GROUND WATER PREDICTION AND RESOURCE MANAGEMENT USING PARTICIPATORYAPPROACH FOR OSMANABAD DISTRICT

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***Abstract*— Drought has been consistently affecting many parts of India.Maharashtra is one of the states amongst it. Specifically, the Marathwada region has been witnessing severe droughts from the last ten years and is getting worse year after year. To tackle this situation, we need efficient water resource allocation, planning and management. Overcoming the water-related issues would be easy if we have a good understanding of the existing groundwater availability. We present a participatory approach to report water availability and depth levels of wells and borewells. Having a record of this data will not only allow us to monitor but also have a better understanding, planning and control over groundwater extraction and its use. We propose an open source- based spatial data infrastructure, which will then be used to calculate the demand and supply of the water. We will also be doing a simulationof various effects of the policies on water availability. Time series analysis will help us to do the future prediction of water availability.**

Keywords- : Machine learning, algorithm, database, Linear Regression, Spatial Data, Open Source, Android App, Web design.

I. INTRODUCTION

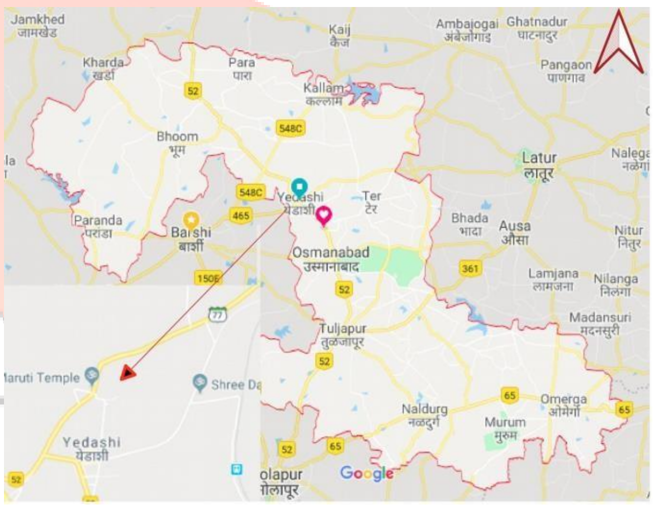
Osmanabad district has reported 70% rainfall this year between June2019 - October 2019 with the deficiency of around 30%. Potable water scarcity is always the problem in our city and even in rural areas of Osmanabad. Instead of focusing on the water supply, we also need to focus on better water resource management. Using advanced technologies like remote sensing and geographic information systems, can not only help in understanding the availability of water in the various existing resources, but also help in efficient planning and control of these resources. Due to ample reach of network connectivity and widespread use of mobile phonesin rural areas, it is possible to contribute to a spatial infrastructure which can have records of existing groundwater resources and its utilization. To better understand and manage the groundwater, first we need to have an understanding of existing water sources and thenits usage. In this project, we have mapped all the borewell and wellsfrom a pilot study area Yedshi. We use this information to understand the water related problems faced by the people can also to find better solutions. We use a participatory approach where local volunteers and borewell owners contribute to the information about water availability. This borewell water availability information is then disseminated to people so that they can understand the problems and see the big picture. This approach can encourage the community to be part of the solution.

II. STUDY AREA

Study area selected for the project is Yedshi, which comes under the taluka and district Osmanabad, Marathwada region. It is located 18 KM towards North from the district head quarters Osmanabad. 22 KM from Osmanabad. 394 KM from state capital Mumbai

Figure 2 : Study Area

Map Source : Google



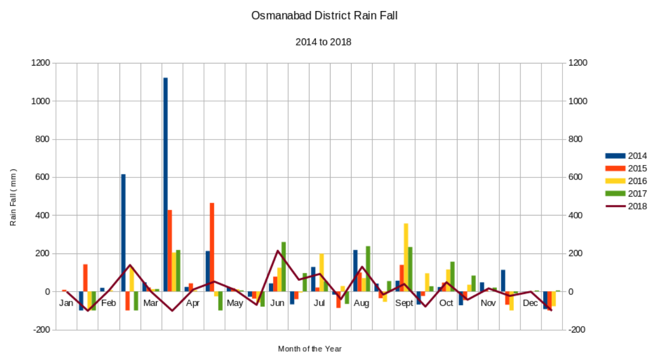
Due to deficit rainfall and unregulated groundwater extractions, water levels have depleted to a very low levels. We have surveyed the Yedshi village on the basis of the following parameters

1. ID of the borewell
2. Latitude of the borewell area
3. Longitude of the borewell area
4. Depth of borewell
5. Construction year of the borewell
6. Elevation of the borewell area
7. Rain year

8. Rain in millitres

9. Usage in litres per borewell

Figure 1 : Osmanabad Rain Fall



III. Water Governance Framework

The Organisation for Economic Co-operation and Development (OECD) is an international organisation thatworks to provide solutions in various domains like environment, social and economic. OECD provides an indicator framework of water governance which has someimportant indicators which should be present in the water governance.

IV.PROJECT IMPLEMENTATION

The process began with creating a prototype of the Android App using proto.io. After the prototype was created the next step was to make different forms and designed the front end of the app. Construction of various forms for wells and borewells was done next. A SQL Lite database was generated for the data sent by the forms.

The machine learning process started by first creating a sample dataset of about 1000 entries with different column names like ID, Lat, Long, Constructionyear,

Depth, Elevation, Rainmm and Rainyear. After this unsupervised machine learning was performed wherein Hierarchal and K-means clustering were done. 8 models in total were tested out of which Linear regression, Gradient boosting and Time series analysis were finalized. All of these models and predictions were carried out on the sample dataset created.

We started off with developing our simple to use front end and backend using Django Framework. A dashboard was then added for data visualization. Integration with our Android App was done using REST APIs made based on List based Serializers from Django REST framework

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V.Methodology

The data collection and processing involves the followingsteps:

1. Mapping of buildings and locality details of thevillage
2. Categorization of these buildings into types likeresidential, civic, commercial etc.
3. Collection of the borewell , wells, and other water source for drinking purpose using the ODKCollect mobile app
4. Machine learning and creating sample dataset to test out algorithms .
5. Integrating mobile app and website and then finally integrating algorithms to the mobile app and website respectively.
6. Providing recommendations and suggestions tovillages as per data analysis

VI. SYSTEM ARCHITECTURE

Open-source software has evolved enough to build the entire GIS based infrastructure. As we can see in the block diagram, we are using the Geo-Django framework, which is an extension of Django with Spatial support. Using Django allows us to develop faster, scalable and cloud-based applications. As Django uses python, we can take advantage of all python- based libraries for visualization and spatial data processing. The database used here is PostGIS which supports the spatial queries. We are using the GeoServer, which is Java-based map server which gives us the OGC based standard services like WFS, WMS and WCS

Finally, for hosting the application we use Nginx, which is a modern and fast webserver along with the Gunicorn application server. We use an open layer for map, which is good enough to provide various mapping functions. Using these services, we can also use the Spatial Data on the QGIS for additional data processing and analysis. Using the REST API which Django framework provides, we can build mobile app.

Initially every module that was to be implemented was tested. Each module was carefully tested for different sets of inputs to get an idea about the efficiency. After this, errors were detected in some of the test cases which were then rectified.
The dataset entries were increased to increase the accuracy and reduce the loss.
Various algorithms such as linear regression and logistic regression were tested and finally linear regression ,gradient boosting and time series analysis was chosen. We still encountered a lot of errors due to unavailable dependencies.
While working on the android application, we encountered various while creating the forms.
Also while we worked on the database for collecting data from the app, a lot of data went missing.
The dashboard of the website was supposed to generate reports but due to certain commit errors, the reports generated were inaccurate. We created a few static graphs for our website using Node.Js and Chart.Js.

Linear Regression explains the relationship between one dependent variable and more than one independent variable. Here we use the caret library to import the Regression Model and use it directly. Dataset file is in the xlsx format, so we import the file using the import dataset field given in R studio.Then the data is split into Dependent and Independent variables. X is considered as Independent and Y is considered as Dependent.

The dataset is designed such that we record user entries individually based on parameters like ID, lat, long, depth, elevation, constructionyear, rainmm , rainyear and usagelit . This makes our data consist of nine features.

Once the dataset is ready, the next important task was to split the dataset into training set and test set. This is in order to train the model with one portion of the data called the "training set" and test the prediction results on another set of data called the "test set".

Using the "train_test_split" function we split our data. Here, "test_size =0.7" indicates that 70% of the data is the test set. The min-max accuracy of the model was checked using the mean of the actual predicted values and applied predicted values. The accuracy of the model was about 96% .

Gradient boosting is a machine learning technique that produces a prediction model in the form of ensemble of weak prediction models , typically decision trees. Here we imported libraries gbm and xgboost which have inbuilt functions to carry out gradient boosting. Just like it was done for Linear regression, even here we split the dataset into test and train set with a split ratio of 0.7.

The time series analysis of the dataset was used to plot graphs and make interpretations on the data provided. For this we just used certain inbuilt functions of provided by R studio.

The Android App we have created is a simple User friendly design with various forms to collect data from our volunteers and users in Yedshi village regarding various features of the well and borewell such as the water level,quality of water,forms to register new borewell etc.Besides the data on well and borewell we have also collected data about the amount of rainfall in the area,recharge structures to help understand the total water usage and requirement for various well and borewell.

We are also creating a map along with various filters to show the functional and non functional wells and borewells.Our Android Application will be a smart and easy way for the people of Yedshi village to enter in data and predict the time period of availability of water based on the amount of rainfall in the region and the usage of water.

The Android App is connected to the Django Backend where all the data coming from the website and the application will be stored.

The website is developed using Django Framework which lets us seamlessly integrate the front end and back end using the Model-View-Template. We have created the front end of the website to make it as simple as possible so that even people who are not tech savvy can easily navigate and access the required information thus increasing their participation and reducing queries.

Through the website we plan on gaining user input through a participatory approach wherein each person takes responsibility of their own well or borewell data. The volunteers on ground can collect general data and feed it into our back end through simple forms made available. This data would then be displayed for all to see using data visualization techniques.

The website will be integrated with our Android App so that we maintain consistency when it comes to data. REST Framework will be used to bridge the gap between our website and Android application. The prediction model will also be integrated into our website to make it more dynamic and give people a sense of how much water must be used to make the most of the rainfall recieved.

VII. RESULTS

Figure 1: Yedshi village borewell map

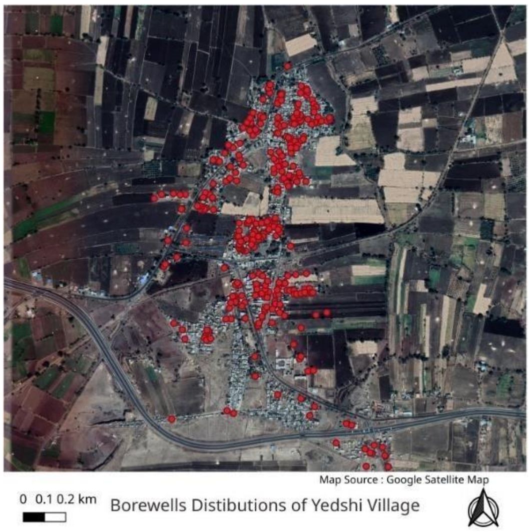

Figure 2: Home page of Android App.

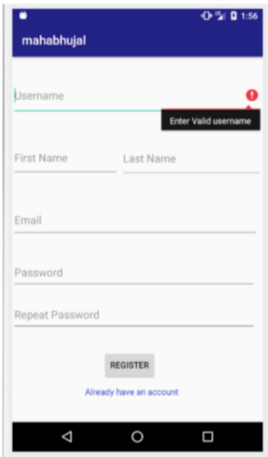

Figure 3: Registration form

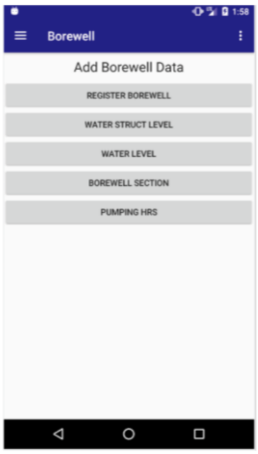

Figure 4: Borewell data forn

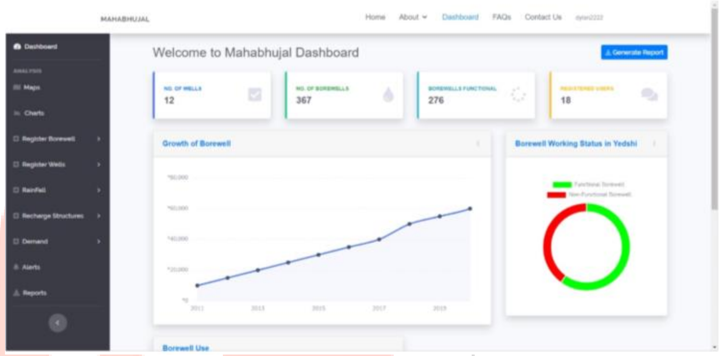

Figure 5: Website dashboard

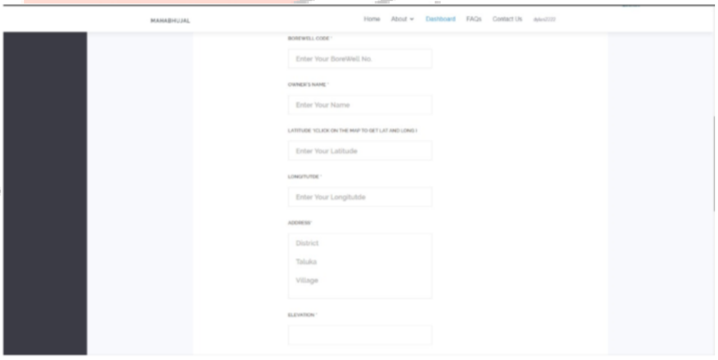

Figure 6: Registration form of website

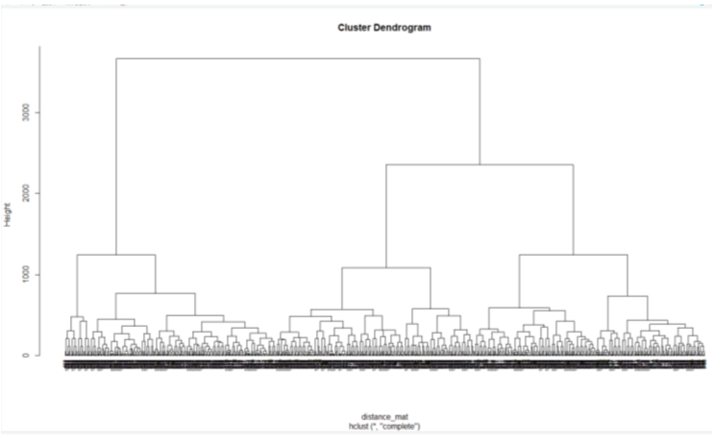

Figure 7: Dendogram of dataset

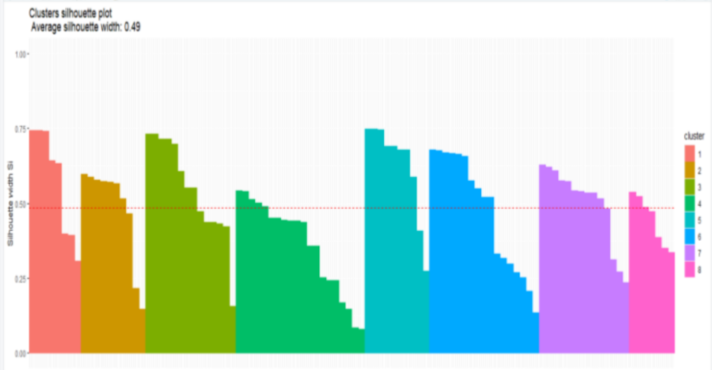

Figure 8: Cluster Silhouettes Graph

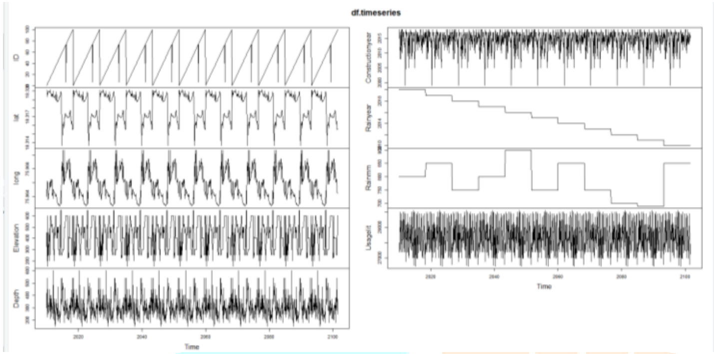

Figure 9: Times series analysis graph

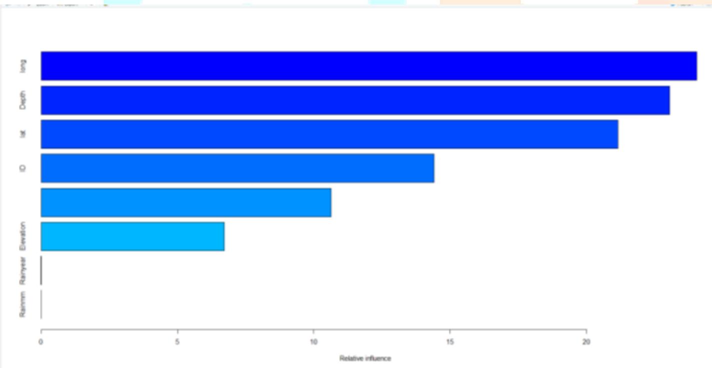

Figure 10: Relative influence graph of the nine parameters of our dataset.

Yedshi village is located on an elevated geographical area. The town faces massive rainwater runoff. More than 90% borewells get dry in March itself. Every house which has a borewell should install a rainwater harvesting structure to increase the overall groundwater level in the village.In future, we can also think to have a centralized water distribution system so that people should stop digging more borewells. Since the maximum number of borewells are used for residentialpurposes, it reduces the chances of exploitation of the water resource. The few commercially usedborewells are used as potable water sources in the various water purification plants.

VIII.Conclusion

Water resource control and planning and management is the need of the hour. With the help of the community and using the participatory approach, we can better understand groundwater exploitation. With the proposed system, we willhave a complete picture of the groundwater usage and exploitation. Based on the work done in this proposed system, we can conclude that with open source technologies and community contribution, a local water resource can be monitored and managed to maintain the groundwater levels from reaching dangerous lower levels. . The predictions done using machine learning algorithms further helps in understanding the water requirements of the village and what measures need to be taken to fulfill them. Our android application and website have been integrated to function independently and also depend on each other for data generation.

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