CHAPTER 3

OBJECTIVES AND METHODOLOGIES

3.1 OBJECTIVES

The main objectives of the research work are enlisted in the following.

(a) To develop microwave remote sensing based techniques of flood detection and monitoring using the following types of data.

(i) Passive Microwave Brightness Temperature data.

(ii) Active Microwave SAR Scattering Coefficient data.

(b) To develop microwave remote sensing based technique of flood prediction using the following types of data.

(i) Passive Microwave Brightness Temperature data.

(ii) Passive Microwave sensed Precipitation data.

(c) To develop microwave remote sensing based technique of soil moisture measurement using the following types of data and computation system.

(i) Passive Microwave Brightness Temperature data.

(ii) Artificial Neural Networks.

3.2 METHODOLOGIES

The following methodologies are followed for achieving the set targets as per the objectives mentioned in the previous section.

3.2.1 Methodologies of Flood Detection and Monitoring using Microwave Remote Sensing

The different methodologies followed for flood detection and monitoring using microwave remote sensing techniques are discussed sequentially in the following sub-sections.

3.2.1.1 Flood detection and monitoring using brightness temperature difference

The methodology followed for flood detection and monitoring using brightness temperature difference is shown as the following steps.

Step 1- Selection of the study area.

Step 2- Selection of suitable frequency and polarization for flood detection and monitoring.

Step 3- Determination of brightness temperature values at suitable frequencies and polarizations.

Step 4- Computation of brightness temperature difference.

Step 5- Comparison of the results of computation with standard data from authentic source.

Step 6- Error calculation.

Step 7- Determination of the *best frequency and polarization* of brightness temperature data, based on accuracy level calculations, for flood detection and monitoring by brightness temperature difference method.

3.2.1.2 Flood detection and monitoring using brightness temperature ratio

The steps to be followed for the work are-

Step 1- Selection of the study area.

Step 2- Computation of brightness temperature ratio at 37 GHz.

Step 3- Comparison of the results of computation with standard data from authentic source.

Step 4- Analysis of suitability of the brightness temperature ratio for flood detection and monitoring.

Step 5- Possible modification of the method for higher accuracy.

3.2.1.3 Flood detection and monitoring using passive microwave polarization index

The steps to be followed for the work are-

Step 1- Selection of the study area.

Step 2- Computation of polarization index values from brightness temperatures at different frequencies.

Step 3- Comparison of the results with standard data products from authentic sources.

Step 4- Determination of the suitable frequency for more accurate analysis.

Step 5- Drawing inference regarding the suitability of the method, based on accuracy analysis.

3.2.1.4 Flood detection and monitoring using active microwave scattering coefficient

The steps to be followed for the work are-

Step 1- Selection of the study area.

Step 2- Determination of synthetic aperture radar (SAR) scattering coefficient values for the points within the selected area.

Step 3- Comparison of the scattering coefficient values with standard data from authentic source.

Step 4- Selection of the best polarization configuration based on accuracy analysis.

Step 5- Drawing inferences regarding the suitability of the method for flood detection and monitoring.

3.2.2 Methodologies of Flood Prediction using Microwave Remote Sensing

The different methodologies followed for flood prediction using microwave remote sensing techniques are discussed sequentially in the following sub-sections.

3.2.2.1 Flood prediction using polarization index

The steps to be followed for the work are-

Step 1- Selection of the study area.

Step 2- Selection of the suitable frequency for computation of polarization index from brightness temperature.

Step 3- Computation of polarization index values at suitably selected frequency for the area of study.

Step 4- Comparison of the results of the computation with the record of actual occurrence of flood collected from authentic source.

Step 5- Inference regarding the validity of the method for flood prediction, based on accuracy analysis.

3.2.2.2 Flood prediction using precipitation data

The steps to be followed for the work are-

Step 1- Selection of the study area.

Step 2- Determination of precipitation values for the points within the study area.

Step 3- Computation of the sum of precipitation values.

Step 4- Comparison of the results with the record of actual occurrence of flood, as collected from authentic sources.

Step 5- Drawing inferences regarding the validity of the proposed method for flood prediction, based on accuracy analysis.

3.2.2.3 Cloudburst prediction using brightness temperature difference

The steps to be followed for the work are-

Step 1- Selection of the study area.

Step 2- Determination of brightness temperature values for the points within the study area at different frequencies and polarizations.

Step 3- Computation of brightness temperature difference values.

Step 4- Comparison of computed values with the ground truth data from authentic sources.

Step 5- Drawing inferences regarding the validity of the method for cloudburst prediction, based on accuracy analysis.

3.2.2 Methodology of Soil Moisture Measurement using Microwave Remote Sensing

Following are the steps followed in developing a technique of measurement of soil moisture using microwave remote sensing.

Step 1- Selection of Study Area.

Step 2- Collection of Brightness Temperature data in all frequencies possible from passive microwave satellite.

Step 3- Development of an Artificial Neural Network based soil moisture estimation system using different combinations of brightness temperature data as inputs.

Step 4- Measurement of soil moisture using standard methods.

Step 5- Correlation of the measured and ANN estimated soil moisture values.

Step 6- Selection of suitable ANN configuration and brightness temperature combination for soil moisture estimation with high accuracy.

3.3 VALIDATION METHODS FOR THE EXPERIMENTAL RESULTS

Following are the different types of validation done for the accuracy analysis of the experimental results.

(a) Validation of the experimental results by comparison with standard laboratory testing.
(b) Validation of the experimental results by comparison with standard data products from authentic sources.
(c) Validation of the experimental results by comparison with standard reports from authentic sources.

The sources of validation are explained in brief in the following sub-sections.

3.3.1 Bhuvan portal of ISRO

Bhuvan is a portal of National Remote Sensing Centre (NRSC) of Indian Space Research Organisation (ISRO) for dissemination of data [72]. Geo spatial services provided in Bhuvan portal are-

(a) Dissemination of tile-wise one time satellite data of IRS sensors.
(b) Satellite derived products pertaining to various themes and domains.

In the present work the date-wise flood maps provided by Bhuvan were used for-

(a) Pin-pointing the flooded points in the maps.
(b) Correlating with the experimental findings.
(c) Identifying the flooded dates with non-flooded ones.

The source for Bhuvan maps for use such as validation as explained here is- *https://bhuvan.nrsc.gov.in/bhuvan_links.php*

A sample flood map obtained from Bhuvan portal is shown in Figure 3.1. In the map the inundated areas are shown as light blue patches.

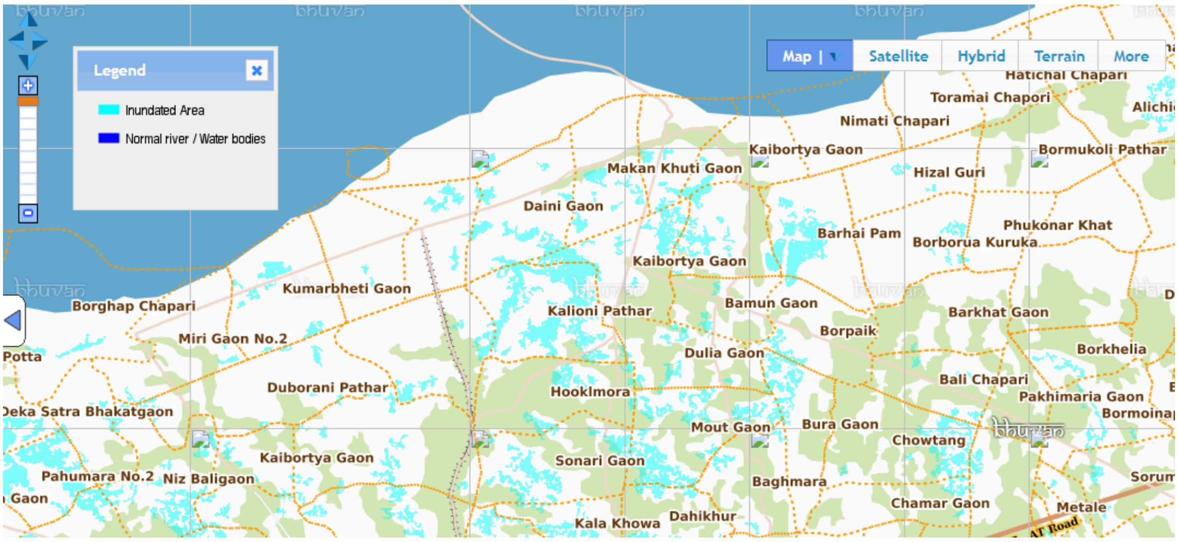

Figure 3.1: Bhuvan flood map of some places of Jorhat district of 8th June 2018

3.3.2 ASDMA flood reports

Assam State Disaster Management Authority (ASDMA) publishes daily flood report online, in its website *http://asdma.gov.in/reports.html*. The flood report consists of the following useful points, apart from many other details.

(a) Name of the districts affected.
(b) Names of the revenue circles affected.
(c) Number of villages under each revenue circle affected.
(d) Total crop area affected circle-wise.
(e) Names of the rivers flowing above danger level.
(f) Total population affected circle-wise.
(g) Population affected circle-wise.

The ASDMA flood reports are used in the present work for the following validation activities.

(a) Identification of flooded area on a particular date.

(b) Monitoring of increasing or decreasing trend of the flooded area.

(c) Correlating the experimental findings with the reported flooding extents.

(d) Validating experimentally found flooded area with the affected crop area reported by ASDMA.

3.3.3 Ground based testing

Following ground based testing methods are followed while validating the experimental findings.

(a) Soil Moisture measurement from different points covered by the pixels of the brightness temperature image of the passive microwave sensors. The soil moisture values are measured using the standard laboratory testing technique of Gravimetric soil moisture measurement

(b) Walk through survey to the flooded places with GPS location finder was done. The exact locations of flooding were recorded with their coordinates for a particular date and time.

3.4 REMOTE SENSING SOFTWARE USED

The software used for the image processing and analysis of the remote sensing images of both passive as well as active type is- Beam Visat. BEAM is an open-source toolbox and development platform for viewing, analysing and processing of remote sensing raster data. Originally developed to facilitate the utilisation of image data from Envisat's optical instruments, BEAM now supports a growing number of other raster data formats such as GeoTIFF and NetCDF as well as data formats of other Earth Observation (EO) sensors such as MODIS, AVHRR, AVNIR, PRISM and CHRIS/Proba. Various data and algorithms from many different sources are supported by dedicated extension plug-ins in the software.

3.5 CONCLUSION

The methodologies followed for detection, monitoring and prediction of flood, as well as measurement of soil moisture using microwave remote sensing are discussed in the chapter. However, individual methods and algorithms developed along with the details of data set used are discussed at length in chapters 4, 5 and 6 respectively. All the methodologies discussed are simple in nature, but are expected to be efficient in producing the results with high accuracy.