USE OF REMOTE SENSING SATELLITE IMAGES IN RICE AREA MONITORING SYSTEM OF BANGLADESH

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ABSTRACT

In this work, we developed a satellite-based Boro rice monitoring system which will be capable of collecting data on rice production area of whole Bangladesh along with a graphical statistics of rice production area every season. In this monitoring system, Bangladesh has been divided into 7 regions and the production area of Boro rice for these 7 regions has been calculated using only the MODIS (Moderate Resolution Imaging Spectroradiometer) satellite data. Our system does not require any ground truth data. The principal approach requires remotely detected information from MODIS at 250m250m spatial resolutions gained more than two distinct time periods: sowing season which is from December 1 to January 10 and growing season which is from January 11 to April 10 throughout the year (Boro Seasons). Total of eight years 2008-2015 MODIS data have been accumulated and an improvised Normalized Difference Vegetation Index (NDVI) threshold of the Boro rice model has been used for rice area extraction. This monitoring system has some features like region-wise and area-wise information, search options, improvement/deterioration analysis, and rice area extraction map view. The rice monitoring system can be used by the Department of Agriculture of Bangladesh or Food ministry for the collection of accurate and up-to-date information on the country's rice production. It will also be able to provide information on Boro rice production readily accessible to decision-makers and government agencies to help respond better during and after natural disasters or in any need. Moreover, we believe that our developments of forecasting the Boro rice yield would be useful for the decision-makers in addressing food security in Bangladesh.

Index Terms— Remote Sensing, Map, Boro Rice, NDVI, Monitoring Systems

1. INTRODUCTION

Rice generation in Bangladesh is an essential piece of the national economy [1]. The prevailing nourishment harvest of Bangladesh is rice, representing around 75 percent of horticultural land use (and 28 percent of GDP) [1]. So it is very much important to build a system which monitors the rice because of improper management it could create a problem like food storage. Accurate and timely information is a vital necessity for taking any decision. So the accurate information of spatial distribution of rice fields is needed for annual production projections and management. However, most agricultural surveys rely mainly on statistics based on limited ground samplings at which data are extrapolated on a national scale. Although the census can provide statistical estimates, slow and unsystematic collection of data can limit the ability to make timely decisions. Moreover, rice agriculture is strongly linked to environmental issues, from water management to climate change. For these reasons, long term inter-annual monitoring is also required in order to study the production and cultural impacts of these factors. Satellite remote sensing can support this long term monitoring requirement at regional and global scales. Currently, there is no remote sensing satellite based rice monitoring system in Bangladesh. Still Bangladesh agriculture's data collection process is manual [2]. They accumulate rice production information from farmers and this information is arranged and checked each season. Every data is compared each year to see the adjustments in its production. This sort of checking is dull and exceptionally inclined to information mistakes. A rice monitoring system is very much necessary for determining the total rice production of our country. Main purpose of our Boro rice monitoring system (BRMS) is the projection of rice production of Bangladesh seasonally region wise using MODIS satellite images. BRMS shows the production area in a very user-friendly way and graphically. BRMS will be helpful for Bangladesh government to see the whole dataset in a single monitoring system. They will be able to see the production changes from year to year through this system. The system have some user-friendly features which will help the user to monitor the Boro rice production of Bangladesh.

2. DATASET CREATION:

Our main purpose is to build a Boro rice monitoring system for the whole Bangladesh using MODIS satellite images. To accomplish this, the first goal is to get the Boro rice production results for the whole Bangladesh then use the production results to build the monitoring system. From the Earth Explorer website, the MODIS vegetation index product of Aqua and Terra that are MOD13Q1 and MYD13Q1, are downloaded. A total of eight years of data assembled and processed considering two periods: the sowing period which is from December 1 to January 10 and the growing period which is from January 11 to April 10 throughout the year (Boro Seasons). Then all years data are downloaded from the website in HDF format. To convert this HDF file to a tiff file so that data can run in ArcMap, the MODIS Reprojection Tool (MRT) is used. Then the sowing and growing tiff files are integrated. Boro pixel has to be counted after the integration of the sowing and growing images. A pixel is considered as Boro if that pixel is found in both sowing and growing images. Then the Boro rice area calculation process starts. The area of the Boro rice can be calculated after counting all the Boro pixels of a region. The procedure is a simple math. If one pixel represents 250*250 square meters, the area of a single-pixel is $((250 \times 250)/1000)$ or 6.25 hectors. Therefore, the total rice production area of a region will be equal to the multiplication of the total number of pixels of that region with 6.25 hectors. Using this process the Boro rice area is calculated and made a dataset for entire Bangladesh. Boro rice production results of 2008-2015 have been accumulated to a dataset. This process uses an improvised threshold range for sowing $0.19 <=$ NDVI $<=0.51$ and growing $0.48 <=$ NDVI $<= 0.65$ respectively which was decided from our other work [5] and the algorithm flowchart is given below in figure 1:

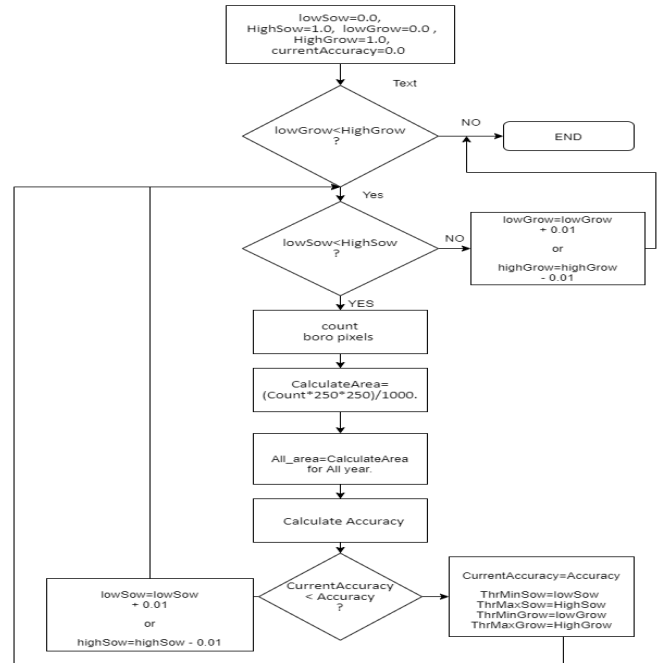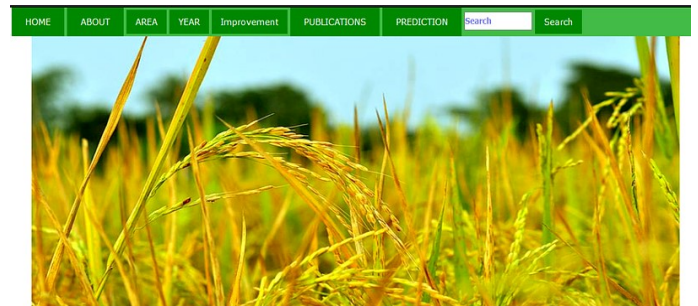## 3. BORO RICE MONITORING SYSTEM(BRMS)

Bangladesh is not a very large country. But it is always better to work with small regions to get the better precisions. And working with a large region and acquiring a specic result from there is tough let alone for a country. So, the system has divided the map of Bangladesh into 7 regions . Those are Dhaka, Khulna, Rajshahi, Chittagong, Sylhet, Barisal, Rangpur. There are some advantages of small regions like comparing production results among regions. When a user demands a production result of a specic region or a specic year then the system fetches the data from the database and reveals the result on a web page. Figure 2 shows the home page of BRMS.

The monitoring system has many features like area-wise, year-wise information. Users can also search for a particular area or region. All production informations are shown using 2 graphical techniques like bar chart, pie chart. Below given some features of this system:

Fig. 1. FlowChart of Algorithm [5]

Fig. 2. Home Page of BRMS

- Area wise Information

- Year-wise information

- Improvement/ Deterioration analysis

- Search option

- map view of extracted rice area

Area Wise Information This feature displays the production area of Boro rice in a particular region. For the bar chart on the X-axis, all years for which the production results have been calculated and on the Y-axis, the total production result of Boro rice area has been represented. The bar chart represents the Boro rice production result region-wise. The pie chart also shows the same thing. It has also got another nice feature. Below the bar chart, there is an option for a maximum and minimum part. In the maximum part, it shows the

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year for which the production result was the highest for that particular region. In the minimum part, it shows the year for which the production result was the lowest for that particular region.Figure 3 shows the Area-wise information of rice monitoring system.
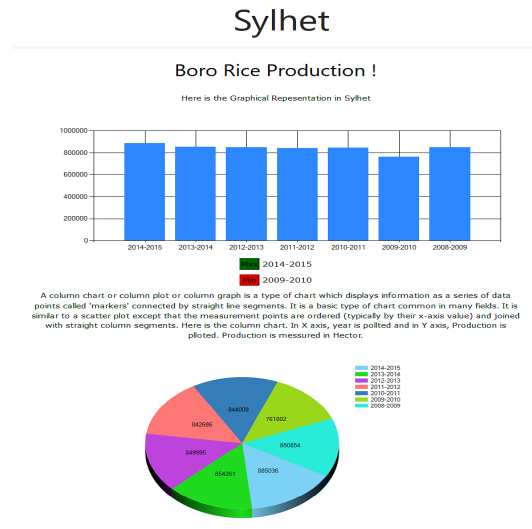

Fig. 3. Area-wise information of rice monitoring system

Year Wise Information This feature displays the production area of Boro rice in Bangladesh for a particular year. For the bar chart on the X-axis, all the 7 regions have been represented and on the Y-axis, the total production result of the Boro rice area has been represented. The bar chart represents the Boro rice production result year-wise. The pie chart also shows the same thing. It has also got another nice feature. Below the bar chart, there is an option for a maximum and minimum part. In the maximum part, it shows the region name for which the production result was the highest for that particular year. In the minimum part, it shows the region name for which the production result was the lowest for that particular year. Though it's easily understandable which regions are doing great and which are not through graphical representation. Those areas are not having a decent production should emphasize and take proper steps to increase production.Figure 4 shows the Year-wise information of the rice monitoring system.

Improvement/Deterioration analysis : This feature displays the improvement or deterioration of rice production over the years. This is a very important feature to know that if the production has improved or not than in the previous year. This information will be shown on the bar chart. For the bar chart on the X-axis, all the 7 regions have been represented and on the Y-axis, the total production result of Boro rice area has been represented. It is a comparison between two years which has been shown in a graph like for Bangladesh the production result of 2012 and 2013 will be shown side to side each other so one can easily notice whether there has been
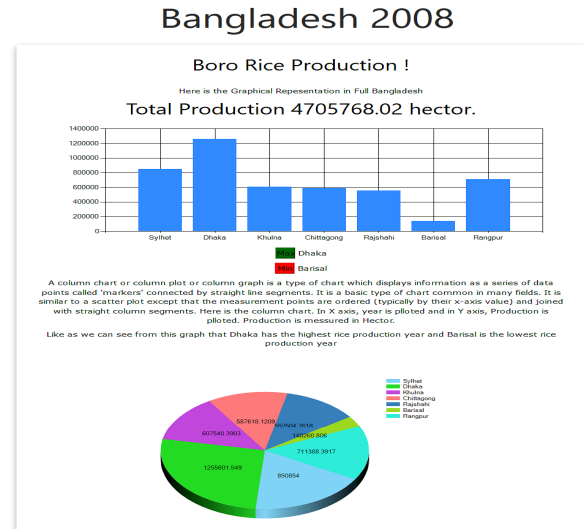

Fig. 4. Year-wise information of rice monitoring system

improvement or deterioration than the previous year. This graph, will not only show the comparison for any specific region,but It will also show the comparison between all the 7 regions for all pairs of years. Here it has also got one nice feature which is below the graph where there will be a place for improvement and deterioration. In the improvement part, it will show all those region names for which the improvement has been taken place in comparison with the previous year. In the deterioration part, it will also show all those region names for which the deterioration has been taken place in comparison with the previous year. We think it is a very excellent feature to understand better about the production of our country. It is a very user-friendly feature that will help its user to understand better whether there has been improvement or deterioration.Figure 5 shows Improvement/Deterioration of rice monitoring system.
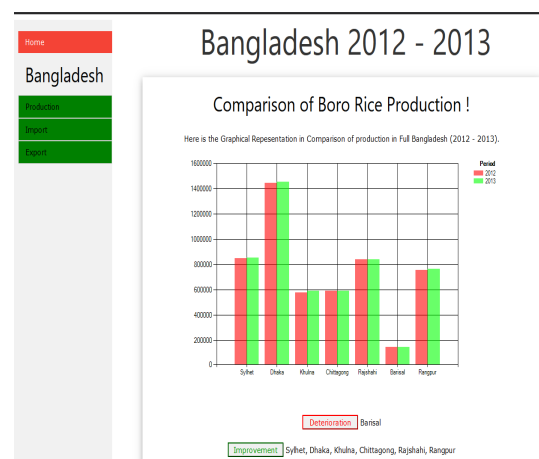

Fig. 5. Improvement/Deterioration of rice monitoring system

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Search option: As a web-based monitoring system, it is a must to have a search option. Here in this monitoring system, there is also an option for search where users can search for a particular year or a particular region. When a user searches for a particular year like 2008 or any year, it will show the Boro rice production result of all the regions graphically for that particular year which has been searched by the user. But when a user will search for regions like Dhaka, Khulna, Rajshahi, Chittagong, Sylhet, Barishal or Rangpur then it will show the Boro rice production result of all the years for that particular region graphically. On the contrary, it can be said that if a user searches by year then it will show the user the year-wise information and if a user searches by region then it will show the user the area-wise information. This search option has been added to the navbar of this system.Figure 6 shows the Search Option of BRMS.
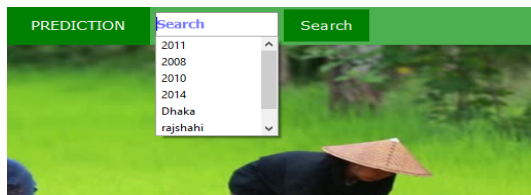

Fig. 6. Search Option of BRMS

Map View of extracted rice area

This is one of the most user-friendly features of our monitoring system. This feature divides the map of Bangladesh into 7 regions. If a user brings the mouse near the Sylhet region then the Sylhet region would be highlighted with the total production and it would also happen for the other regions. Along with being highlighted that particular region will show the name of that region and it will also show the total rice area of that region. If someone clicks on that region then it will show all the production area results of that region and it will show the graphical representation of the production area results of that region for all the years. Figure 7 shows an example of the Map view of our rice monitoring system.
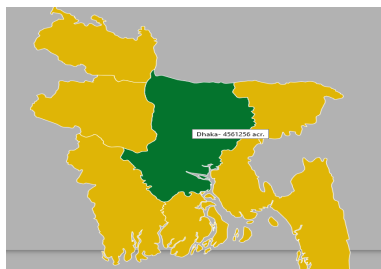

Fig. 7. Map view of the rice monitoring system

4. CONCLUSION

The purpose of this research was to build a user-friendly long term inter-annual rice production monitoring system for Bangladesh so that it would be helpful for Bangladesh government to monitor the staple food of Bangladesh. For getting the dataset, this system has used MODIS satellite images and NDVI threshold values of the Boro rice model for rice area extraction. Average accuracy of our area extraction was approximately 80%. For getting an automated monitoring system we used a single range of threshold for whole Bangladesh which compromised the best accuracy for each region. Our study reflected that if we use different NDVI threshold for different region, better accuracy might be possible. This system has shown information of the Boro rice production area through region-wise, area-wise, improvement/deterioration analysis, search option, map view of extracted rice area. With these features, it would be very much helpful for its users to keep monitoring the system more systematically and usefully. In the end, we think our research would help keeping track of the total Boro rice production area of Bangladesh which would help rice research in various ways.

5. REFERENCES

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