present land use is detected and a list is prepared showing the details use of each plot. So that in future legal steps could be taken so that conversion could be restricted. In the second stage spatial database is created for different components of the system like canals, sewage channels, soil, vegetable farms, crop status at different

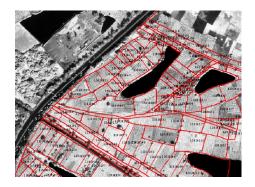
times of the year, fishery sites etc. using LISS III and PAN merged data of the project area of different time period. The accuracy of identification and classification of the LISS III-PAN merged data is evaluated with the ground truth data.

The database will be updated using ALOS data. Vegetation indices will be derived to monitor the crop growth, condition and utilization pattern.

Data will be collected at various sample points on composition of sewage, toxic chemicals at various channels at different times of the year. This will be modeled to study the flow concentration at various channels, the intensity of toxicity and its effect on vegetables and soil.

5. Discussion and Result:

Plot level boundary and Land use of the study area is delineated using cadastral map and satellite data. Spatial Database creation of the study area for canals, sewage channels, and vegetable farming area is already done using LISS III and PAN merged data.



In the East Kolkata Wetlands three types of landuse practices are seen these are the farming with city garbage, sewage fed pisciculture and paddy cultivation using both sewage and effluents from the fisheries. It is thus necessary to show the field situation and corresponding satellite data.

Figure 2 Plot level boundary overlaid on the IKONOS data



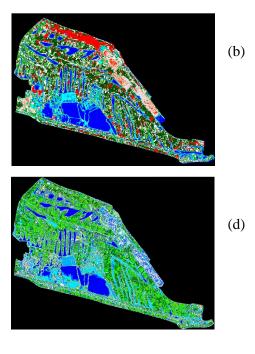
(a) Figure 3a and 3b : Image of PAN-LISS III merged data and classified image



Figure 3 c and 3d : Image of IKONOS Multispectral data and classified image



Figure 4 Garbage and sewage farming



It is to be mentioned that in East Kolkata in the waterbodies sector number of big fish ponds/ wetlands receive raw sewage and produce fish and other animal protein with the help of sunlight through the photosynthesis process.

5.1 Land use Classification

Regarding landuse classification mouza wise dag boundaries are overlaid on the IKONOS images through proper GCP points. The information of dag numbers and other related informations are kept in Arc/Info environment. A query system is developed to retrieve the information relating to a particular plot.

It is so accurate that the Govt. has used this result for enactment of a legislation related to landuse control in the RAMSAR site- East Kolkata Wetlands.

		Part III]		A GAZETTE, EXT			
Registered No. WB/SC-247	No. WB(Part-III)/2006/SAR-4	The East Kolkata Wetlands (Conservation and Management) Act, 2006. Table 1					
The		[See clause (5) of Schedule I.]					
	Gazette	Mouza Dhapa Substantially water body Productive farming area Urban/Rural settlement area					
Kolkata		Substantially water body oriented area (1)		(1)		(Ш)	
		38, 39, 41 to 85, 93 to 96, 108 to 111,	87 to 89, 91, 105, 106.		37, 40, 92.		1.1.1
		सत्यमेव जयते		Sheet No. 2:		1.000	
Extraordinary Published by Author	ity	206, 207, 209; 211, 212, 233, 235, 236, 241, 242, 256, 260,	229, 239, 255, 267.	205, 210, 230, 231, 237, 240, 243 to 248,	203, 229, 239, 255, 267, 213 to 228, 232.	201, 202, 204, 208, 238, 249 to 252.	203, 213 to 228, 232.
CAITRA 10] FRIDAY, MARCH 31, 20	06 [SAKA 1928	263 to 266, 268.		253, 254, 257 to 259, 261, 262.	or to object and provide the		
PART III—Acts of the West Bengal	Legislature.	Sheet No. 3:					
GOVERNMENT OF WEST BENGAL		410, 417, 444,	402, 403, 443, 445, 447.	401,	4 to 409, 445, 447. 1 to 416,	421, 422, 427 656.	
LAW DEPARTMENT Legislative		446, 516, 545, 573, 599, 625, 645, 646, 649, 653, 654, 657.		411 to 416,			
				418 to 420, 423 to 426,			
NOTIFICATION				428 to 442, 448 to 478,			S (1
No. 404-L.—31st March, 2006.—The following Act of the West Bengal Legislature, having been assented to by the Governor, is hereby published for general information:—				479 to 514, 515, 517,			
West Bengal Act VII of 2006				518 to 544, 546 to 572, 574 to 598,			
THE EAST KOLKATA WETLANDS (CONSERVATION AND MANAGEMENT) ACT, 2006.				600 to 624, 626 to 644, 647, 648,			
(Passed by the West Bengal Legislature.)				650 to 652, 655, 658 to 673,			
[Assent of the Governor was first published in the Kolkata Gazette, Extraordinary, of the 31st March, 2006.]			an state of	2901 to 2964.	All the la	stermet.	1.195.454
An Act to provide for conservation and management of	-	Sheet No. 4:	 			1993 - 1993 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 - 1994 -	
and for matters connected therewith and incidental thereto. WHEREAS the wetlands act as regulator of water regime, source for underground water recharging, mechanism for waste water treatment, air quality purifier and store of water for fire-fighting and have great ecological significance for human life; AND WHEREAS there is an increasing pressure on land for human settlement leading to filling up of the wetlands; AND WHEREAS the East Kolkata wetlands are ecologically and socio-economically very important; AND WHEREAS it is expedient to provide for conservation and management of the East Kolkata wetlands and for matters connected therewith and incidental thereto:		720, 750, 824 840, 878 to 884,	708, 724, 725, 726, 732, 737,	701 to 707, 709 to 719,	708, 724, 725, 726,		901 to 936, 938 to 947,
		887 to 900, 937, 948, 950, 951, 952, 954,	739, 763, 788, 816, 817, 818, 820, 825, 826,	721 to 723, 727 to 731, 733 to 736, 738, 740, 741, 742 to 749, 751 to 762, 764 to 787, 789 to 815, 819, 821 to 823, 827 to 839, 841 to 853,	732, 737, 739, 763, 788, 816,		953.
		2827, 2857 to 2860.	854, 876, 877, 885, 886, 949, 955 to 964, 970, 2742, 2744, 2764 to 2766, 2851 to 2856, 2861 to 2868.		817, 818, 820, 825, 826, 854, 876, 877, 885, 886, 901 to 936, 938 to 947, 949, 953, 955 to 964,		

Figure 5a: Legislation EKW ACT [1]

The legal professionals are so happy to have a legislation where each and every plots are identified and classified assigning specific land use class which has been appended in the legislation. Possibly it is the first kind of legislation in our country which was used RS technology so extensively to enact and elaborate and illustrated legislation.

Table 1:Existing Land Use Pattern Of EKW:

Land use Class	Area				
Substantially Water Body	5852.14 ha. Of which				
area	fish farming Constitute				
	3898.70 ha. (45.93%)				
Agricultural Land	4959.86 ha (38.92%)				
Productive Farming Area	602.78 ha. (4.73%)				
Urban Settlement	91.53 ha. (0.73%)				
Rural Settlement	1234.99 ha. (9.69%)				
Total	12,500 ha				

Figure 5 b: Satellite based landuse classification is a part of the ACT

West Bengal Act VIII of 2006, The East Kolkata Wetlands (Conservation And Management) Act, 2006 with plot wise land schedule has been prepared on the basis of high resolution satellite data. Needless to say that different organizations of the govt. associated with EKW management activities conferred its accuracy.

The paper is basically focused on the preparation of the informatory required for the proposed study "Study of the Ecological impact of sewage-irrigated vegetable faming of Calcutta Metropolis using Remote Sensing and GIS". Related chemical data required for the development of working model using of PALSAR and PRISM are collected and which may be validated later. It is also proposed that the study will take care of the nutrient availability in these sectors of land use classes.

6. References

[1] The Kolkata Gazette West Bengal Act VIII of 2006 The East Kolkata Wetlands (Conservation and Management) Act, 2006.