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Digitization of Inland Water Resources for Fisheries through Remote Sensing and Geographical Information System - A Study in Ratnagiri District

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Abstract

Natural inland aquatic resources such as rivers, creeks, mangroves as well as manmade resources such as reservoirs, shrimp farms and shrimp hatcheries of Ratnagiri district were mapped using Remote Sensing and Geographical Information System (GIS). IRS P6 LISS III images were used for mapping. A total of 10 rivers, 24 creeks and 2435.16 ha of mangrove area were identified and mapped. There are 65 reservoirs, 40 shrimp farms and 2 hatcheries in the district. Digital maps of each resource with details were incorporated using GIS techniques. IRS P6 LISS III images with 23 m resolution can be processed after enhancing resolution to 15 m by merging with Landset ETM+ image to map inland fisheries resources through Geographical Information System.

Keywords: Inland fisheries resources, remote sensing, GIS

Introduction

Ratnagiri is a coastal district of Maharashtra situated on the West Coast of India, which in endowed with enormous aquatic and fisheries resources. A total of 10 rivers, 65 reservoirs and 24 creeks supports the inland fisheries. The inland fisheries production of the Ratnagiri district was 21 mt during the year 2014-15 (Anon, 2016). In Ratnagiri district, brackish water area suitable for farming is 2201 ha, of which only 134.73 ha have been developed for shrimp farming. Geographical Information System (GIS) is applied to classify sectorwise aquaculture practices by using information like human resources, specific site, economics, markets and socio-cultural resources (Kapetsky et al., 1988; Meaden & Kapetsky, 1991). These studies mainly focused on locating and inventorising the available area for inland fisheries through GIS. Salam & Ross (1999) identified and mapped the suitable area for fresh water and brackish water culture through remote sensing and GIS.

Except the study, by Ghatge (2008) in which inland fisheries resources of Greater Bombay district have been digitized, no other study exist on developing digitized map in Maharashtra. Inland resources of Ratnagiri district have been digitized using IRS P6 LISS III and Landsat ETM+ data. An attempt was made to digitize the inland resources of Ratnagiri district using remote sensing to prepare inventory of inland resources and generate digitized maps of various inland resources.

Materials and Methods

Ratnagiri district with an area of 8,208 sq. km along Konkan region of Maharashtra ($18^0 04'$N $73^0 20$ E to $16^0 30'$ N $73^0 52$ E) was selected for the study. Mandangad, Dapoli, Guhagar, Ratnagiri and Rajapur were slected as coastal blocks while Khed, Chiplun, Sangmeshwar and Lanja fromed the non-coastal blocks (Map 1). Digital satellite images of study area from satellite sensors, with different spectral and spatial resolutions were used for the present study (Table 1). Information regarding inland fisheries resources were collected from fisheries related organisations of the Ratnagiri district and questionnaires were prepared, tested and used (McGoodwin, 2001) to collect the information about shrimp farms.

Ground truth data was collected using handheld e-trex Garmin GPS receiver set to universal Transverse Mercator (UTM) projection with world Geodetic System 1984 (WGS84) Datum (Lillesand et al.,

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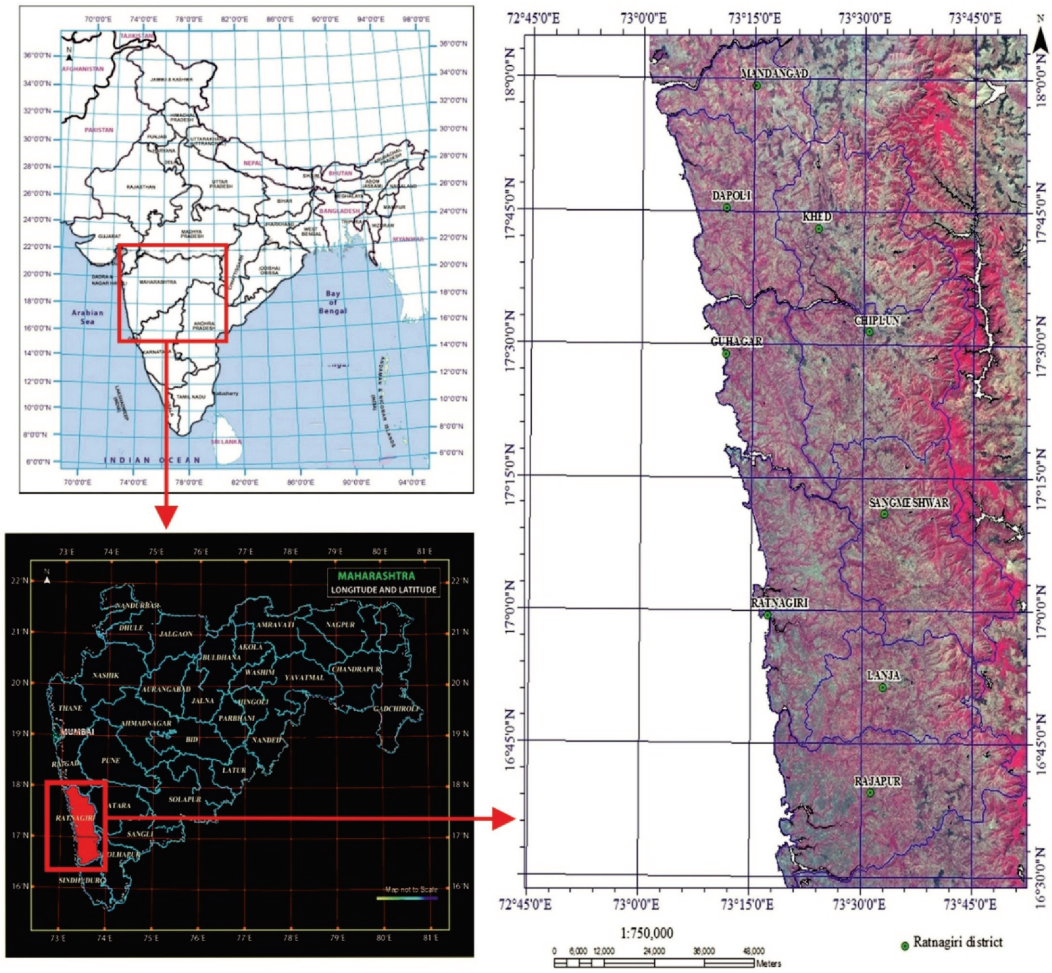
Table 1. Details of the satellite data

Sr. No.	Satellite	Sensor	Acquisition Date	Spectral resolution	Spatial resolution(m)
1	Landsat	ETM+	14-October- 99	PAN 0.520-0.900	15
2	IRS-P6	LISS III Multispectral	7-March-12	B2 0.52 - 0.59 B3 0.62 - 0.68 B4 0.77 - 0.86 B5 1.55 - 1.70	23.5



Map 1: Study Area

2004). The details along with geographical location of inland fisheries resources such as creeks, rivers, reservoir, mangroves, shrimp farms and shrimp seed hatcheries were collected as per Ghatge (2008).

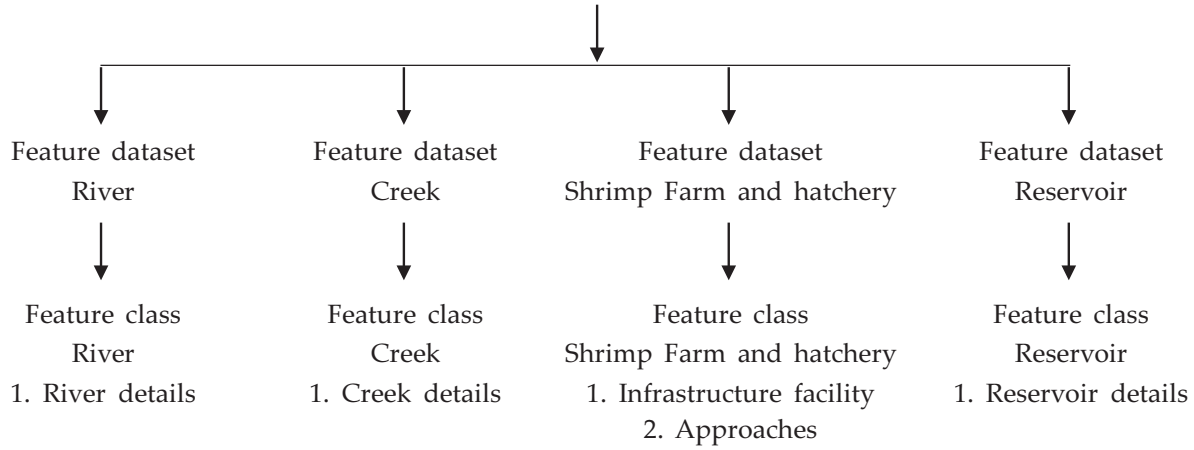
Image processing was done with the help of ERDAS Imagine 9.1 software and ArcMap version 10.1 was used as GIS platform. Satellite data obtained in Tagged Image File Format (TIFF) was converted to ERDAS Imagine format. Radiometric qualities of the imported images were enhanced by using haze correction. The resolution merge was performed to bring all the images with same resolution of 15 m to improve the spatial quality. Supervised classifi-

cation was performed using ERDAS module. Maximum Likelihood Classifier^{TM} was used to identify river, creek, shrimp farms and hatchery, reservoir and mangrove forest. The adequate spectral signatures of landcover classes were extracted by signature editor and spectral signature were obtained with AOI tool. The spectral signatures for different landcovers were selected based on field data collected and reference images (Gao, 1999). Colour codes were assigned to signatures, to classify the land cover classes in the image. Thereafter, supervised classification was performed with attribute option maximum, minimum, mean and standard deviation. Pixels of transformed image after supervised classification were assigned with colour code. The classes belonging to same landcover class were merged together to form one class. LISS III image pixels values were used to classify rivers, creeks, shrimp farms and hatcheries, reservoir and mangrove and are as detailed in Table 2. Georeferanced data sets of inland fisheries resources were created in the personal geodatabase. The feature class of each fisheries resource was created using the Microsoft Access database (Flow chart 1). Satellite images of study area were geolinked with data class in the Arc Map10.1 software. Digitized image with 15 m resolution of each feature with integration of detailed information were generated.

Table 2. Details of LISS III image pixels value

Sr. No.	Resources	Image	High pixel value of land	Low pixel value of water
1	River	band 2	71	67
		band 3	69	52
		band 4	76	60
2	Creek	band 2	92	76
		band 3	68	52
		band 4	82	45
3	Shrimp farm	band 2	85	77
		band 3	75	67
		band 4	80	68
4	Reservoir	band 2	84	69
		band 3	82	47
		band 4	78	45
5	Mangrove	band 2	75	64
		band 3	54	48
		band 4	73	61

Flow chart 1 - Procedure for creation of feature class from feature dataset

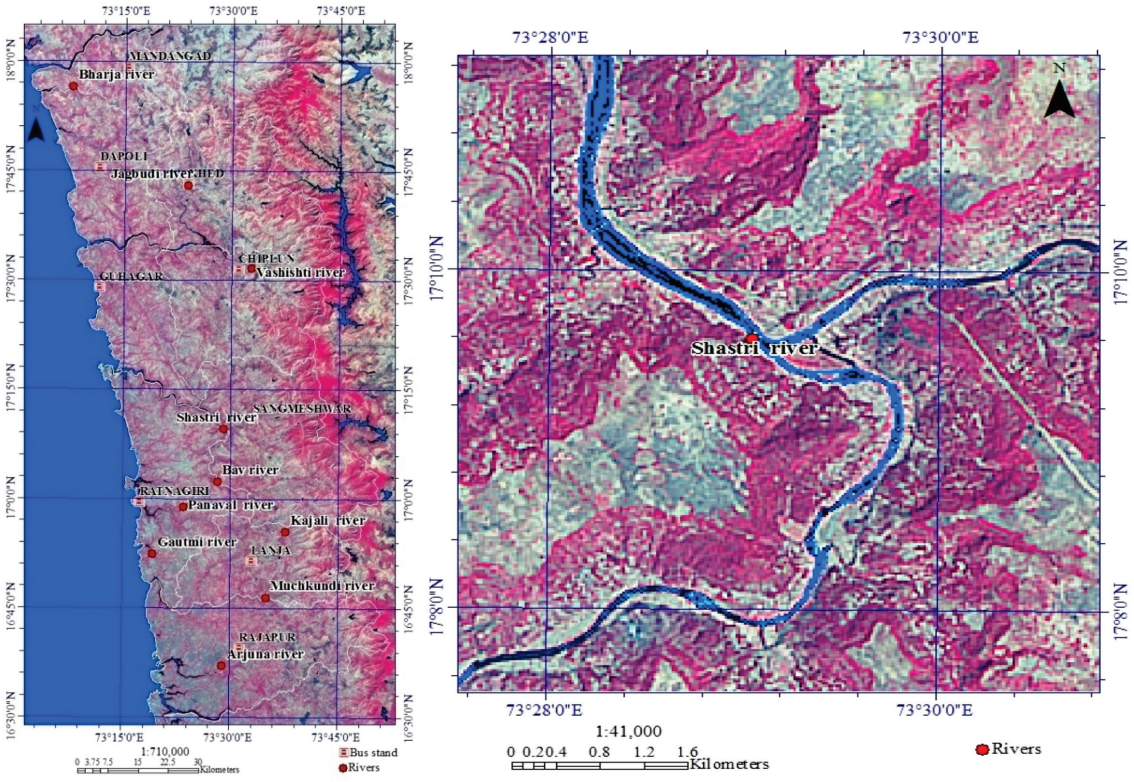


Results and discussion

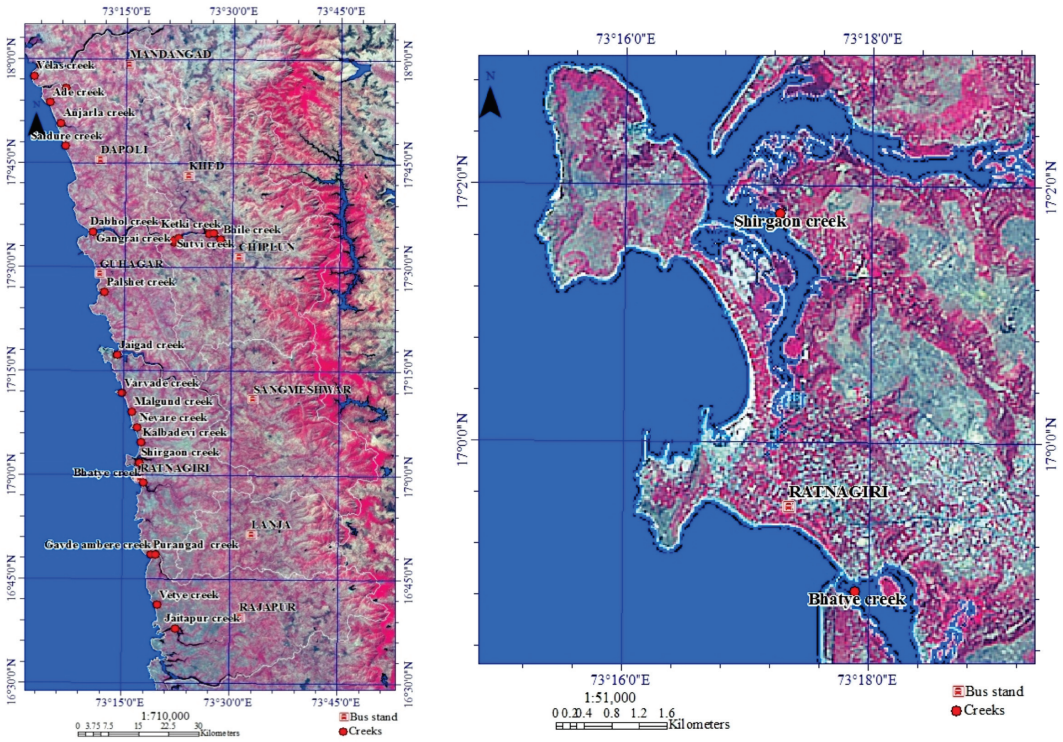
A total of 10 rivers were studied in the Ratnagiri district, of which five were comparatively large rivers and rest were small coastal rivers (Map 2). Rivers with more than 10 km length were identified as large and the rest considered small rivers. The large rivers were Vashishti, Jagbudi, Shastri, Arjuna and Muchkundi, while small coastal rivers were Panaval, Bav, Kajali, Gautmi and Bharjariver. Ratnagiri district receives on an average 3188 mm of precipitation during monsoon (Anon, 2016), therefore, irrespective of river class they discharge large amount of water into Arabian Sea during monsoon and post-monsoon period. Chopra et al. (2001) estimated the total wet land area and estimated area of 10.8 sq km as waterlogged lake/ ponds cover oxbow lakes, in the state of Punjab.

The creeks are one of the most important natural resource contributing to the inland fisheries of Ratnagiri district. In this study, 24 creeks (Map 4) were mapped in coastal as well as interior blocks of Ratnagiri district (Table 3). Jagtap et al. (2001) estimated that the total wet land of Maharashtra as 1567 sq. km by using LANDSAT data, of which 44.6% area was estuarine.

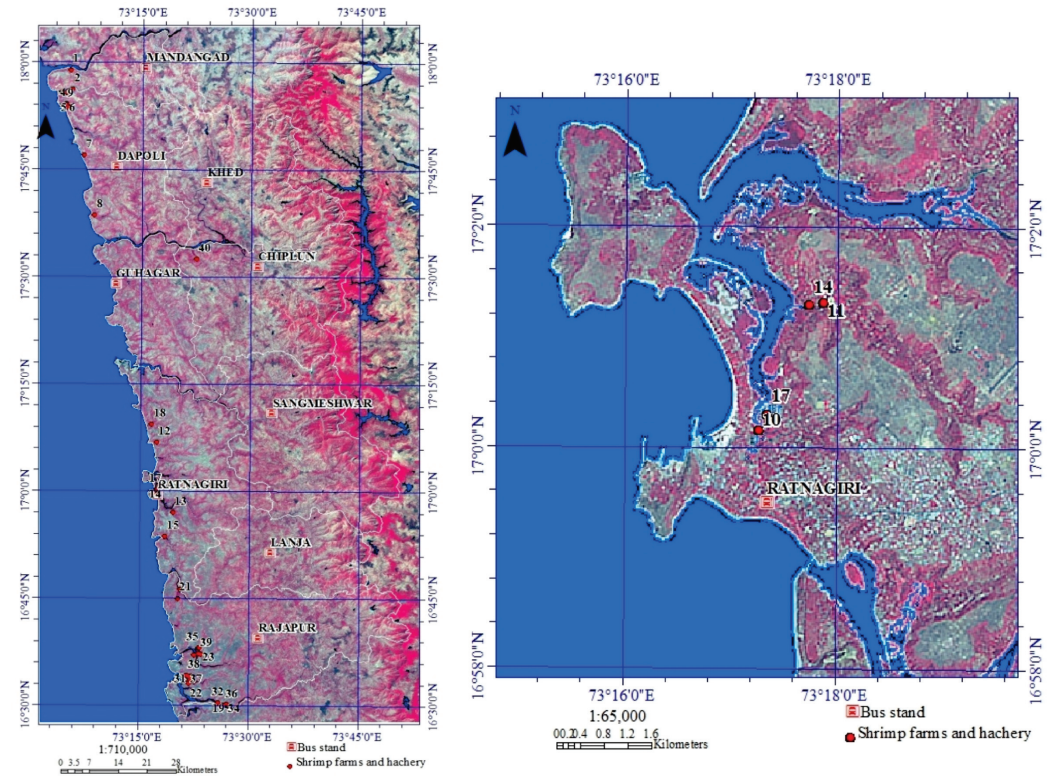
Even though the total suitable brackish water area available for Aquaculture in the Ratnagiri district was 2201 ha (Anon, 2015), the area utilized for farming was only 134.73 ha. Total of 40 brackish water farms were studied in Ratnagiri district and their locations are shown in Map 4. Though the first brackish water farm was established way back in 1984, the development was slow and no new farms were developed after 2005. The reason for lack of expansion of brackish water farms may be due to the Coastal Regulation Zone Act, 2005. Only two shrimp hatcheries were functional in Ratnagiri of which one was established in 1998 and other in 2006. Ghatge (2008) have also mapped the shrimp farms and hatcheries using digital satellite image of Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Toposheet in the Greater Mumbai region. Kartik et al. (2005) estimated total area of 20431.034 ha as



Map 2. Geographical locations of rivers in Ratnagiri district



Map 3. Geographical locations of Creeks in Ratnagiri district



Map 4. Geographical locations of Shrimp farms and hachery in Ratnagiri district

Table 3 Details of creeks in Ratnagiri district

Sr. No.	Name of block	Number of creek	Name of creek
1	Mandangad	2	Bankot (17°59′5"N 73° 2′56"E) and Velas creeks (17°57′28.21"N 73° 2′3.04"E)
2	Dapoli	5	Kelashi (17°55′46.58"N 73° 3′21.76"E), Ade (17°53′42.91"N 73° 4′23.79"E), Anjarla (17°50′41.31"N 73° 5′52.41"E), Saldure (17°47′22"N 73°6′33"E), Dabhol creeks (17°35′3.26"N 73°10′32.62"E)
3	Guhagar	1	Palshet creek (17°26′21.10"N 73°12′11.93"E)
4	Chiplun	6	Sutvi (17°33′35.22"N 73°21′50.67"E), Ketki (17°34′48.70"N 73°26′45.90"E), Bhile (17°33′59.99"N 73°28′23.26"E), Songaon (17°34′56.42"N 73°27′24.19"E), Chiveli (17°33′50.02"N 73°21′48.17"E) and Gangrai creeks (17°34′11.18"N 73°22′31.85"E)
5	Ratnagiri	9	Jaigad (17°17′17.88"N 73°14′2.03"E), Varvade (17°11′48.88"N 73°14′47.34"E), Malgund (17° 9′6.78"N 73°16′11.64"E), Nevare (17° 6′46.83"N 73°16′58.89"E), Kalbadevi (17° 4′39.11"N 73°17′30.03"E), Shirgaon (17° 1′46.75"N 73°16′57.97"E), Bhatye (16°58′50.81"N 73°17′53.67"E), Purangad (16°48′27.87"N 73°18′59.74"E) and Gavdeambere creeks (16°49′26.57"N 73°19′37.45"E)
6	Rajapur	2	Vetye (16°41′15.74"N 73°19′55.55"E) and Jaitapur creeks (16°37′50.99"N 73°22′27.49"E)

suitable for culture using IRS 1D LISS III along Palghar taluka of Thane district. The shrimp farms of Andaman and Nicobar island of India were mapped through GIS by Sing et al. (2012).

About 65 reservoirs were studied in Ratnagiri district and thier geographical location are shown in Map 5. The total area of reservoirs in Ratnagiri district was 1708.548 ha (Department of Irrigation). The maximum reservoir size of 186 hectare was in khed block and minimum reservoir size with 0.8 hectare in Chiplun block. Department of Fisheries has access to only 40 of these reservoirs for fisheries development. Jayanti et al. (2006) have estimated the area of reservoirs in Andhra Pradesh State by using remote sensing and Salgaonkar (2010) has also estimated area of reservoirs in Ratnagiri district as 117.87 ha in pre-monsoon and 1674.08 ha in post-monsoon period. Total area recorded in this study was 1549.18 ha. Area reported in the present study are average values while area of reservoir reported by Salgaonkar (2010) are minimum and maximum value. Total mangroves area estimated in Ratnagiri district was 2135.26 ha. Nakhawa (2009) estimated mangroves area at 949.07 ha in Ratnagiri block using remote sensing and GIS.

Digitized maps of Inland Fisheries Resources in Ratnagiri district will be of immense help to planners and administrators for understanding distribution of resources suitable for fisheries. development. These maps can serve as base maps to spatially display the inland water resources available in the district.

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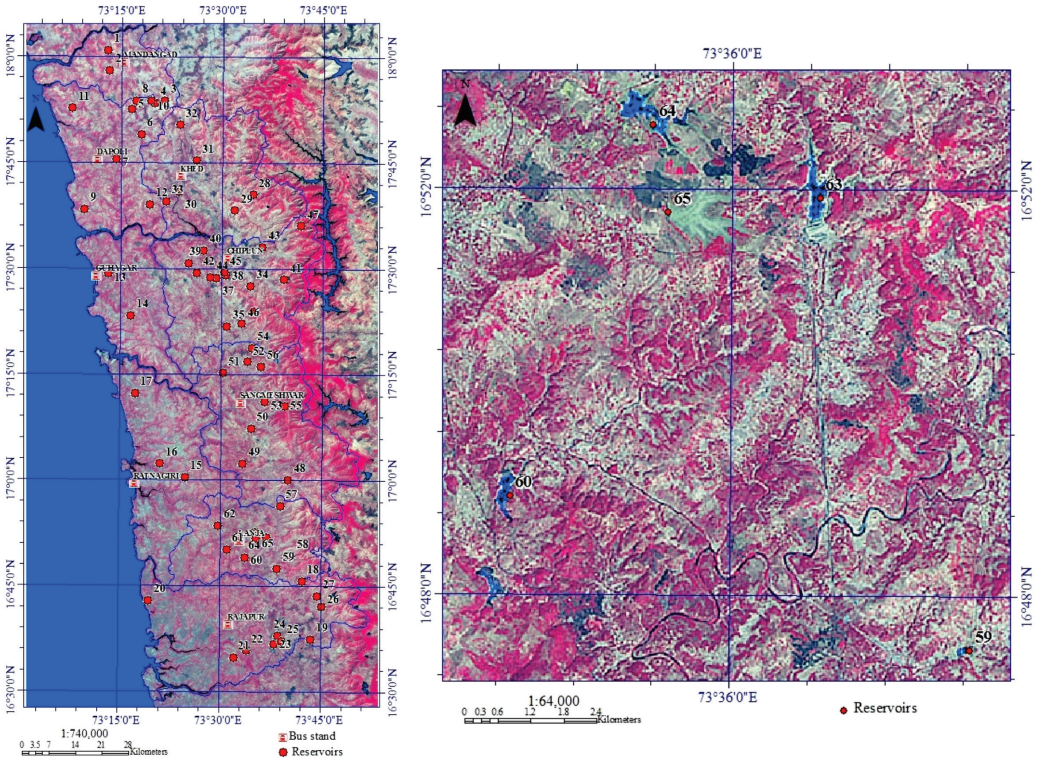

Map 5. Geographical locations of reservoirs in Ratnagiri district

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