Chapter: VII

7. Summary and Conclusions

The research undertaken was aimed at designing and development of a Spatial Decision Support System for Drought Management. The two major objectives covered in the study are (1) The potential use of geospatial data for drought analysis and (2) the development of a spatial decision support System for drought management. This includes a broad holistic approach to understand the climatic variability over the study area and its impact on the cultivation. The geospatial approach to understand the dry, wet condition and taking into multiple parameters to formulate the decision support system. This understanding was further used to develop a program that can be implemented and shared on the web portal at the discretion of the administrators.

The sub-objectives combined, ultimately leading to the SDSS-DM, included:

5. To formulate and evaluate satellite-based indicators for drought characterization
6. To develop spatial models for drought Assessment.
7. To develop a geo-spatial technique to quantify seasonal drought assessment.
8. To develop a Spatial Decision Support System for Drought Management (SDSS-DM) to monitor crop growth, precipitation condition, and temperature conditions in the study area.

As envisaged at the outset of the work undertaken, all the objectives were attained. This study can act as a prototype, for the drought management from interactive and user-friendly developed SDSS on an open-source platform as a case study of Lakhpat and Nakhtrana Taluk of Kutchh district.

The Multispectral remotely sensed data was essentially used as the source of remote sensing images for the study area in conjunction with other ancillary data. Some of the ancillary data like weather data, soil type maps, Landuse / Landcover maps, Demographic data, and Geo-physical data were obtained from authentic sources. All the data was put into a database and emphasis was laid on the use of open-source tools. Open source tools have the advantage of being free of cost and licensing issues. Postgres was used as DBMS with PostGIS as a spatial

extension to handle vector and raster data. All queries were developed making use of the SQL. Java, JSP, and HTML were the coding languages employed for the development of the Graphical User Interface.

The present study has developed and demonstrated a pathway of drought assessment and analysis using various freely available datasets. The present study is to develop an SDSS for drought management which will help decision-makers, planners, researchers, and citizens to visualize and analyze various Agri-meteorological parameters over study areas like Crop growth monitoring, Rainfall variation, Temperature variation, Soil Moisture contents, Crop water conditions, and available resources or facilities in the study area.

7.1 The major findings of the study

As there are various layers of information to be processed and multiple outputs to be generated, many query statements have been generated for the same. To ease the user interaction and to help the non-technical user to efficiently ingest data and generate appropriate outputs, the entire tool was packaged into an Information and management System. The developed system has a Graphical User Interface (GUI). The present GUI provides facilities to the user to conveniently select and visualise data for the required week/month/season (as the case may be) and display the generated outputs.

The generated satellite-based indicators such as NDVI, NDWI, SPI, PCI, and ISDI were able to characterize agricultural drought at a space-time scale and proved their usefulness to study the duration, progress, and severity of agricultural drought throughout the season or year.

With the help of various Agri - meteorological indices year 2011 and 2015 experienced normal conditions whereas, the year 2012, 2013, 2014, and 2016 experienced normal to severe drought conditions. In addition to the utility of ISDI for seasonal agricultural drought characterization, it can be used to quantify in advance the impact of drought on reduction the agricultural yield. Some more years' data and some station validation need to be incorporated to arrive at a more accurate model.

The developed ISDI model-generated results illustrates the year 2015 and year 2016 experienced moderate to severe drought condition over the majority of the villages in the study area.

The approach, conceptualized and implemented in the present study, could be a step forward for the existing conventional approaches in providing a new pathway that is feasible and can be operationally implementable with current and future satellite data for growth stage-wise, and seasonal agricultural drought assessment in the study area or district level for disaster management planning.

7.2 Limitation of the Study

The study undertaken is in the Kharif cropping season for the study area, which goes in rhythm with the southwest monsoons. The clouds cast by the monsoons caused the unavailability of optical satellite images which limited the incorporation of the other indices for the analysis

Lack of real-time meteorological data and scarce monitoring station required for the analysis and validation, was a challenge for the calibration of the model for the study area thereby limiting the study to the comparison between the statistical estimates.

The study is feasible for monitoring at the regional scale only owing to the available data. whereas at the finer spatial resolution if available the SDSS would be available for village level or plot level analysis. Various paid Finer resolution satellite data like World view-II, Cartosat-2, Ikonos, and QuickBird etc can be used in future for the detailed analysis and enhance the capabilities of the system.

7.3 Future scope

The current study addresses the early drought analysis in the Lakhpat and Nakhatrana Taluk of Kachchh district India using satellite data followed by several other standard data products, model data, and in situ measurements with the help of RS and GIS technology.

- The SDSS-DM which has been developed currently focuses on Drought monitoring over the study area in Lakhpat and Nakhatrana Taluks of Kachchh district, India as a case study.
- However, the same can be expanded to incorporate details to local level and scalable to regional and country level. To enhance the capability and accuracy of the system additional input parameters need to be incorporated for drought analysis and management.

- The additional inputs like crop yield, crop types, cultivated areas under various crops, evapotranspiration, and field information from various sources can be integrated with SDSS-DM to enrich the decision-making capabilities.

- The user can ingest data through the GUI and process based on defined criteria, once the appropriate input layers are present in the database.

- The developed SDSS-DM elucidates the power and benefits of an open-source platform in the field of agricultural decision making support system. It provides functionalities to the user for drought analysis, resource visualization, and decision framing tool.

- Being an open-source system, further models could be developed and incorporated for other crops over different geographical areas. The present system adopted a semi-automatic approach, and in the future, a fully automatic approach can be implemented for data archival to dissemination along with model integration.

- This SDSS-DM has an advantage in that it's a relatively cheaper solution as compared to the proprietary commercial software. Also, it owes a wide scope for customizability and scaling of the system. Making it more feasible for the departments to adopt it.

- The integration of a field-based sensor network can be used to fine-tune the model and a real time agriculture growth and practice can be monitored for increasing yield and improving the practices scientifically. This evidence-based approach can also help to address sustainable resource utilization

From the present study it can be concluded that this is an attempt to develop a SDSS-DM for spatial planning in the field of drought management, still there are scopes for future up-gradation in the system capability by adding some indices and modules in account to drought assessment which can be calculated from other important agricultural and meteorological parameters. This study can be further be used for the agriculture and vegetation growth monitoring coupled with in-situ device making it techno-based spatial agriculture practise.