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A Survey on NDVI Estimation Techniques Using MODIS Data

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Abstract: Kerala Flood 2018 causes massive destruction of the vegetation area. For the estimation of this Greenfield changes we can effectively use the NDVI technique. MODIS data is used for calculating NDVI. Processing the high resolution Satellite Images is a challenging task. Several authors proposed different methods to solve this problem. This paper summarizes these different works and the methods used in them.
Keywords: Remote sensing, Satellite image processing, NDVI, MODIS data, Greenfield estimation

I. INTRODUCTION

Remote sensing using satellite images has gained popular attention due to its versatility and accuracy. This is very useful for processing large geographical area of interest. Greenfield estimation is one of the most popular applications of remote sensing. NDVI is the most common technique used for this purpose. NDVI which stands for Normalized Difference Vegetation Index is an indicator of vegetation greenness. It is computed from the difference between the reflectance of the near-infrared and the red bands. MODIS data which is an open source provided by NASA are used for calculating NDVI. Many authors tried to analyse MODIS data with the help of NDVI in order to indentify green area, effect of landslides on vegetation, crop identification, yield estimation etc. Also some author tried to implement new algorithms to reduce noises in the MODIS data. This survey is just an evaluation of some of these techniques.

II. RELATED WORKS

Authors, Jing Huang et al. [1] proposed a Normalized Difference Vegetation Index (NDVI) based estimation for harvest yield calculation. Here they used correlation analysis technique of crop yield and MODIS-NDVI data in order to find the best timing for booting, flowering, and ripening of the crops. Their study concentrates on Chinese three small counties of Province of Yunnan, and they selected corn, winter wheat and paddy rice as the three main crops. This system works comparatively well in small regions. It identifies the crop types efficiently in small regions. This is a 10-year comparison of crop fields. But extra inputs are needed to find out crops other than the mentioned ones.

This paper [2] particularly studies the after effects of the 2008 Wenchuan earthquake. The earthquake causes major landslides that led to serious vegetation destruction. NDVI drops in an interval of time can be used to find out landslides. MODIS possess such good quality resolution that is very useful for landslide identification. At first, threshold is determined. For that, MODIS NDVI data is analysed for a short duration of 8 days in a small area. Then it is extended to a larger area. After comparison with the SPOT5 images, 75 % accuracy is found. This method is very useful for land slide that occur rapidly.

In this paper [3], the authors mainly focus on land cover change. They used an Extended Kalman Filter to determine per-pixel change of NDVI time-series satellite data. The centre pixel of 3*3 matrix of MODIS pixels were compared spatially with its neighbouring pixel's amplitude and mean parameter to find change factor. The threshold is determined form this change index which classifieds the pixel as change or no change. 89% accuracy is claimed for the change detection. It is only evaluated for the case of settlement development detection.

The authors, Bin Tan et al. [4] developed an algorithm which is enhanced technique on TIMESAT algorithm for extracting phenology of vegetation metrics. They incorporated the ancillary information, land surface temperature and snow-cover flag in order to improve the TIMESAT algorithm. This enhanced TIMESAT algorithm has better overall retrieval ratio than the original TIMESAT software. For the validation the study depends on the ground data according to the experience of the data collectors. There occurs the subjective influence of the data collector, which is the main obstacle in this area according to this study.

For reconstructing the high resolution NDVI time series data the authors Liying Geng et al. [5] developed a compound technique with eight techniques to avoid the noise. First they detect noisy data using the de-noising algorithms, then to replace the noisy data with the medians of the de-noised values of each technique. The asymmetric Gaussian algorithm, the filter for changing weight, the double logistic algorithm, the data reconstruction interpolation technique, the iteration filter of mean value, modified slope extraction algorithm for best index, the Savitzky-Golay algorithm, and the Whittaker smoother technique are the eight techniques used to form the compound de-noising algorithm. Thus this compound algorithm helps effectively to avoid the drawback of individual techniques.

Differentiating cultivated land from the native grassland is an effective mapping job developed by the authors William S. Mcinnes et al. [6] They used the Normalized Difference Vegetation Index technique with MODIS data to separate the two classes of vegetation. The idea behind this technique is that the spring green up rates observed at pixel level may be different for different types of plants. The study concentrates on the dry mixed grass region of Alberta, Canada. They claimed 73% overall accuracy for this technique. In order to improve the result quality, the paper suggests the use of mechanistic temperature and climatic variables along with the MODIS data.

The authors Joseph Knight and Margaret Voth [7] present an efficient technique for mapping impervious land cover. They used the multi-temporal NDVI MODIS data of multiple years for this study. The sequential maximum angle convex cone and linear spectral un-mixing (LSU) are the methods used for analysing the data. These methods treat each pixel as a linear combination of its constituent land use and land cover classes. This system guarantees 77% accuracy particularly for the LSU algorithm and capable of mapping impervious land covers over large areas. The availability of high resolution data, and total time required for processing huge amount of data are the factors which limits the full results of this study.

Vandana Tomar et al. [8] analysed the MOD13A1-NDVI data of the state of Haryana, India in order to estimate the crop yield. They tried to assess the influence of different fertilizers for the crop year of 2005-06 in the Rice Equivalent Yield. Average pixel reflectance of a 3*3 spatial window at the regional level of the NDVI layer assessed to understand the linear regressive relationship. They used a spatial interpolation method which is inverse distance weighted to analyse the influence of different fertilizers like Nitrogen, Phosphorus, and Potassium. Finally, they suggest in order to have the maximum efficiency level of the use of fertilizers in a particular area, there must be the evaluation of the correlation between the vegetation index, final crop yield and major nutrients.

The relationship between crop progress stages of corn and fractal dimension which is derived from satellite data has been analyzed in the paper by Yonglin Shen et al. [9] The theory of fractals is used to measure the roughness that may be high for the NDVI images of the corn fields during the flowering and harvesting stages. They developed the dimensionality reduction based algorithm to calculate the fractal dimension for the irregular region of interest. The state of Iowa was the region analyzed in their report. They claim that their advanced criteria for the detection of progress stages of corn from multi-temporal remote sensing images have 84% accuracy.

The authors Zhenyu Jin and Bing Xu [10] developed an automated compound smoother, which can reduce the noise of the NDVI time series data. They named it RMMEH method, and is fast and nonlinear technique. Primarily the system processed the row NDVI data by finding the arithmetic average of each pixel comparing to its two neighbours. In the next step, which is called maximum operation, the upper envelope strategy is used to take the maximal value. Then the system leads to an endpoint processing and weighted moving average of the data. This new advancement has the following advantages that the system needs no ancillary data, system works automatically without the intervention of an expert, and it is highly sensitive to noises.

TABLE I
Various Metors used to improve the modis-ndvi data set

Sl. No.	Approach used	Pros	Cons
1	Extended Kalman Filter method [3]	-Updates mean and amplitude parameters of time series data. -Accurate indication while a pixel started to deviate from neighbouring.	-Performance gain over the NDVI is insignificant
2	Enhanced TIMESAT Algorithm [4]	-Provides the smoothing of Savitzky-Golay, double logistic and Gaussian filtering. -Accuracy of estimating phenology dates improved. -Threshold tuning is easy.	-There is no exact agreement between enhanced vegetation index and normalized difference vegetation index.
3	Effective Compound Algorithm [5]	-De-noises the data effectively with fidelity. -Maintains the quality of original data.	-Since eight individual techniques are used, complexity in implementation.
4	RMHEH [10]	-Reduces the noise of NDVI efficiently. -runs automatically without the intervention of an expert	-based on the pre-supposition that all contaminations depress the NDVI values -not suitable for modelling anthropogenic activities

III.CONCLUSIONS

In order to estimate the greenfield destruction due to the Kerala flood 2018, NDVI technique is a useful measure. High resolution satellite images from the MODIS data set, an open source provided by NASA, are made used for this calculation. In order to understand the different approaches towards this task, the evaluation study of different works on the NDVI helps to gain knowledge on the processing of raster data. Noise content must be corrected before the calculation of NDVI, for this we can effectively use RMHEH algorithm, which have advantages over all other techniques evaluated during this study. All the ten papers suggest NDVI as the best technique to calculating the vegetation loss for the large area.

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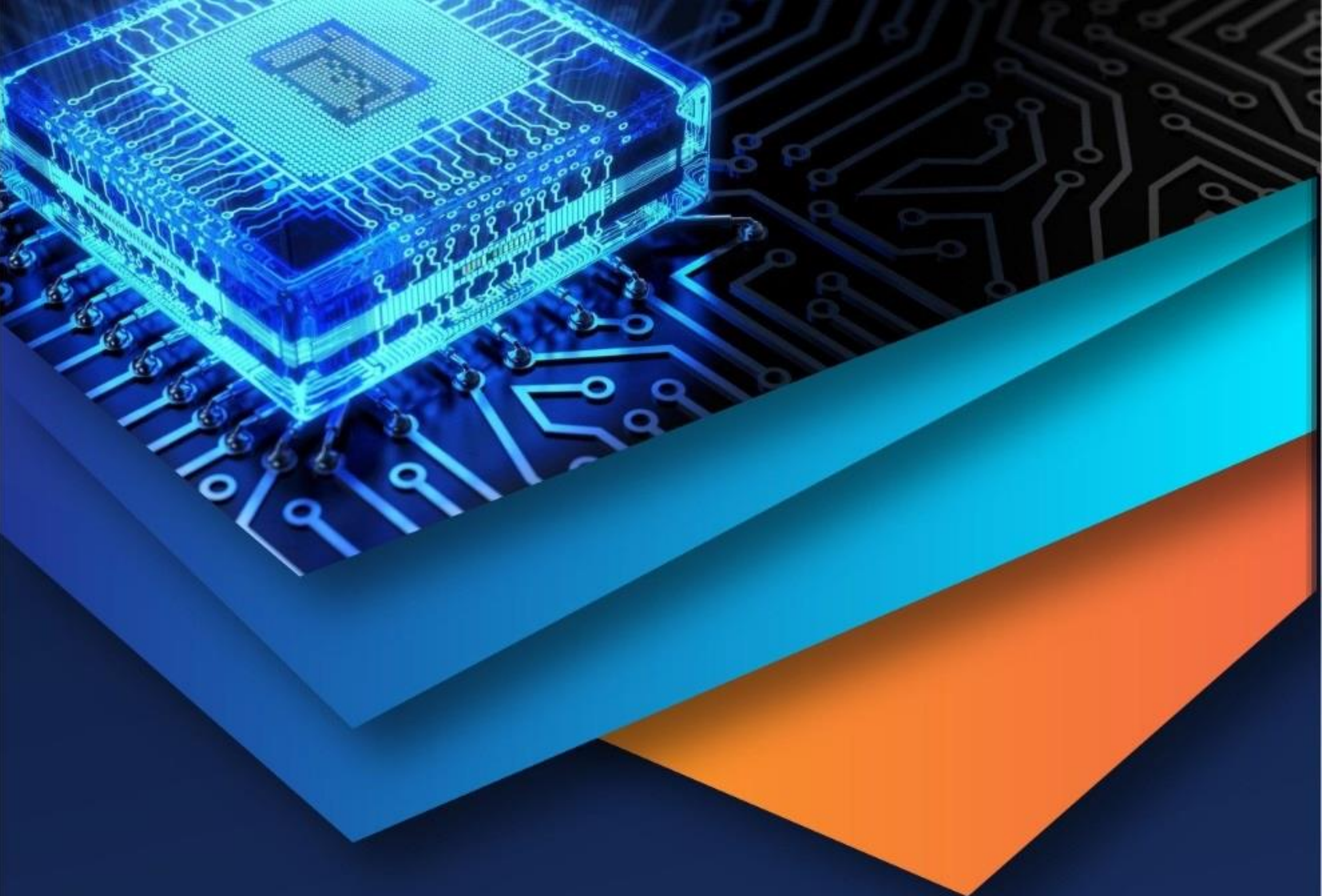

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