3. Study Area and Data Collection

3.1 General

This chapter describes the study area and data used in the study. In the present work, Vishwamitri watershed is selected as a site of the study. Due to the unavailability of SAR data for the Vishwamitri watershed during inundation period, the applicability of the SAR for inundation mapping is shown over Kerala and Assam regions.

3.2 Study areas and Data collection

The study area is located in the Vadodara district of Gujarat State of India. In this work, the Viswamitri Watershed has been selected as the study area. The Vadodara district area, which is located south of the Tropic of Cancer and in the transition zone of heavy rainfall areas of South Gujarat and arid areas of North Gujarat plains, has a subtropical climate with moderate humidity. The Vadodara district forms a part of the great Gujarat plain. The eastern portion of the district is hilly terrain with several ridges, plateaus, and isolated relict hills that have an elevation in the range of 150–481 m above the mean sea level. The southeastern plateau has the highest peaks of the district—Amba Dungar and Mandai Dongar 637 m above the mean sea level. The Vishwamitri river, which falls in the Vadodara district, is considered as a major tributary of the Dhadhar river. The Vishwamitri river originates from the hills of Pavagadh, which is 43 km northeast of Vadodara. The Pavagadh hill is made of trappean rocks that emerge abruptly 830 m above the mean sea level. The Viswamitri river has a channel length of around 70 km and 58 km of this channel length flows through the Vadodara District. It meets the Dhadhar river at Pingalwada in the Vadodara district. Figure 3.1 shows the geographical location of the study area.

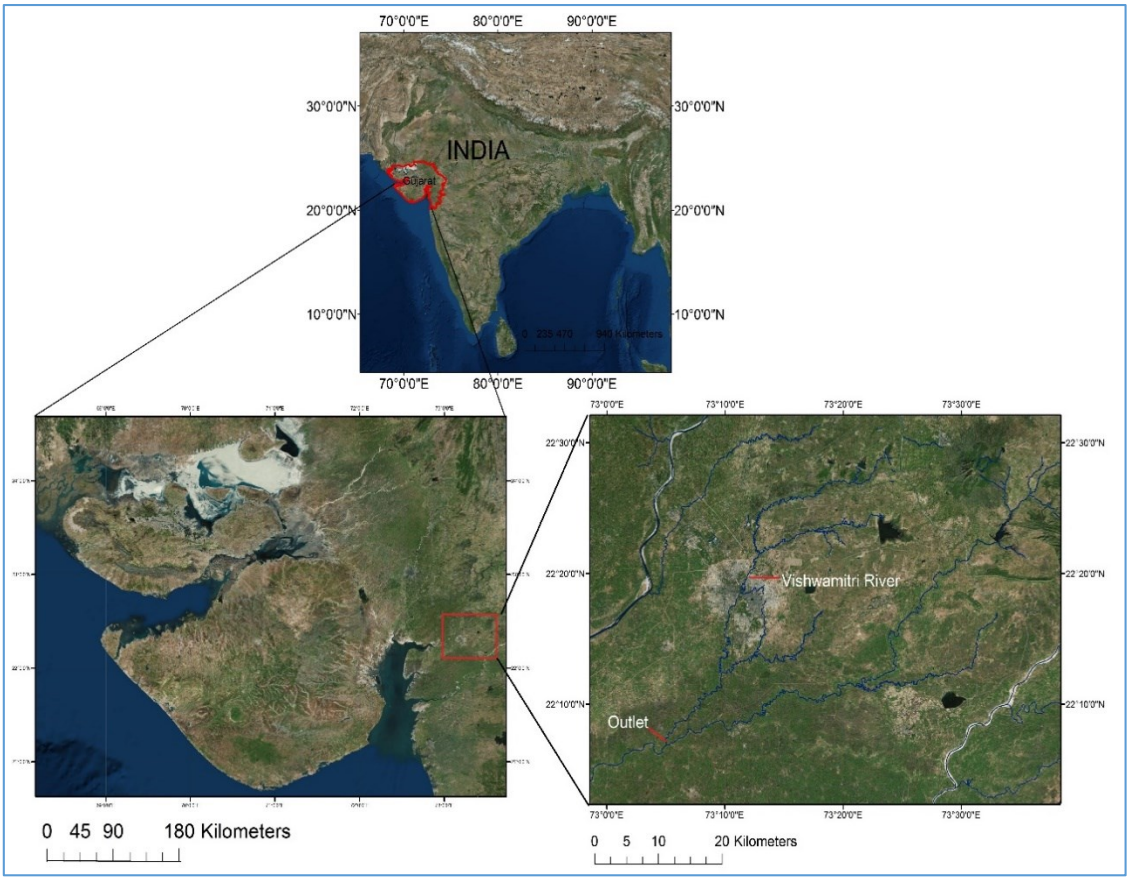

Figure 3.1: Geographical location of the study area Viswamitri river.

Kerala

Kerala is a small, elongated coastal state in peninsular India's south-western tip. It is surrounded by the Western Ghats in the east and the Arabian Sea in the west. A part of the state of Kerala was considered in this study. The state faces severe and varied damages due to floods and heavy rainfall. Monsoon circulation dominates the climate of India and Kerala in particular. The wind blows from the oceans to the south of the Asian land masses during the half of the year, while a seasonal wind blows from the Asian land masses to the oceans in the south during the other half of the year causing a spectacular reversal of pressure and wind patterns between the two six-month periods. South-west monsoon (June-September) and post-monsoon (October-November) are the main rainy seasons in Kerala. The state witnessed heavy floods in the year 1924 and 1961. The IMD recorded rainfalls for 15 to 17 August 2018 were found to be comparable to the rigorous storm that occurred in 1924 (Central Water Commission, 2018). Heavy rainfall resulted in high surface runoff in Kerala's major river basins, filling all dams and subsequent opening of these dams, causing widespread flooding in downstream areas, low-lying coastal areas, and Kerala's backwaters. Figure 3.2 shows the area covered under the study. The National Aeronautics and Space Administration Alaska Satellite Facility (NASA/ASF) houses a complete archive of Sentinel-1 SAR data processed by the European Space Agency (ESA). The

Sentinel-1 Level-1 ground range detected (GRD) data acquired in interferometric wide swath (IW) mode, which is the predefined mode over land with VV and VH polarizations, were downloaded via the ASF application programming interface (API). Sentinel-1 and Sentinel-2 data that are available closest to event date were acquired on 21 August 2018 at 00:40:44 and 22 August 2018 at 05:06:49, respectively. The specific parameters of the Sentinel-1 and Sentinel-2 products are given in Table 3.1.

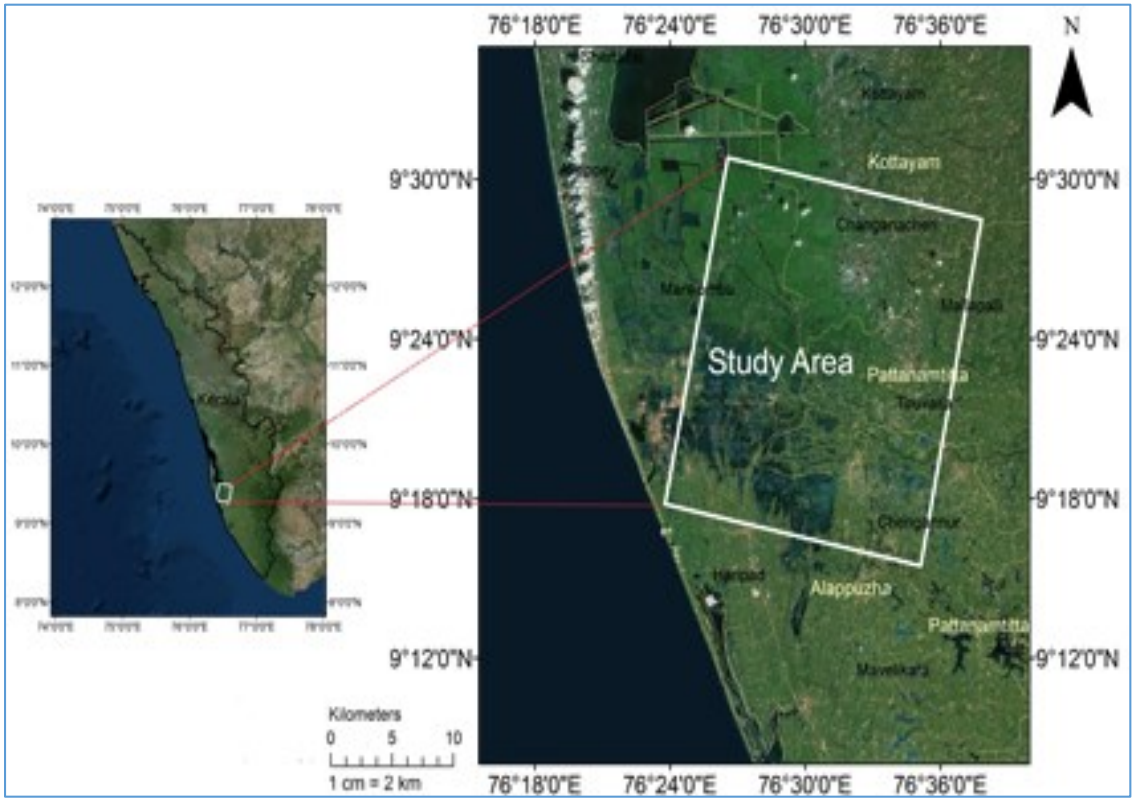

Figure 3.2: Study area Kerala.

Assam

Assam is a state in northeast India, situated south of the eastern Himalayas along the Brahmaputra and Barak River valley. The state has recently witnessed heavy flood in July 2019. The Brahmaputra basin falls within the monsoon rainfall regime, getting an average rainfall of about 230 cm. The heavy floods in the Brahmaputra river in Assam owing to the increase in water concentrations of the Brahmaputra river and its related tributaries likely led from high continuous rainfall in the upper catchment regions of the Brahmaputra Basin. Figure 3.3 shows the area covered under the study. Sentinel-1 and Sentinel-2 data that are available closest to event date were acquired on 14 July 2019 at 11:57:18 and 16 July 2019 at 04:27:09, respectively. The specific parameters of the Sentinel-1 and Sentinel-2 products are given in Table 3.2.

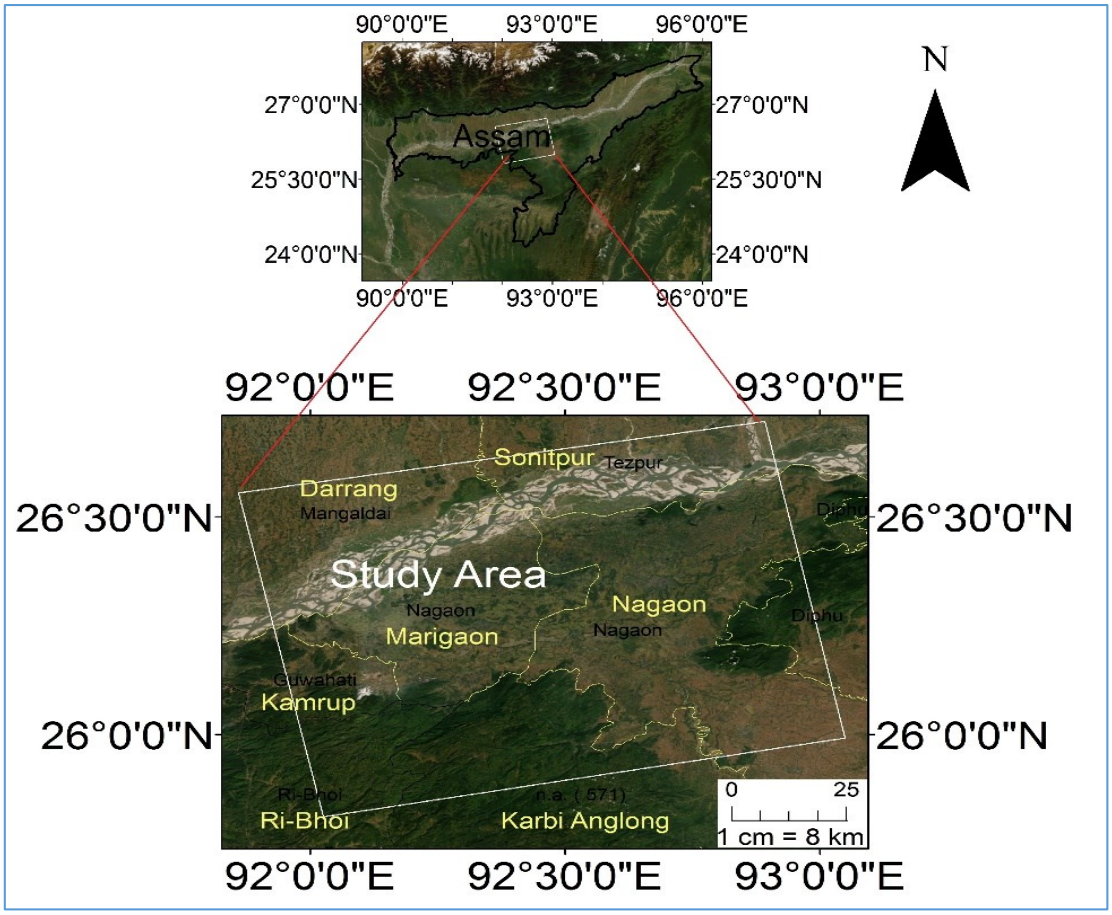

Figure 3.3: Study area Assam.

Data Characteristics

Cartosat-DEM

With the prime objective of delivering high-resolution satellite data of 2.5 m in-track stereo, Indian Space Research Organization (ISRO) launched Cartosat –1 on May 5, 2005. The quality verification process is performed by panning and draped visualization in order to demarcate distortions. The DEM is referenced to WGS84.

SRTM-DEM

The SRTM data are projected in a geographic (lat./long.) projection taking into consideration the WGS84 horizontal datum and the EGM96 vertical datum. It is considered global DEM with one-arcsecond resolution (approximately 30 m at the equator). Two different C-band and X-band interferometric radar images of the same area are captured by two antennas that are about 60 m apart. C-RADAR Vertical reference and Polarization are EGM96 geoid and HH VV, respectively, whereas X-RADAR Vertical reference and Polarization are WGS84 ellipsoid and VV, respectively. Elevation data are obtained after processing interferograms.

ASTER-GDEM

ASTER GDEM was generated by using the stereo-correlation of more than 1.5 million along-track stereo images of 15 m horizontal resolution, which are obtained by the visible and near-infrared

(VNIR) sensor covering land surfaces between 83°N and 83°S. Initially, ASTER (GDEM-V1) with 30 m horizontal resolution and absolute vertical accuracy of 20 m (95% confidence interval) were made open for public use. The data are referenced to WGS84 and EGM96 vertical datum.

Sentinel–2

The European Space Agency's Sentinel–2 Multispectral Imager measures the reflected solar spectral radiances in 13 spectral bands ranging from the visible to the shortwave infrared bands. The primary purpose is to monitor vegetation, water bodies, cropland, urban areas, land use and land cover change at local, regional, national and global scales. Sentinel–2A and –2B can together revisit the same region every five days with data acquisitions available in Level 1C processing. The data characteristics of Cartosat DEM and Sentinel–2 data used in the study are given in Table 3.3. Bands 1, 9 and 10 at 60 m resolution are dedicated mainly to atmospheric corrections and cirrus-cloud screening. As they do not contain surface information, those 3 bands were omitted after the pre-processing phase from the analysis.

Table 3.1: Specifications of Sentinel-1 and Sentinel-2 products used over Kerala.

	SENTINEL-1A	SENTINEL-2B
PRODUCT NAME	S1A_IW_GRDH_1SDV_20180821T004109_20180821T004134_023337_0289D5_B2B2	S2B_MSIL1C_20180822T050649_N0206_R019_T43PFL_20180822T085140
REPEAT CYCLE	12 days	10 days
INSTRUMENT	C-SAR	Multi-Spectral Instrument
PRODUCT TYPE	Ground Range Detected	S2MSI1C
ACQUISITION MODE	Interferometric Wide swath (IW)	INS-NOBS
SENSING DATE	21-Aug-18	22-Aug-18
PASS	DESCENDING	DESCENDING
TRACK	165	-
ORBIT	23337	7624
POLARIZATION	DV (dual VV+VH polarization)	-

Table 3.2: Specifications of Sentinel-1 and Sentinel-2 products used over Assam.

	SENTINEL-1A	SENTINEL-2B
PRODUCT NAME	S1A_IW_GRDH_1SDV_20190714T115653_20190714T115718_028113_032CCD_F972	S2B_MSIL2A_20190716T042709_N0213_R133_T46RDQ_20190716T083530
REPEAT CYCLE	12 days	10 days
INSTRUMENT	C-SAR	Multi-Spectral Instrument
PRODUCT TYPE	Ground Range Detected	S2MSI1C
ACQUISITION MODE	Interferometric Wide swath (IW)	INS-NOBS
SENSING DATE	14-Jul-19	16-Jul-19
PASS	ASCENDING	DESCENDING
TRACK	41	-
ORBIT	28113	12314
POLARIZATION	DV (dual VV+VH polarization)	-

Table 3.3: Data characteristics of Cartosat DEM and Sentinel–2 data used in the study.

	Acquisition technique	Spatial resolution		Projection
Cartosat DEM	Satellite stereo images	1 arc-second or 30 meters		WGS84
Sentinel-2	Multispectral Imager (MSI)	Band 2-Blue	10 m	WGS84
		Band3-Green	10 m	
		Band4-Red	10 m	
		Band5- Vegetation Red Edge	20 m	
		Band6- Vegetation Red Edge	20 m	
		Band7- Vegetation Red Edge	20 m	
		Band8-NIR	10 m	
		Band8A- Narrow NIR	20 m	
		Band11-SWIR	20 m	
		Band12-SWIR	20 m	

Landsat 8

Data products (ID: LC08_L1TP_148045_20180423_20180502_01 and LC08_L1TP_148045_20181101_20181115_01) were acquired from the United States Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center. Landsat 8 level 1T data products are orthorectified images of the thermal infrared radiance-at-the-sensor. The land surface temperature data in summer and winter were derived from the thermal infrared sensor (TIRS) Band 10 (10.30–11.30 µm) at a spatial resolution of 100 m, resampled to 30 m using a cubic convolution resampling method, which were respectively acquired at 11:02:51.19 AM local time for both summer (23 April) and winter (1 November) in 2018.