Research Paper

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Analysis of Multi-Temporal Lai Datasets: a Case Study of Rice Crops in Raichur District, Karnataka, India.

Geology

KEYWORDS : LAI, Remote Sensing, MODIS.

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ABSTRACT

Seasonal monitoring of agricultural crops is one of the trending research in recent years, which helps to identify some important issues related to crops. Satellite images gives a information with high temporal resolution which supports the monitoring of the dynamic objects like agricultural crops. An attempt has been done to analyze the variation of Leaf Area Index(LAI) with respect to space and time of rice crops in Raichur. The minimum rice LAI recorded in the month of June and the maximum is recorded in the month of October. The average mean LAI of rice throughout the year is 1.429 m2/m2 and the mean standard deviation is 0.626. The highest deviation 1.041 is identified in the beginning of November just right after the harvesting. The research demonstrates the use of multi-temporal satellite images and remote sensing to monitor the crops over large extent.

1. Introduction

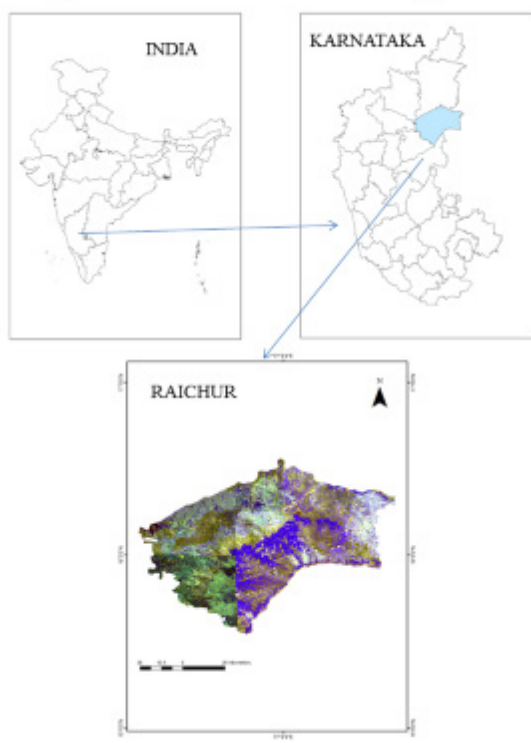
Seasonal monitoring of agricultural crops is one of the trending research in recent years, which helps to identify some important issues related to crops. Crop monitoring can be done by fieldwork or through remote sensing using different multi-temporal satellite images. Remote sensing applications in agriculture helping many farmers and decision makers in recent decades. Satellite images gives a information with high temporal resolution which supports the monitoring of the dynamic objects like agricultural crops. Green LAI is generally preferred since it is a measure of the area available for photosynthesis (Anthony et al. 2015). An attempt has been done to analyze the variation of Leaf Area Index(LAI) with respect to space and time of rice crops in Raichur.

One important way that biophysical variables such as LAI are measured at the landscape scale is through satellite remote sensing (Jensen and Binford 2004). Many satellite platforms gives LAI at global sale with very high temporal resolutions. Leaf Area Index measures one half of the total leaf area of the vegetation per unit area of soil (background) surface (Darvishzadeh et al. 2009). Knowledge of LAI is important for quantifying energy and mass exchange rates of water and carbon between the vegetative canopy and atmospheric interface, including fluxes of carbon, solar energy, and water (Michael Spanner et al. 1994). LAI is considered as very important parameter as it is used in different models to extract bio-physical parameters. As an important input or output parameter of several dynamic process models, such as crop-growth and land-surface models, LAI functions as a bridge that connects dynamic-process models to remote-sensing radiative models (Zhiqiang Xiao et al. 2009). The LAI, given a value between 0 and 10, is one of a number of standard products for the terrestrial surface that are available from the MODIS sensor on board the Terra (EOS AM) satellite, launched in 1999, and the Aqua (EOS PM) satellite, launched in 2002 (Torbern Tagesson et al. 2009). Understanding the LAI dynamics of one specific region is one of the steps in applying models for estimating evapotranspiration and productivity (Xavier and Vettorazzi 2004). This study demonstrates the change of LAI values based on the season in Raichur district and in particular the rice crop LAI has been analyzed.

2. Study area

Raichur district exists between 15° 09' and 16° 34' N latitude and 75° 46' and 77° 35' E longitude in between two major rivers, the Krishna and the Tungabhadra (Figure 1). Agriculture is the primary source for living, and rice is the major crop grown. The district consists rice growing area of around 165000 hectare; the production is nearly 468464 tons, and the yield is about 2990 kg per hectare every year (Rajanna 2008). The district covers an area of 8433 km^2 in which agriculture covers 6874 km^2 (81.51%). The climate of the district is characterized by dryness for the major part of the year and a very hot summer.

Figure 1. Location of the study area.



3. Materials and methods

3.1. MODIS MOD15A2 LAI

Global MOD15A2 gives LAI images of 8 days temporal resolution and 1-kilometer spatial resolution in the sinusoidal projection. Total 46 images of every 8 days in 2012 was used in this study. These data use to study surface biophysical properties, and many studies proved that, it is very well correlates with vegetation indices like Normalized Differential Vegetation Index(NDVI), Enhanced Vegetation Index(EVI) etc. LAI is a dimensionless and it is defined as the green leaf area per unit ground surface area (LAI = leaf area / ground area). The unit of measuring LAI is m^2 / m^2 and the value of LAI ranges between 0 to 10. The images consist of 256 grey shades which converted to 0 to 10 range by using formula, LAI = LAI_{PIX}/25.5. where LAI_{PIX} is the grayscale LAI value at particular pixel. The conversion of values is just to maintain the standard range and the analysis can be done by grey scale values also.

3.2. Methods

3.2.1 Processing

MODIS15A2 product consist of 5 datasets namely Fpar (Fractional Photosynthetically Active Radiation), Lai, FparLai, FparExtra, FparStdDev (Standard Deviation) and LaiStdDev. Layer stack operation in ERDAS imagine software was performed to separate the LAI datasets. The LAI product was re-projected to WGS(World Geodetic System) 1984 from sinusoidal projection. This product image covers almost entire south India. Raichur area was cropped and separated as new image for further analysis and this was done by sub setting the LAI product. Figure 2 shows the 46 Raichur LAI products with reference to date. As mentioned, the focus was to analyze the rice crop LAI variation so for that, only the rice crop areas were clipped and separated. Figure 3 shows the rice LAI images of 2014. Further statistical analysis and plotting was done in Microsoft Excel.

Figure 2. Raichur total LAI images of 2012.

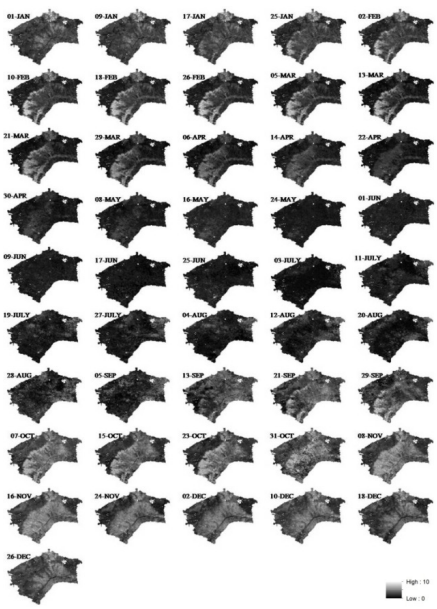
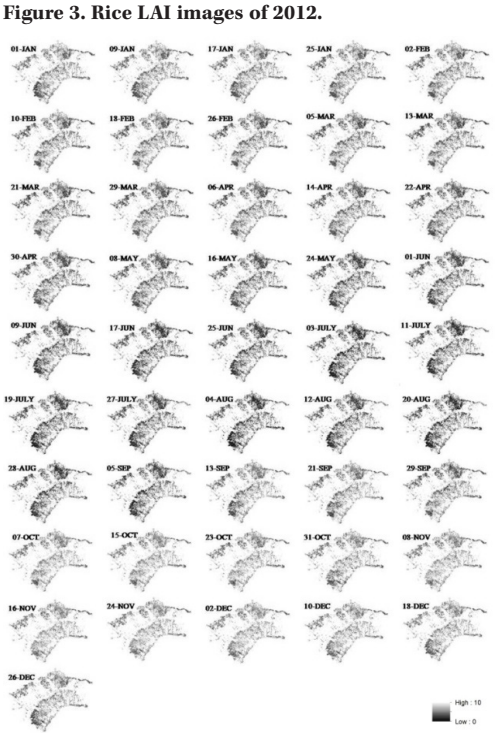


Figure 3. Rice LAI images of 2012.



4. Results and Discussion

In the study area, the kharif season which depends on rainfall starts in middle of the June. The rice plants growing was identified in the starting of the August and it shows a rise in LAI values. At the end of the October, there was a high LAI before the harvesting. The rabi season which is more depend on canal irrigation starts in middle of January and ends at the middle of April. Compare to kharif, rabi shows less LAI because of less rainfall. The minimum rice LAI recorded in the month of June and the maximum is recorded in the month of October. The average mean LAI of rice throughout the year is 1.429 m2/m2 and the mean standard deviation is 0.626. The highest deviation 1.041 is identified in the beginning of November just right after the harvesting. The Raichur is also known for its very hot summer so the LAI is less in summer with normal deviation. The figure 4 shows the Line chart indicating the variation of LAI of total Raichur area. The figure 5 shows the Line chart showing the variation of rice with the time. The research demonstrates the use of multi-temporal satellite images and remote sensing to monitor the crops covering a large area. These bio-physical parameters extracted are very useful in decision making and management.

Figure 4. Variation of Total LAI of Raichur with time.

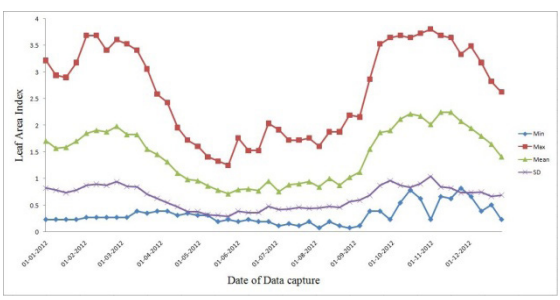
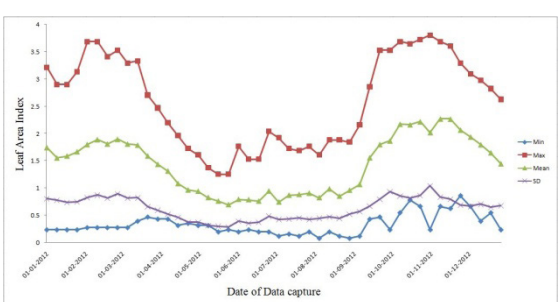


Figure 5. Variation of Rice crop LAI with time.



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