COMPARISON OF IRS AND LANDSAT DIGITAL DATA FOR WETLAND STUDIES

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Abstract *IRS LISS-II and LANDSAT TM data of Gulf of Kachchh area of the same date (May 4, 1988) was used to evaluate LISS-II data in comparison with TM data for wetland studies. This was done by (i) comparing radiance values of various wetland categories and (ii) analysing separability of wetland features. Similar points of 3×3 pixel size of various wetland classes, like, coastal water, reef area, mudflat etc. selected on both data sets. Radiance value for all features are higher in LISS-II data than TM, this may be because of higher sun elevation angle of LISS-II data. To check the separability of various wetland features, ratio of radiance values has been computed for every feature and compared with all remaining features. Here, the contrast between various categories is more or less same. However, TM bands 3 and 4 show slightly better discrimination for wetland features. Unsupervised classification was carried out using all 4 bands. In TM, coastal waters can be classified further as deep and shallow. Mudflat area gets mixed up with other categories in TM data. This may be because of different tidal condition. In principal component analysis both LISS-II and TM data comes out as two dimensional (i.e. dimensionality of both the data is 2), TM data has higher variability than LISS-II data and so it has capacity to cover more classes. Overall, TM data is slightly better than LISS-II data for classification of wetland categories. This may be because of higher radiometric resolution of TM data.*

INTRODUCTION

Evaluation of IRS data for wetland studies was carried out using standard as well as enhanced products of IRS LISS-II and LANDSAT TM (Nayak et.al.1988). The present exercise has been carried out in continuation to this work by comparing IRS LISS-II and LANDSAT TM digital data. The Gulf of Kachchh area was selected as IRS data and LANDSAT data of same date as well as ground truth information were available. In this work, grey values were converted to radiance values. It was observed that LISS-II bands 1 and 2, and TM bands 3 and 4 give better separability for various wetland categories.

OBJECTIVES

The main objective of this study is to evaluate IRS-1A LISS-II and Landsat TM data for wetland studies. This is accomplished by performing the tasks: (i) comparing radiance values of various wetland categories obtained from LISS-II data and TM data, and (ii) analysing separability of wetland features using both LISS-II and TM data.

DATA USED

The data products given in Table 1 for the area around Sikka in the Gulf of Kachchh were used for the study. It can be seen from the table that both data have slightly different tidal conditions.

Table 1 Details of data used

Path	Row	Date	Sensor	Tidal condition	Sun elevation in degree
150	45	4-5-88	LANDAT TM	ET-0119	60.850
34	52	4-5-88	IRS LISS-II	ET-0209	71.150

METHODOLOGY

Area of 512 x 512 pixel was extracted from LISS-II (340 sq.km) and TM (235 sq.km) data. The following steps were followed for analysing both LISS-II and TM data.

(i) Similar points of 3x3 pixel size, of various wetland classes, like coastal water, reef area, mudflat, sand etc. were selected on both data sets. Wetland map prepared using visual interpretation of both data (Nayak et al., 1988), was used as ground truth information.

(ii) Average digital number (DN value) of each 3x3 matrix were noted using COMTAL image processing system.

(iii) These DN values were converted into radiance values using the following formula:

$$\text{Radiance} = (\text{Saturation Radiance}/\text{Maximum DN}) \times \text{DN} \qquad (1)$$

Saturation radiance for various bands and maximum DN values for LISS-II and TM are given in Table 2.

(iv) Plots for radiance values versus various wetland categories were drawn.

(v) Mean values and standard deviation of all wetland features for each band was calculated (Table 3).

(vi) Contrast between wetland categories was calculated, using ratio of radiance of two categories as a criterion.

(vii) Unsupervised classification using the concept of multidimensional histogram was carried out. Maximum standard deviation indicating distance between two classes is 0.5. Minimum percentage of the total population to be classified as a single class is 2%. Grey level for TM is 256 and LISS-II is 128.

Table 2 Saturation radiance (mw/cm^2-sr-μm) S/N Ratio

Band	IRS LISS-II L2B	LANDSAT TM		LISS II	TM
	Lmax	Lmax	Lmin		
1	14.069	15.21	-0.15	142	152
2	22.653	29.68	-0.28	152	281
3	18.019	20.43	-0.12	155	232
4	16.445	20.62	-0.15	147	341

Maximum DN value for LISS II = 127
Maximum DN value for TM = 255

Table 3 Mean value and standard deviation of all wetland features

B	Sen-sor	Deep water		Shallow water		Reef area		VOS		Sand		Mud flat	
		SD	M	SD	M	SD	M	SD	M	SD	M	SD	M
1	TM	0.135	6.59	2.268	6.20	0.209	6.02	0.05	7.15	0.746	7.714	0.315	6.13
	LISS II	0.167	9.11	0.271	9.00	0.438	7.47	0.141	8.58	0.580	10.11	0.731	7.35
2	TM	1.506	5.37	0.442	5.75	0.573	5.42	0.153	6.80	1.127	7.565	0.448	5.62
	LISS II	0.775	8.49	0.450	8.47	0.670	7.04	0.122	8.65	0.878	10.34	0.464	6.91
3	TM	0.324	2.91	0.443	3.22	0.316	3.73	0.312	5.20	0.996	4.779	0.788	4.17
	LISS II	0.460	5.56	0.481	5.70	0.383	5.43	0.122	6.95	1.305	8.937	0.420	5.72
4	TM	0.092	1.40	0.549	1.77	0.422	3.15	0.141	5.33	0.607	5.309	1.801	3.23
	LISS II	0.133	2.90	0.405	3.10	0.527	3.95	0.0	5.82	1.074	6.129	0.408	4.27

B: Band; M: Mean; SD: Standard Deviation

RESULTS

Comparison of Radiance Values of TM and LISS-II Data

The actual radiance values of various wetland features for both LISS-II and TM have been plotted and given in Figs. 1 to 4.

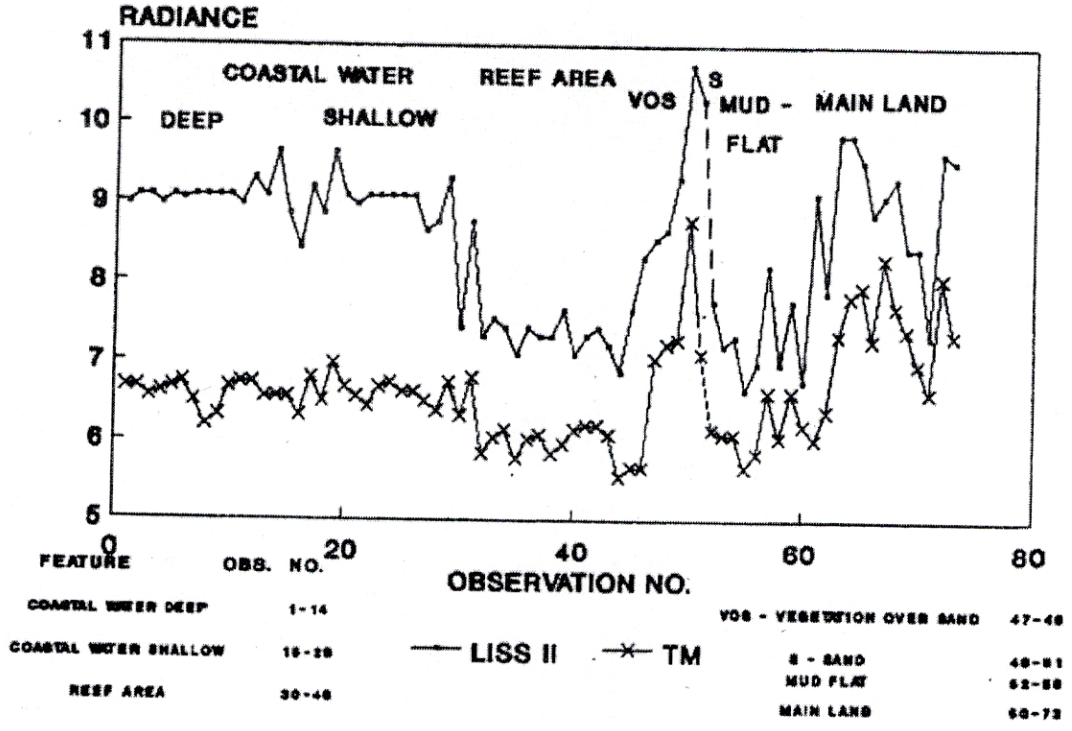

Fig. 1 Band 1 data

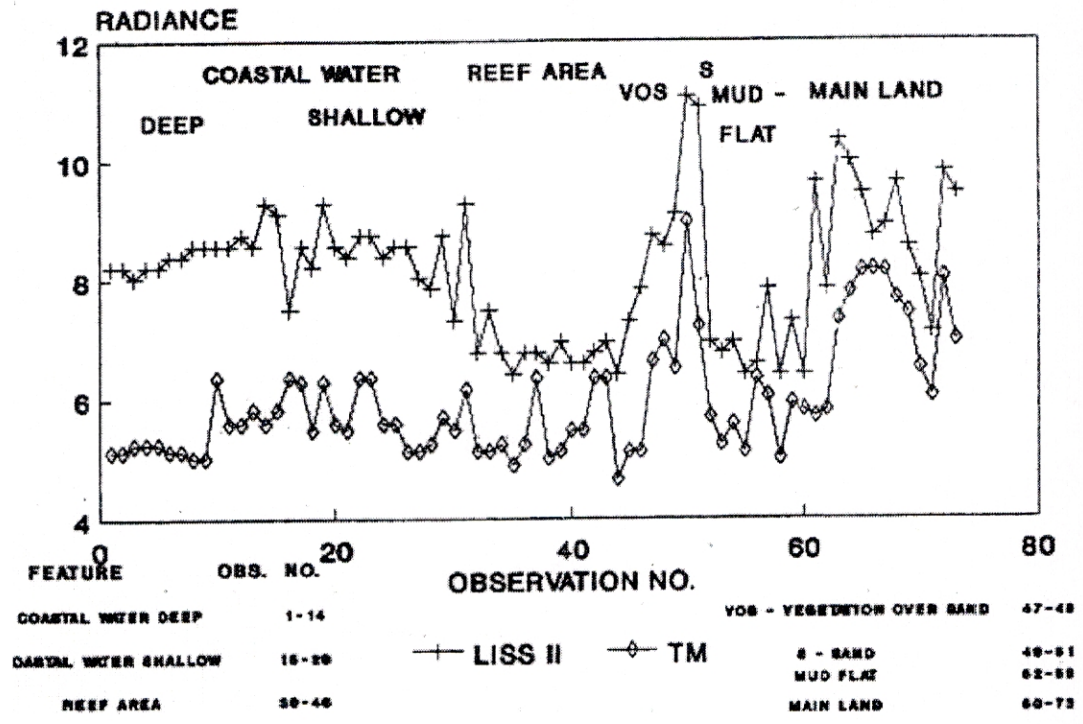

Fig. 2 Band 2 data

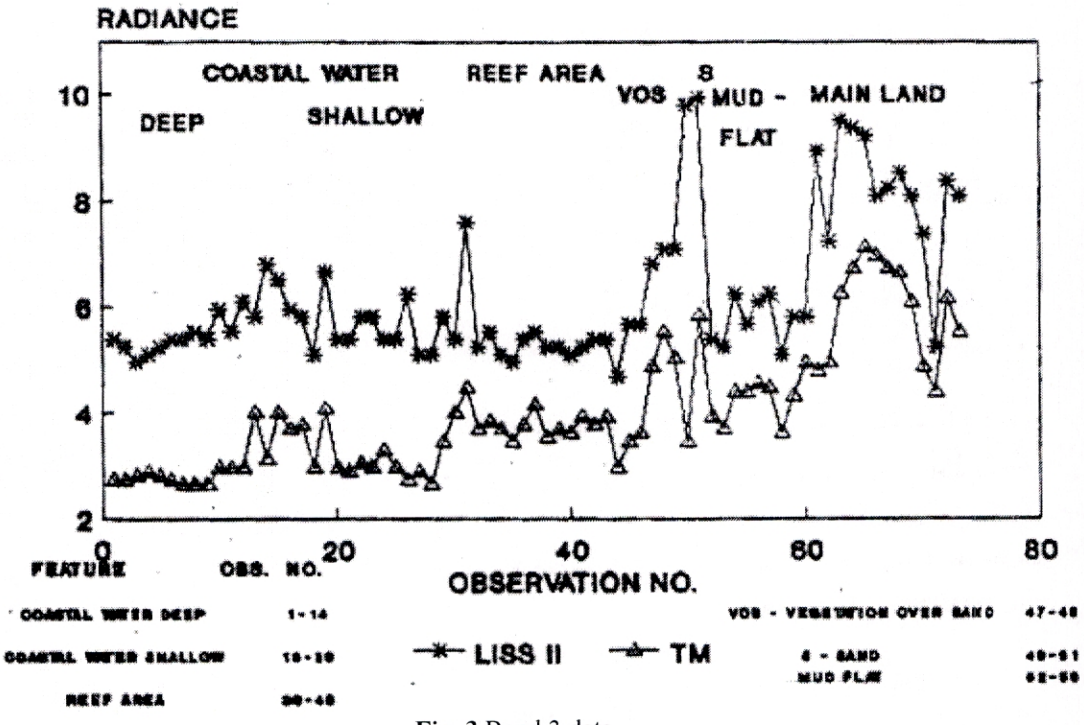

Fig. 3 Band 3 data

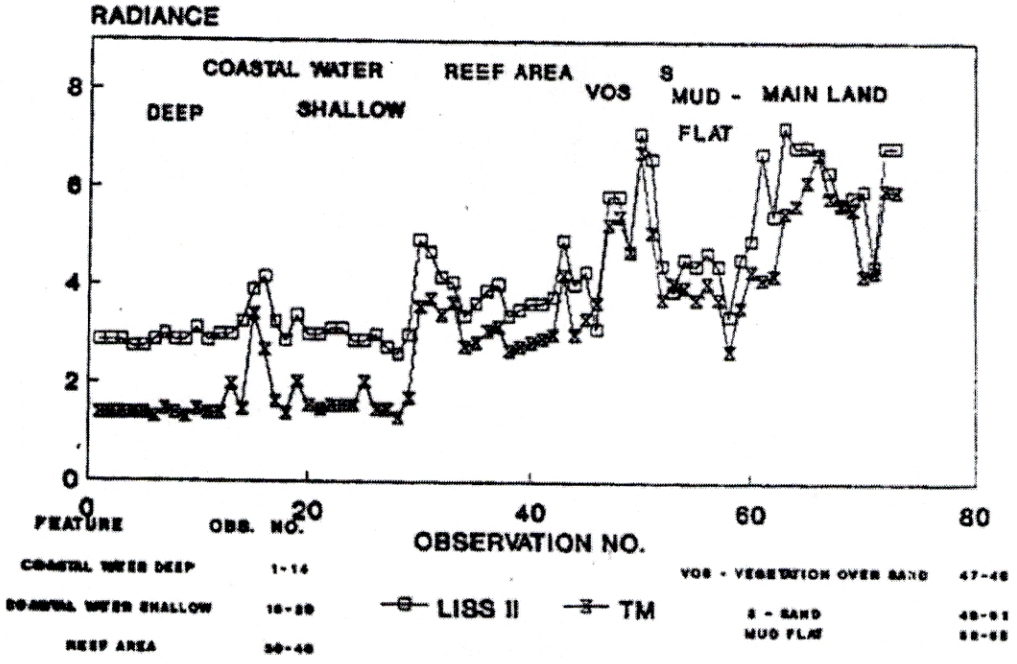

Fig. 4 Band 4 data

The observations made were: (i) radiance values for all features are higher in LISS-II data than TM, (ii) in bands 1 and 2, the difference in radiance values between coastal waters and reef area is distinct in LISS-II data, while in TM data, this difference between reef area and coastal water is slight. For other features the difference in TM and LISS-II data are good, (iii) in band 3, there is not much difference between reef area and coastal water in LISS-II, while in TM data, a slight difference is seen, (iv) in band 4, both data show distinct difference, (v) range – the range of radiance values is small in TM as compared to LISS-II; the values of radiance reduces with increase in wavelength; and the range also increases towards higher wavelength in TM.

These difference may be because of one or more of the reasons: (i) Sun-elevation angle: LISS-II data gives higher radiance values compared to TM data which may be due to high sun elevation angle of LISS-II, (ii) Tidal condition: the difference in tidal condition between the acquisition of both data is about 50 minutes. This may have significant effect on the radiance values of coastal water. The sediments are constantly moving and are governed by the tidal conditions thus their concentration may change at particular location. The difference in radiance may be because of water column above wetland, and (iii) S/N ratio: the S/N ratio in LISS-II data is poor than in TM data.

Separability

To check the separability of various features, ratio of radiance values has been computed for every feature and compared with all remaining features (Table 4).

Table 4 Ratio of radiance values

Sl.No.	Ratio	Band 1		Band 2		Band 3		Band 4	
		TM	LISS II	TM	LISS II	TM	LISS II	TM	LISS II
1	DW/SW	1.06	1.01	0.93	0.99	0.90	0.97	0.79	0.93
2	DW/RA	1.09	1.22	0.99	1.20	0.78	1.02	0.44	0.73
3	DW/VOS	0.92	1.06	0.79	0.98	0.56	0.80	0.26	0.50
4	DW/SA	0.85	0.90	0.71	0.82	0.60	0.62	0.26	0.47
5	DW/MF	1.07	1.20	0.95	1.22	0.70	0.97	0.43	0.66
6	SW/RA	1.03	1.20	1.06	1.20	0.86	1.04	0.56	0.78
7	SW/VOS	0.86	1.05	0.84	0.96	0.62	0.82	0.33	0.53
8	SW/SA	0.80	0.89	0.76	0.82	0.67	0.63	0.33	0.51
9	SW/MF	1.01	1.22	1.02	1.23	0.77	0.99	0.55	0.73
10	RA/VOS	0.84	0.87	0.080	0.81	0.72	0.78	0.59	0.68
11	RA/ SA	0.78	0.74	0.71	1.68	0.78	0.61	0.59	0.64
12	RA/MF	0.98	1.02	0.96	1.02	0.89	0.95	0.98	0.92
13	VOS/SA	0.93	0.85	0.90	0.84	1.09	0.78	1.00	0.95
14	VOS/MF	1.16	1.17	1.21	1.25	1.25	1.21	1.65	1.36
15	SA/MF	1.25	1.38	1.34	1.50	1.14	1.56	1.64	1.43

LISS-II bands 1 and 2 give better contrast than similar band of TM data for every wetland feature under consideration. However, vegetation over sand category is identified easily in TM band 2 data. TM bands 3 and 4 show excellent discrimination for wetland features, though sand category can be better delineated using LISS-II data.

Classification

Unsupervised classification using concept of Multidimensional histogram was carried out for given subscene using all 4 bands. In computation of unsupervised classification digital numbers (DN) (i.e. grey values instead of radiance values) have been considered. TM gives 5 classes whereas LISS-II gives 4 classes (Table 5).

Table 5 Result of unsupervised classification

Mean quantization level of different bands in each class									
	TM					LISS II			
Class No.	1	2	3	4	5	1	2	3	4
BAND 1	15	31	47	63	79	23	31	31	47
BAND 2	15	31	47	63	79	23	31	39	47
BAND 3	15	31	47	63	79	23	31	39	47
BAND 4	15	31	47	63	79	23	31	31	47
No. of pixel in each class:	7680	9967	203989	27741	12255	10	9755	32843	219546

Different classes available in TM and LISS-II are given in Table 6. In TM, coastal water can be classified as deep and shallow, but some of mudflat merge with shallow water category. In LISS-II, data mudflat category does not mix up with other classes.

Table 6 Available classes in TM and LISS-II

TM	LISS-II
(i) Shallow water	(i)Water
(ii) Deep water	(ii) Reef area
(iii) Reef area	(iii) Mud flat
(iv) Mudflat	(iv) Sand & Veg. Over sand
(v) Sand & Veg. Over sand	

In TM coastal water can be classified as deep and shallow, but some of mudflat merge with shallow water category. In LISS-II data mudflat category does not mix up with any other classes.

CONCLUSIONS

The following conclusions can be drawn from the present study:

(i) LISS-II gives higher radiance values for all wetland features, this may be because of higher sun-elevation angle, but this does not give any advantage in interpretation
(ii) LISS-II bands 1 and 2 and TM bands 3 and 4 give better separability between various wetland categories, and
(iii) TM data is better for classification of coastal water while LISS-II data is better for wetland categories.

REFERENCES

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Nayak, S., Gupta, M.C., Pandeya, A., and Trivedi, C.R. (1988) Evaluation of IRS data for coastal wetland mapping in the Gulf of Kachchh.