A GIStopology to detect coastal groundwater Potential zones and variation of sea water temperature along west coast of Karnataka

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Abstract - **Due to increase in atmospheric greenhouse gases, the coastal water temperature is slightly increasing with time period. For this coastal sea water surface temperature (SST) approach, MODIS has some limitations due to 1km resolution. However, in this work Landsat thermal bands had used for calculating SST. The study area of this investigation comprises coastal zone of Arabian Sea from Nethravathi to Udupi and the data obtained is Landsat8 OLI/TIRS imagery. In this paper, we mainly focussed on identification of potential zones of ground water in a coastal river basin (Pavanje in Karnataka state) and variation of SST in coastal area. Thematic layers like soil, slope, rainfall distribution, land use/land cover, stream density is created with assigned weightage which will support in identification of groundwater potential zones. SST varies from 22.5 to 41.4 degree Celsius temperature and groundwater potential zones is extracted by integrating the thematic layers for the study area.**

Keywords - Thematic layers, Groundwater potential zones, Sea Surface Temperature along Coastal zone.

I. INTRODUCTION

With the ability to work with Landsat thermal bands, it can monitor and map the land surface and water temperatures. SST is the water temperature close to the ocean surface. As Landsat8 OLI/TIRS (Operational Land Imager /Thermal Infrared Sensor) images has a resolution of 30 meters with nine spectral bands, one panchromatic band with 15 meter resolution and two thermal bands of 100 meters resolution which is useful for coastal studies.

Groundwater potential depicts the areas which are having high probability of obtaining groundwater at shallow depth. Therefore, delineation of groundwater potential zones helps in identifying places with groundwater potential.

Table 1Landsat8 OLI /TIRS bands wavelength variation

Bands	**Wavelength (micrometre)**
Band 1- coastal and aerosol	0.435 - 0.45
Band 2 - Blue	0.45 - 0.51
Band 3 - Green	0.53 - 0.59
Band 4 - Red	0.64 - 0.673
Band 5- Near Infrared (NIR)	0.85 - 0.88
Band 6 - SWIR 1 (Short-wave Infrared)	1.57 - 1.65
Band 7- SWIR 2	2.11 - 2.29
Band 8 - Panchromatic	1.50 - 0.68
Band 9 - Cirrus	1.36 - 1.38
Band 10- TIRS 1 (Thermal Infrared)	10.60 - 11.19
Band 11- TIRS 2	11.50 - 12.51

II. STUDY AREA AND DATASETS

The area falls along the west coast of peninsular India and is separated from the rest of peninsular by Western Ghats.

A. For Groundwater Potential Zones

The area lies between 74° 47' 00'' E to 75° 01' 00'' E and 12° 58' 00'' N to 13° 04' 00'' N as shown in figure 1, which covers an area of 170 sq.km. It is part of Dakshina Kannada district of Karnataka. The major rivers in this area are Pavanje River and Shambhavi River. The average rainfall of this area is 3,900mm.

B. For Coastal water Temperature

The area lies between 13º 20’ 36.65’’ N and 74º 40’ 05.41’’ E to 12º 47’ 50.95’’ N and 74º 49’ 44.55’’ E as shown in fig 2.

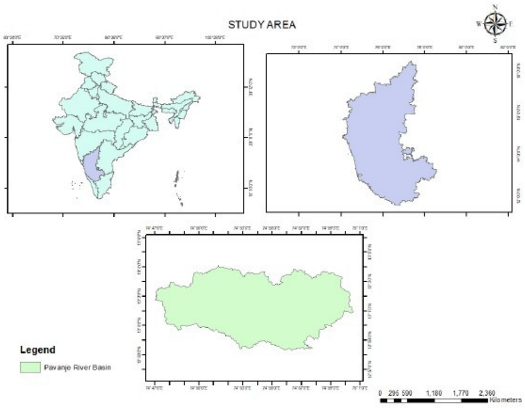


Figure 1Pavanje River Basin

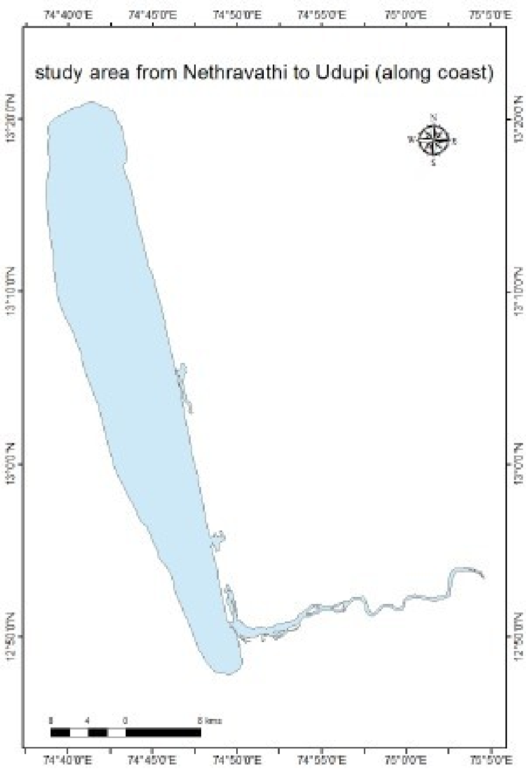


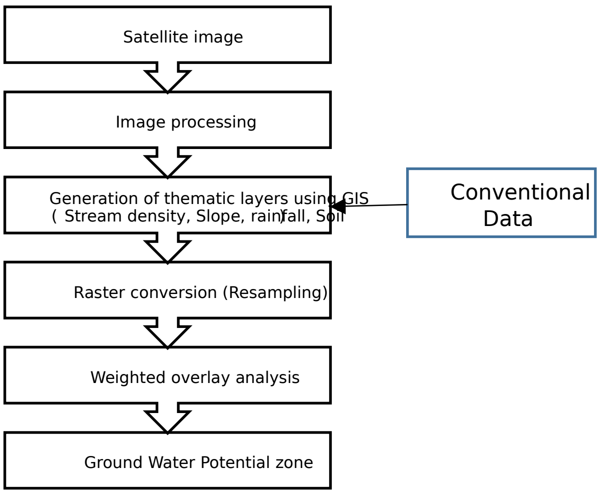
Figure 2Study area for SST from Nethravathi to Udupi region

III. METHODOLOGY

A. Methodology for Groundwater Potential:

The base map of the study area was created by using Google Earth Pro Image. The slope map was prepared by using SRTM 1 arc second DEM. The stream network for the study area was delineated from the SRTM DEM using ArcGIS Spatial Analysist tools. Stream density for the study area was created with the line density analysis tools. Rainfall distribution data is obtained by Indian Water Portal and it was spatially interpolated using Inverse Distance Weighted (IDW), to obtain the rainfall distribution map. Soil map for the area was taken from FAO Geo-network website.

Satellite images from IRS R2, LISS-IV sensor (geocoded with UTM Projection WGS 84 Zone 44N) is used for delineation of Land-use layer. Resampling of all layers to 30m resolution was done because of the variation in resolution of the layers. By overlaying all thematic map layers using weighted overlay analysis, potential zones of ground water were identified and weights for overlay analysis were assigned to each sub criteria according to their respective influences over the groundwater potential.



A For Sea Surface Temperature

For the image pixel values (DN values), we are applying the gain and offset to calibrate the Radiance Values. Here, radiance defines the surface bounced reflected radiation from the target. According to Chander et al., 2009 [1] conversion of pixel digital number (DN) into spectral radiance data is written below,

$$\text{Radiance} = L_\lambda = ML * DN + AL$$

Where,

ML = radiance multiplicative band

AL = radiance additive band

DN = digital number

And the sensor brightness temperature [2] is obtained from sensor spectral radiance by using the following equation,

$T = (K_2 / \ln (K_1/L_\lambda)) - 273.15$

Where T is the brightness temperature of sensor

ln is the natural algorithm and K1, K2 are calibration constants taken from the metadata.

Table 2Landsat 8 thermal bands specifications

Band	L_λ (min)	L_λ (max)	Q_{cal} min	Q_{cal} max	K_1	K_2
Band 10	0.10033	22.00180	1	65535	774.89	1321.08
Band 11	0.10033	22.00180	1	65535	480.89	1201.14

IV. RESULTS AND DISCUSSION

A. Ground Water Potential Zones: Weighted Classification

The weightage for each of the sub criteria [3] is shown in the below table.

Table 3Weighted classification

Factor	Sub criteria	Weightage
Stream Density	0 - 0.2	4
	0.2 – 0.28	3
	0.28 – 0.36	2
	0.36 – 0.44	1
Rainfall-Slope	Low	1
	Moderate	4
	High	6
Soil	A	2
	B	6
Land Use	Water Bodies	2
	Built Up	1
	Forest	5
	Agricultural	6
	Waste Land	5

Table 4Tools used for thematic maps

Factors	Tools
Stream density	Line density analysis
Slope	Spatial Analyst tool (based on SRTM data)
Rainfall	Inverse distance weighted

B. Groundwater Potential Zones

The potential zones of groundwater in the Pavanje river basin was extracted by the integrating various thematic map layers i.e. Stream density, soil map, rainfall-slope, land use map using ArcGIS tools after resampling them. Weighted Overlay Analysis is carried out.

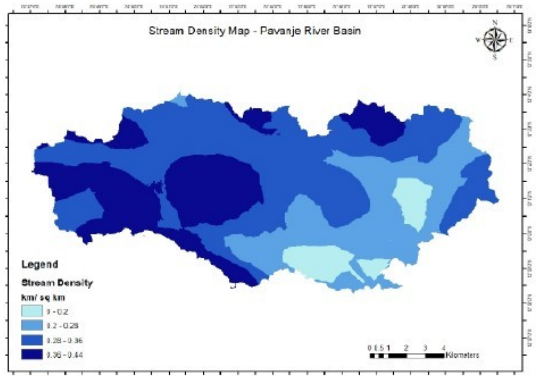


Figure 3Stream Density map of study area

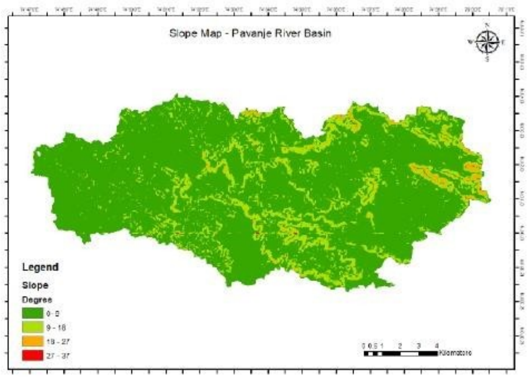


Figure 4Slope map of study area

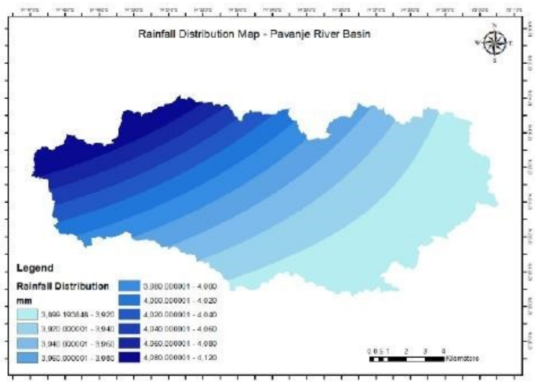


Figure 5Rainfall map of study area

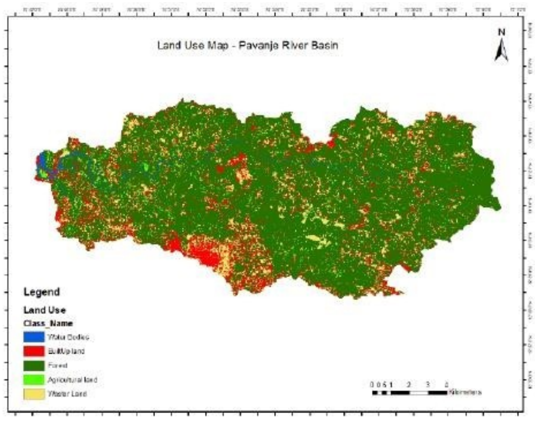


Figure 6Land Use map of Study area

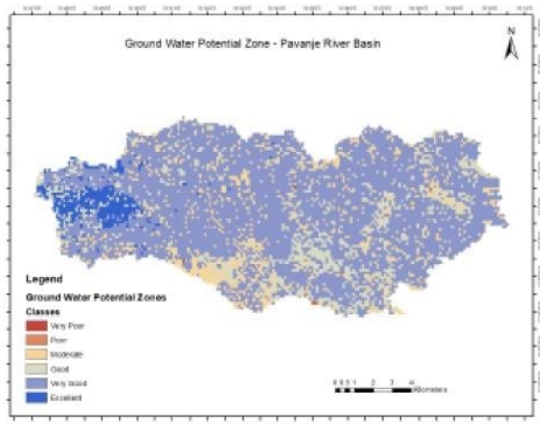


Figure 7Groundwater Potential Zones of Pavanje river basin

C. Coastal Sea water Surface Temperature:

Variation of coastal water temperature is calibrated for 4 years in the months of February to April from 2015 to 2018.

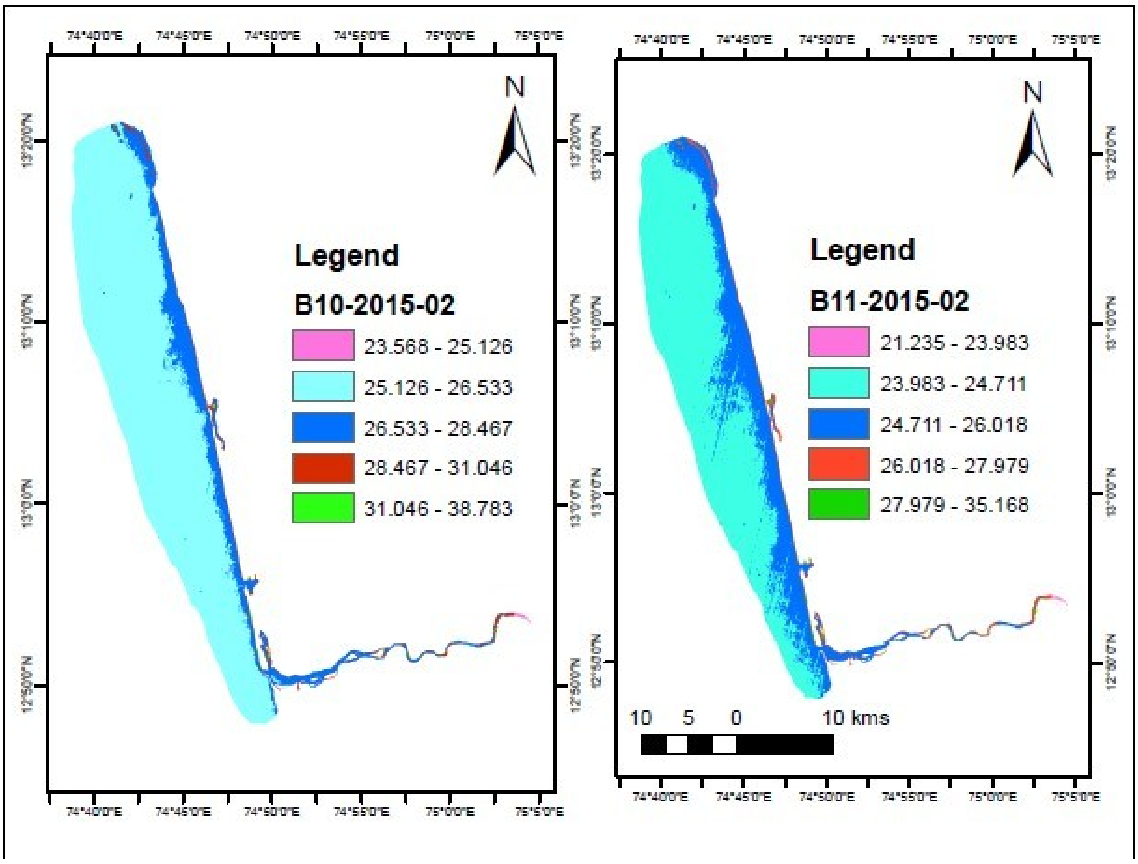


Figure 8Coastal water temperature variation in 2015

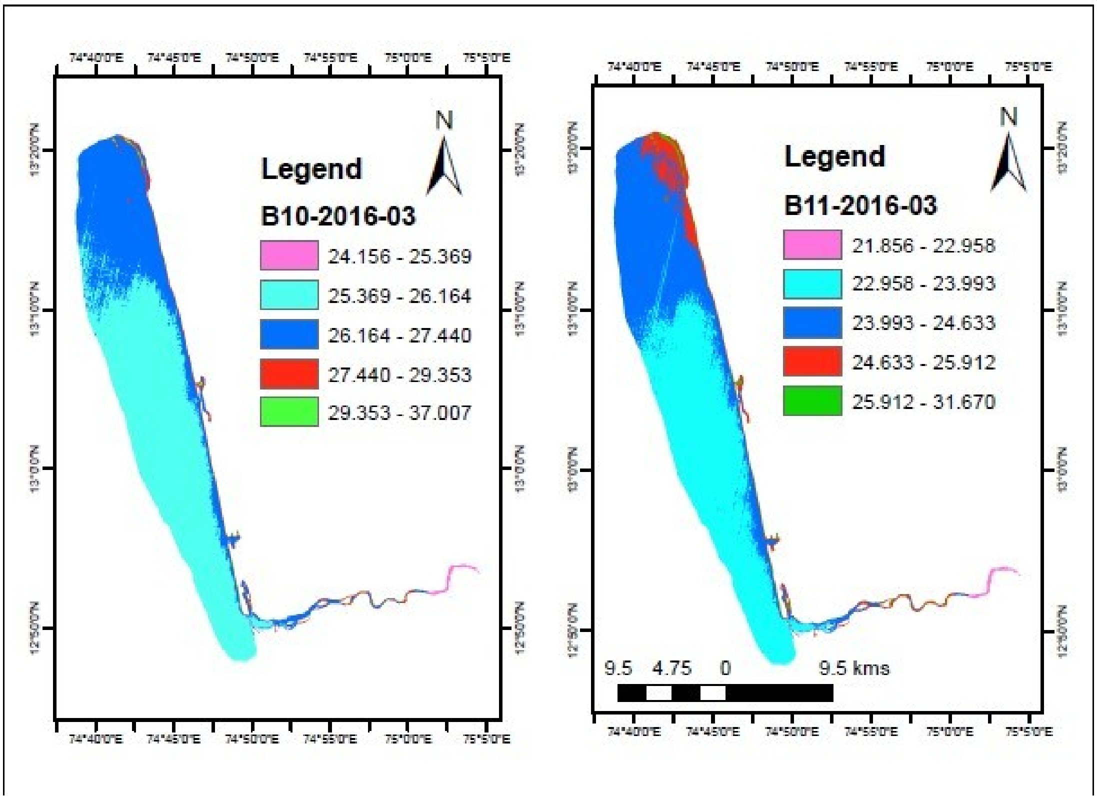


Figure 9Coastal water temperature variation in 2016

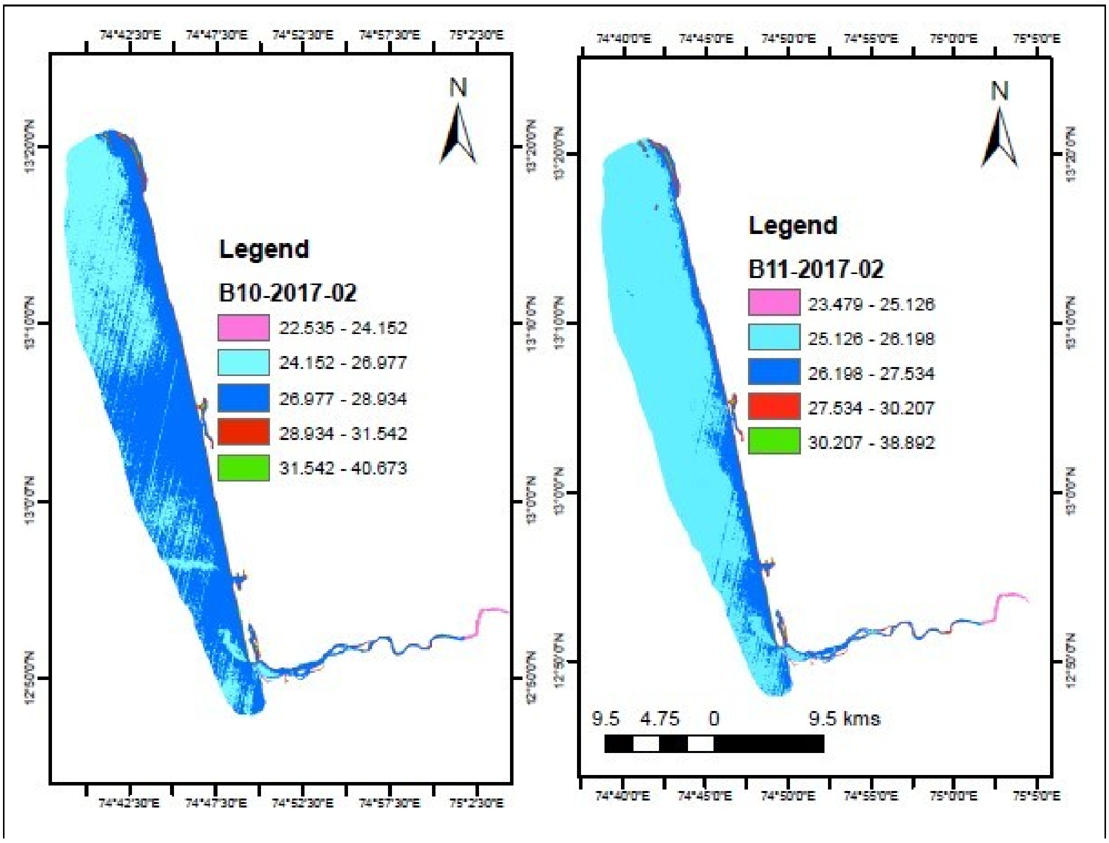


Figure 10Coastal water temperature variation in 2017

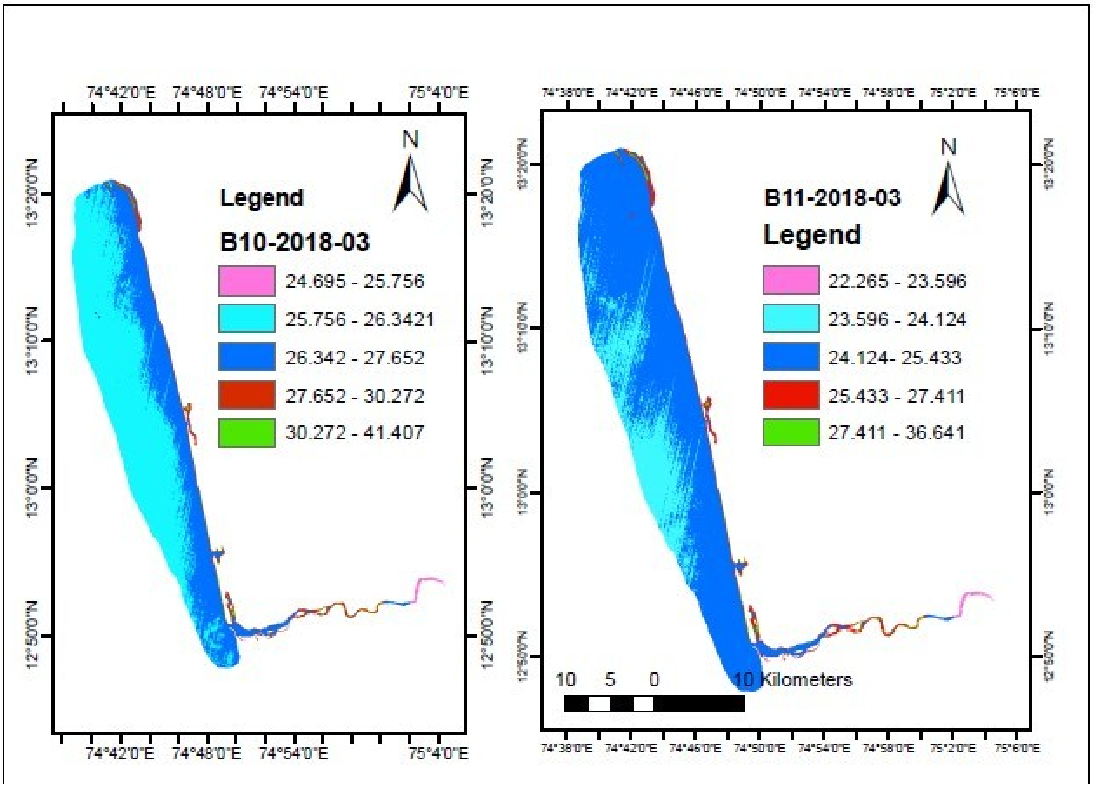


Figure 11Coastal water temperature variation in 2018

V. CONCLUSIONS

High groundwater potential zones are identified in Pavanje river basin which is located in the west coast and the variation in temperature is rapidly increasing from year to year which is shown in the figured results i.e. the maximum temperature is varying from 38 – 41 degree Celsius and high temperatures are identified in Band 10 than Band 11. In the recent year 2018, the sudden temperature changes are identified from pixel to pixel data due to variation in many atmospheric factors. Objective for the future work is to interpolate the coastal water temperature with coastal groundwater potential zones and to identify the correlation between them.

References

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