Geographic Analysis of Agriculture in various Climatic conditions using Big Data Analytics

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Abstract

Big data Analytics is dealing with large and multi-dimensional information. Geographic information have been received from various source like, satellites, remote sensors, with various attributes like, date, time, soil type, location, climatic condition, water status, and etc. Using Clustering and machine learning techniques, the accuracy of the changes will be more positive. Agriculture industries would mainly want to decide the forecast as there were stories related to the loss due to the wrong predictions towards the farming of products. For an Agricultural industry, Geographical information and climatic conditions are very vital for deciding their daily activities.

Keywords: *GIS, Precision Agriculture, Soil, Topography, Hydrology, Vegetation, Climate Model Inter-comparison Project, atmosphere, Hydrosphere, Cryosphere, Biosphere, lithosphere, Agro-climate.*

1. Introduction

Geographic Information System (GIS) has been designed to be available for the geographers who were researching on the Weather forecast, globalization, global warming, greenhouse effects etc,. These details collected by GIS have the structured and unstructured formats. These details may have to be processed and analyzed to be converted to the data. Information which is extracted from GIS has to be analyzed by various techniques using Big Data Analytics.

Big Data is capable enough to deal with bigger Volume, Velocity and Variety of data analysis. As the trend of data volumes are getting “exaflooded”, there are more extensions happening around the world in order to accommodate the archived data which are mainly used for Analytics purpose. The researchers are soon introducing the next standard prefixes such as Peta (10^{18}), Zetta (10^{21}) and Yotta (10^{24}). As the expectation of people for longing the information in large volume, high velocity and huge variety, the analysis should be more accurate, reliable and faster.

Geographical attributes are climate data, soil data, crops information, educational information, medical information, traffic information and etc. These Geographical details are collected from various sources like satellite, remote sensing, various apps in mobile devices, and Global Positioning System (GPS). This variety of data in large volume and in high frequency can only be dealt by the Big Data. Big data Analytics have lot of techniques to find the accurate information.

2. Clustering and Classification

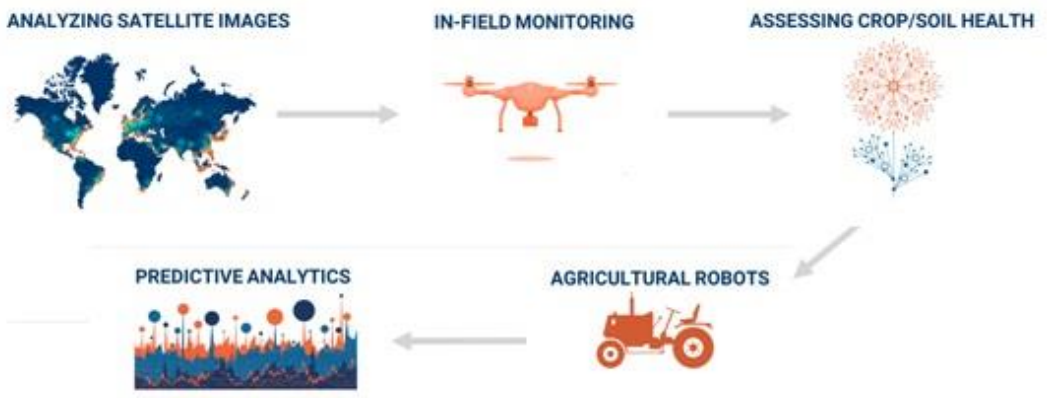
Clustering is a way of classifying the similar structure into a group. The attributes dealt with the Agricultural operations are mainly taken from the data points from GIS, using Remote sensing and Global Positioning System which are just data points without labels. Clustering Algorithms can be used to produce spatially-varied data for subsequent precision agricultural operations.

Precision agriculture (PA) is a management which observes responds and measures the farming with inter and intra-field variety in crops. The idea is to research the returns on inputs from the farming. This goal has to be in an optimized output while preserving resources. The variety of data needed from the farming can be found using remote sensing and Global positioning system (GPS). These data points can variably results in the combination of various similar characteristics. These characteristics can be analyzed in various methods in Big Data.

Agricultural remote sensing data have all the characteristics of Data Mining. The acquisition, processing, storage, analysis and visualization of agricultural remote sensing data are critical to the success of precision agriculture. The Big Data Analytical processes in these characteristics can precise the farm area nature in a particular time with a particular climate.

3. Prediction

Farming management has been an ancient technique of predicting the climate based on the patterns of weather conditions in the farming area. The prediction of any natural calamities is one of the most necessary information which can boost the farmers. From ancient civilizations like Sumer and Indus Valley, the farming is the main source of income which includes the domestication of pigs and other animals. Prediction of weather and land were based on the regular rainfalls and the water levels in any land (Based on near water resources).



The water sources around any farming area can be found using satellites in this modern era. Patterns and predictions of water sources that had been found from satellites were considered to classify the crop and soil near any farming areas. This service from various departments should include the nature of soil and sand from which the farmers can find the products from where they can plant and how. In this way, the large scale farming industries would be more benefitted which will ultimately help in the farming products in the market abundantly.

3.1 Climate Prediction Models

Climate prediction is something that has been taken for a longer time with various parameters in various timing. Weather prediction uses alteration of trace atmospheric gases (carbon dioxide and methane, for example), sea ice and glacier cover, changes in incoming solar radiation, and a host of other parameters [1]. Global Coupled climate Model has been designed to model the changes in climate over the past century into 21st century. The United Nation Intergovernmental Panel on Climate Change (IPCC) uses the climate models by the Climate Model Inter-comparison Project (CMIP). CMIP5 is this project's fifth iteration [1].

Data on seeds, pesticides, machinery and fertilizers are made available and is not properly utilized by the end users such as agricultural officers and farmers. Most of the websites are merely provides the static data and lack in the dynamic interface among stakeholders [2]. The authors specify how various factors that directly and indirectly affect the farming can be studied and analyzed in precision farming.

3.2 The role of prediction in Agriculture

Agriculture is a system that uses nature environment and human socioeconomic activities. Agriculture is mainly affected by climate in many ways. In any climatic conditions, the living beings would need agriculture for their functions in nature. Climate and soil condition provide necessary energy for Agriculture [3].

In different regions, Climate conditions differs in various region based on the season in the specific locations. Agricultural Climate condition is related to the natural elements such as soil, topography, hydrology, vegetation for managing agriculture.

Agricultural production is influenced by the temperature, precipitation, Meteorological disasters and so on.

3.2.1 Soil Prediction

In Agriculture, main key factor is soil. One can predict the soil type using various techniques in Big Data Analytics and data mining based on the area of land and location. There are many classifier algorithms in both of these techniques. These classifier algorithms are applied to extract the knowledge from soil data. Efficient methods should be created that utilize Data Mining to enhance the exactness of classification of huge soil data sets [4].

3.2.2 Topography Prediction

Topography is to find the features in earth's surface. This defines the usage of land for agriculture. The land area can be defined as steep slope land, flat plain area, and with frequent heights in the area. Topography can influence agriculture with the soil and climate as well based on the surface of land. To find a suitable land surface for any products, Big data Analytics using various techniques can be used [5].

3.2.3 Hydrology Prediction

Hydrology is the main part in Agriculture to find the kind of soil and topology for the surface of land. Hydrology is to find the properties of the earth's water, and especially its movement in

relation to land (Based on Soil and Topology). Using various techniques in Big Data Analytics, Hydrology usage can be predicted.

3.2.4 Vegetation Prediction

Vegetation is to know the Plants considered collectively, especially those found in a particular area or habitat. Vegetation Prediction is based on history of approaches in various lands and locations based on the soil, topography and hydrology data.

Forecast prediction would always need the history of above forecast. If the warehouse of these data is huge, the predicted forecast results would always closely match with the reality. To get this close match, Big Data would be a correct solution.

4. Patterns

Another important factor in agriculture other than prediction is to patterning the climate into various categories. There are many patterns to predict the agriculture based on climate, land, location and geographic status. Here in our topic, the climate is much concerned.

4.1 Climate

A climate pattern represents the various climates in various seasons in different atmosphere in different locations. Climate change creates a new weather pattern that prolongs for some significant number of days in a year. There are 5 interacting factors that decide this change of patterns. They are, Atmosphere (Air), Hydrosphere (Water), Cryosphere (Ice), Biosphere (Living Things), Lithosphere (Earth's crust and Upper Mantle)

4.1.1 Atmosphere (Air)

Atmosphere is a layer of gases that surrounds a planet or a material that is kept in place by the gravity of that planet or a material. Atmospheric pressure at a particular location can decide the weather of that location. Earth's atmosphere differs in the properties, such as composition, pressure and temperature. These layers are starting from 7 to 1000 kilometers from the surface. Unfortunately the earth's surface is not flat in nature, the pressure in different surface decides the climate of the location with other factors such as Ice, Living things, Ground water level and the sea water level [6].

4.1.2 Hydrosphere (Water)

Hydrosphere deals with the water levels in land and in the sea environment. Earth's hydrosphere longs for more than 4 billion years. But it continues to get changed due to the seafloor spreading and continental drift, which rearranges the land of the ocean. There are 1,386 million cubic kilometers of water on earth. Hydrosphere is another part of the factor to decide the climate change [7].

4.1.3 Cryosphere (Ice)

Cryosphere is a study about the ice beds in the earth. Ice mainly covers the 75% of our earth. The cryosphere is the frozen water part of the Earth system. Ice and snow on land are one part of the cryosphere. The continental ice sheets have been found in Greenland and Antarctica, as well as ice caps, glaciers, and areas of snow and permafrost. Ice rocks in the Arctic and Antarctic Sea are mainly affected due to global-warming [8].

4.1.4 Biosphere (Living Things)

Biosphere is the regions of the surface and atmosphere of the earth. It can also be defined as any other planet occupied by living organisms. The biosphere is the parts of Earth where life exists. The biosphere includes the root systems of trees, rain forests, mountaintops and ocean trenches. Biosphere is capable of balancing the nature of Living Things [9].

4.1.5 Lithosphere (Earth's crust and Upper Mantle)

Lithosphere is the outermost layers of Earth's structure. It is bounded by the atmosphere above and the asthenosphere (another part of the upper mantle). There are two types of lithosphere, oceanic lithosphere and continental lithosphere. Oceanic lithosphere is associated with Oceanic land, and is slightly denser than continental lithosphere. Tectonic activity describes the interaction of the huge slabs of lithosphere called tectonic plates. Tectonic activity is responsible for earthquakes, volcanoes in the lithosphere.

4.2 The role of Climate in Agriculture

Short-term and mid-term forecasts are often directly applied in management strategies, such as

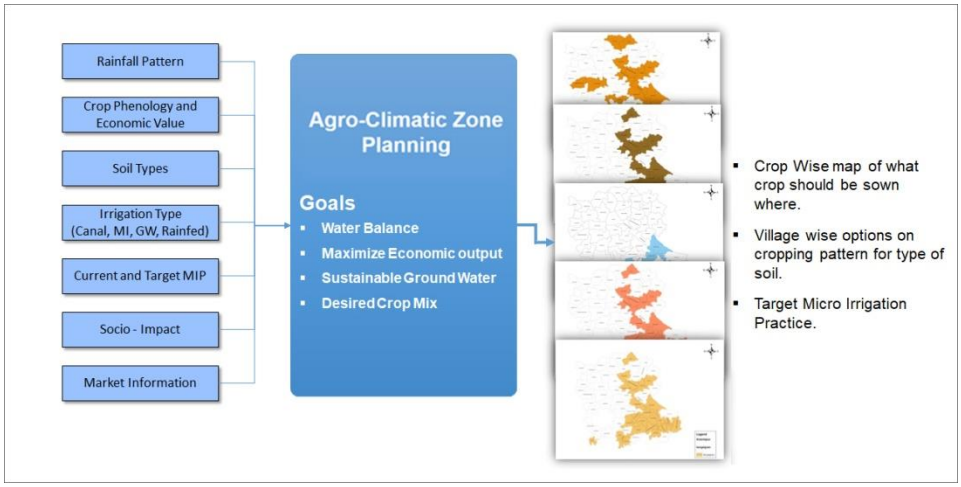
1. Forecast for Sowing date
    a. Forecast of Weather condition for sowing date
    b. Weather condition forecast for sowing date or harvest date
2. Forecast for Agro sowing date or harvest date
    a. Agro-meteorological meteorological condition forecasts in winter for over condition forecasts in winter for over-winter crops
3. Forecast for Winter crops
    a. Weather forecasts for agricultural operation activities (irrigation, fertilizer application, herbicide application, insecticide application) as well as weather forecasts insecticide application, Weather forecasts for processing and transporting of agricultural for processing and transporting of agricultural products and so on)

These climate roles can only be tracked with historical data which can be availed using Big Data Analytics.

5. Agro-climatic Prediction and Pattern

Understanding the climate is essential and important to develop efficient farming systems and for efficient crop improvement research program. Classifying the climate into relevant agro-climatically homogeneous zones will help the transfer of location-specific dry-land technology to

other regions, mainly by identifying limitations for different zones. Understanding and classifying the climate of the area can derive suitable growing conditions for energy plantations.



6. Conclusion

There are various ways and algorithms that can be involved in researching the crop lands and to arrive at the classification and clustering of climatic data inputs for agricultural factor. The patterns and other predictions should be a part in processing the inputs to get the effective agriculture results based on the past historical data. By various techniques in Big Data Analytics with all our historical data, Farming can be enhanced into the next level of this industry.

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