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Dyanamics of Experimental Observation and Estimation of Soil Errosion using Agricultural Data Sciences

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Abstract
Data Mining is conventionally and conveniently greater domain for various aspects in commemorate with knowledge extraction. In the dynamic sense participative of Data Mining is not only extraction it also helps for creating knowledge as prediction which helps to create inner intelligence for decision making. Overall this area of computer science is in demand because of its application in various adoptive levels of humans. We move further to think how generously this can be used to find soil erosion to protect and preserve. As on date many people are working in and around of crop yield or soil properties, finding patterns of soil deceases, method of cultivation, Land classification and survey these are only few. One of the major contributions is working with machine learning algorithms for finding the contributory factor of soil erosion and rate of soil erosion can be classified and treated with soil erosion management techniques. Soil is most demanding and needy substance of human life on the earth. We use technology but forget the farmers to empower them with modern tools for agriculture. As various applications of research scholars has coined the word use of Data Mining aspects in Agriculture known as Agricultural Data Mining or comprehension of broader umbrella we termed as data science. The paper deals with soil erosion and protecting soil surface by considering selected areas of Bangalore rural and deficiency prediction based on natural movement of soil erosion using efficient data mining algorithms.
"Soil formation and soil erosion are two natural and opposing processes
And protecting them is fundamental duty of every human on this earth" –Henry D Forth

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1. Introduction

Data mining word emerged as buzzword for the millennium and this can be taken into account as technique used from extracting meaningful, useful and needed information from many large sets of data for finding non trivial solution which can be either explorative nature or predictive nature. Data mining is always considered as one of the practical learning stage and implementation step in finding the patterns from large amount data known as KDD. Here when

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we refer the large sets of data means it can relate to any subject or fields of interest where research is to be carried out. In other aspect of thought process collective can be preprocessed to transform into useful data for appropriately so that in can be input or rendered into different file formats. In general preprocess may include cleaning data, finding appropriate attribute or selecting appropriate attribute as data label, summarization of data elements, transformation of flat files into data sets, etc. Overall Data is transformed into the computer readable format for dynamic analysis purpose. Considerate amount of Data warehouse is also treated as best data blocks for larger data storage units. Historical storage of soil erosion from last 1 year can be considered for analysis. Similarly day to day data can be considered as operational data and can also used for analysis. In our case metallurgical department collects various soil erosion of season and records as data sets; this can also be used for any future prediction of soil erosion.

Figure 1: Schematic representation Data Mining methods (courtesy: Journal Proceedings on Data Science by Data Flair)

Data Mining uses various techniques such as clustering, tree based classification, machine oriented learning, support vector machines (SVMS), Add hoc Regression, Customer centric Association rules etc. In extending of working data modules these data sets uses various adoptive algorithms to implement in tandem. Above illustrative diagram gives idea of data mining methods or Data Mining techniques.

As indicatively Data Mining in Agriculture is an emerging domain of computer science and it is attracting many research scholars, Data Scientists, and Data mining experts to study more relevant issues of agriculture and combine their work into applications. The relevant applications can be further formulated to enhance the potential growth of their crop or create awareness for making more productive decision for managing their crops efficiency by increasing crop yield by avoiding soil erosion. In my opinion Data mining in agriculture can support farmer's information about various risk involved and how to create proactive methods for avoiding various hazards. There are array of techniques that many papers deals with it. However in this paper we are dealing with just classified data of soil erosion and finding the deficit for predicting the sample data of soil erosion with test run using weka(Waikato tool for Exploring Knowledge and Analysis) tool of classification algorithms by adopting soil erosion data sets.

2. Data mining classification and need of an hour

Classification is always we consider it as one of the progressive challenge and superior techniques adopted in data mining. While other can also be part of techniques such as clustering. In synonymous sometimes we interchange the classification with prediction. In real scenarios both are different classification refers to predictive of categorical values in predictive build models. In predictive model it is continuous. Such as fundamental of data mining text books always gives an idea of prediction like whether to play or not to play at outside if it is raining. In this classical example we assume play is the class attribute. Based on our constructive parameters like play if yes or play with no the decision tree will be generated for indicative model on prior information as label of data sets like prediction to play or not.

K-Nearest Neighbors: This algorithm entirely divides the collected data set into two or more possible portions which are known as training set[primary machine data] and test set[secondary machine data]. These sets in turns usually divided in the ration of 70:30[not as standard], 70% being assumed to be training set and 30% being assumed to be the test set. Then the algorithm uses the primary set to adopt to train the model for accurate and definite prediction. To check and validate the accuracy of the build model it is later applied to the test set and a confusion matrix is build to show case how many records belongs to a particular attribute/ or labeled field have been correctly predicted taken into study.

Classification algorithms include: k-Nearest Neighbors, Naïve Bayes, ID.3, CART (Classification and R Tree mechanism),ID (Chi-Square Automatic Interaction Detector) and MARS which extends the learning decision trees in order to handle numerical data more précised values. K-nearest is however the most widely used classification algorithm which has its application in concept building Search and Improved Systems.

Random Forest is a decision tree algorithm in classification of Data Mining which classifies the instances or records in the form of a tree. A large number or volume data sets of classification trees are made or considered to be building in random forest

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approach. By default the number of trees or node made by this algorithm is 100 to 500 but these sample node can be increased or reduced or set as threshold as per requirements of the model. Every node under the tree takes each of the instance or observation as machine input and then gives the output as leaf node by going through the several rules made by the tree based on pre training. The most common and discussed outcome for each observation is treated as the final output. A new observation is fed into all the trees as nodes and taking a majority vote or binning for each classification model. An OOB error known as Out-of-Bag error is estimated for the cases or samples which were not used as prior in building the decision tree. OOB is estimated as percentage.

3. Primary Facts of Soil And Water Erosion

Soil is one of the key elements and it is natural phenomenon as we refer it as biogeochemical. It is always intersecting between two point of reference biologic and geologic with chemical process. Soil formation leading to the greater contribution of crop cultivation in other way it turns to be every human necessity for food, clean water and fresh air and these are big carrier for dealing with biodiversity.

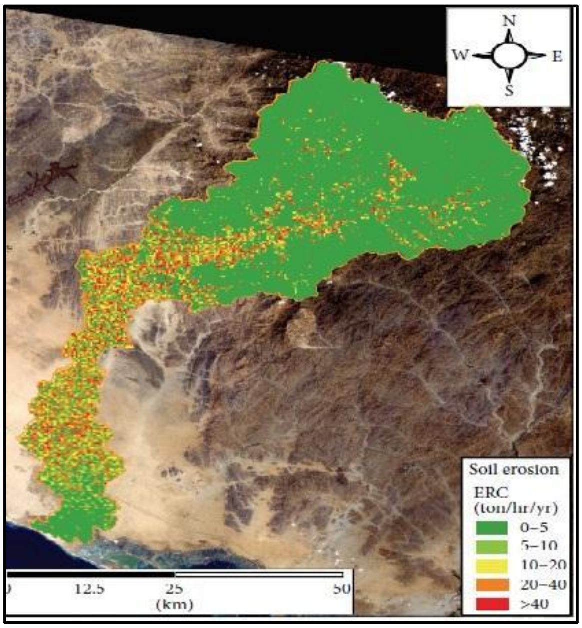

Figure 2. Schematic representation of various forms of soil erosion (source: Soil Erosion Estimation using Remote Sensing Techniques by Hindawi Publishing)

Major Concern in Soil Erosion is Water Erosion

In referring water platelets and other components, several types of water erosion we can notice such as rain drop(terming as splash or splash in nutshell), sheet of erosion, rill and finally gully or small channel of moment. A further study indicates as stream banks by pulling plates into large masses into the stream of soil sources and be carried away. Dynamic wet soil on minor steep sleeps which likely to move slower towards downhill (termed as solifluction) or less sloppy. In general raindrops falls on gutted bare soil it loses particles and push the splash or scattered them into the air. When small amount of rain above the soil surface of particle it tends to run over and under soil surface of gutted spot forming this sheet which causes sheet lateral erosion. When we talk about rill or gully erosion are purely causes due to concentrated water moves down slope. The general tendency of water which collects into rills and later water particles coalesces to form larger channels and resulting to gully erosion.

Predictive patterns of water erosion rates on Form Land

When we focus more on calculating soil erosion rate on farm land it always affects by characteristics of rain, soil erodibility, slope geometrical characteristics and cover of vegetative in practice. In 1917 first experimental observation were established on controlled studies on field plots and tiny watersheds. In this case erosion dynamic plots were 72.6 ft long and 9 to 10 % slopes were subjected or tested to estimate and identify the data quantification. Predicting erosion rates of recorded using by the method of Universal Soil Loss Equation (USLE), this was first developed by prof.Wischmeier and prof.Smith. The designed equation is

A=RKLSCP

A is Computed Soil Loss or gutted/Unit area and tons per noted acre area
R is the noted factor of rain fall
K indicates soil erodibility factor in random
L is indication of slope length in approximate portion
C is the cropping factor
P is erosion control factor. This equation generally derived to predict the water erosion parameters on farm land surfaces of the soil due formation of large gullies.

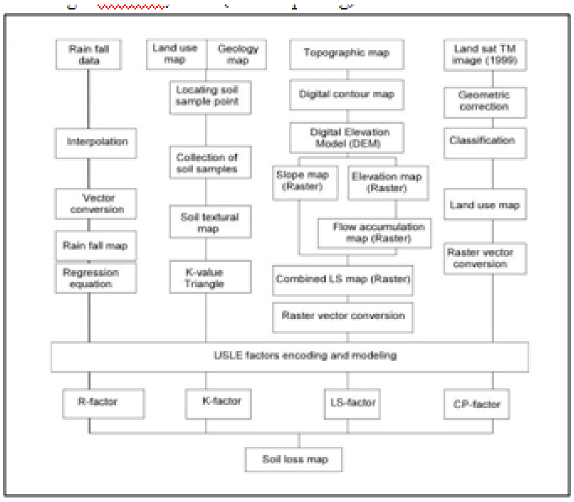

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Figure 2.1: Flow chart of GIS USLE methodology for estimating soil loss Image: Behadur, 2009 (www.isprs.org)

Soil Erosion Modelling

Model can be build on soil loss determination mechanism consists of two classified base phases. As selected first one is the water phase generally determines the water loss erosion and second one is the sedimentation phase to determine the sediment particles.

At the water phase total kinetic energy within rainfall, overland flow and yearly precipitation values and at the sedimentation phase of model considering rate of soil detachment by raindrop impact and transport and moment capacity of overland flow values are calculated for every pixel by generating maps for each input data (Faust,1989).

This predictive model for the assessment of soil erosion risk is called Morgan model. The input parameters and operating functions about this model are given below.

Water phase:

E = R (11.9 + 8.7 log 10 (I))…….(1)

Q = R exp (- R c / R o)………….(2)

[R c = 1000 MS BD RD (E t / E o) 0.5 (3)

R o = R / R n] …………………..(4)

Sediment phase for estimation:

F = K (E exp (– 0 , 0 5 A)) 10 – 3 ……(5)

G = C Q 2 (sin S) 10 – 3 …………….(6)

Operating functions as Indicative in equations

E : Kinetic energy of rainfall (J /m 2)

Q : volume of overland flow (mm)

F : Rate of splash detachment (kg / m 2)

G : Transport capacity of overland flow (kg / m2)

Input Parameters:

MS : Soil moisture content at field capacity

BD: Bulk density of the top soil layer (g /cm3)

RD: Topsoil rooting depth (m)

E t / E o : Ratio of actual (E t) to potential (E o)vapor transpiration

R : Annual rainfall (mm)

R n : Number of rain days in the year

I : Typical value for intensity of erosive rain (mm / h)

K : Soil detachability index (g / J)

S : Steepness of the ground slope expressed as the slope angle

A : Percentage rainfall contributing to permanent interception and stem flow

C : Crop cover management factor

W : Rate of increase in soil depth by weathering at the rock soil interface (mm / year)

V : Rate of increase of the topsoil rooting layer (mm / year)

T: Total Soil depth(m)

(Reference model credibility www.ijetsr.com and www.isprs.org)

Energy and Pressure Relationships

There is direct relation we can establish very easily between the soil water erosion and pressure among water particles. Pressure can be easily found out but the energy in water more or less depends on the force of water.

Pressure Relationships in Saturated Soils

In classic example if we take beaker of 100 cm bottom size and water depth to be noted to 20 cms and it weighs around 200 grams the random pressure p of the water at the bottom of beaker is equal to

P=force/area=2000 g/100 cm2=20/g/cm

[Tested Credibility is found at www.vdocuments.mx]

This in another way we can say at the 20 cm pressure is more and drastically it reduces to when 10 cm of level. This means water pressure decreases with distance by creating pressure of around 14.7 lb/in. This is main causes where water saturates and bulk of soil can be eroded on surface of soil

Pressure Relationships in Unsaturated soils

Taking extension of above example if we insert a small diameter glass or capillary tube and insert into the water of beaker then due of adhesion of water molecules move towards interior wall of the tube. Generally due identification of cohesive forces or random forces between water molecules causes all other traced water molecules to move upwards. This experiment will clearly indicates that at even height of 20cm above the water surface the pressure remains the same. In this case its indicative that if two soil cohesion occurs due to equilibrium condition then pressure remains unaltered. Then we can draw the conclusion that

1. Water in unsaturated or gutted soil remains negative or under stress portion of water.
2. It decreases the water or soil pressure with increase distance with above the free surface of water molecules

4. Application And Use Of Universal Soil Loss Equation

The equation we generally referred as USLE was designed to predict or forecast the long term erosion rates of measuring soil points for erosion on farm land leads to acceptable levels of erosion. This can be partially used with Indian soil condition as there may be more number of uncertain conditions found. As indicative and procedure for computing is concerned.

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Figure 3: Hydrological soil Grouping Map of satellite image helps to find out the various water pressure (Image courtesy: Land Use and Survey Reports Bengalure)

Assuming that there is field in Nandi hills and surrounding slope has vertical gradient of 8% and is almost about 300 feet long. The general cropping system of ragi or corn and tilted salty corn with tillage and planting on the cornel space with broader dimension of plane surface the following table of p is found

Table 1: Observational Values of P for contouring (www.dl.sciencesocieties.org)

Land scope in %	Calculated P value
1.1 to 2.1	0.70
2.1 to 7	0.60
7.1 to 12	0.70
12.1 to 18	0.70
18.1 to 24	0.80

If farming had been consider on the contour and mixed with minimum amount of tillage for ragi and radish then the corn in the rotation of land usage the factor for contour c would have been considerable around 0.075. This drastically reduces the soil erosion predicted as 4.5 tons per acre which somewhere between 12 to 15 metric tons per hectare/acre

Soil Loss Tolerance Value

One of the most important parameter while calculating soil erosion is soil loss tolerance value and can defined and treated with two ways. Many soil scientist either lack of knowledge or may be not followed the procedure of conscious that how much T value is to taken into account. If T value reads maximum at instant then soil erosion is to be offset by maximum rate of soil development. This will always consider as moment of equilibrium between soil loss and gain. If we consider shallow soil over the palette of hard rock have always smaller values. In other hand soils over claypans will result to rooting depths and in need of smaller T values. Here importance is given to the maintenance of certain thickness of soil. This might be because of overlying or underlying impermeable layer that might exists for longer due to water adhesion or water cohesion. There was some evidence in satellite data artificial removal of the surface soil reduces yields (Referred Journal source: www.edoc.pub)to less than half of the crop yield which obtained from un-eroded soil when no fertilizer is used. General application of fertilizer containing 2 quintals then nitrogen may increase its value to highest even normal slope of soil surface. As agricultural data sets shows average soil loss with continuous bluegrass(congress) was 0.03 tons per acre and resulted in the removal of somewhere between 2.5 cms of soil everywhere. This result somewhat 50 tons per acre or 2.5 cms of soil loss which is huge loss for crop that may reduces crop yield. USLE equation always helps to find the exact amount to maintain the soil loss at below certain T value

Table 2: For assigning or indicative Soil Tolerance Values with different rooting depths of sample soil. (Internet Source: www.edoc.pub)

	Soil Tolerance Values			
Rooting Depth in	Renewable Soil		Non Renewable Soil	
Cm	Ton/acre	Ton/ha	Ton/acre	Ton/ha
<25	1.0	2.2	1.0	2.2
25-51	2.0	4.5	2.0	4.5
51-102	3.0	6.7	3.0	6.7
102-152	4.0	9.0	4.0	9.0
>152	5.0	11.2	5.0	11.2

Water Erosion Cost

Every year unexpected rain fall may results huge soil erosion greater loss to the farming community. Recently sedimentary erosion in and around of chickkballapur caused massive setback to the growth of crops which is loss to ragi and other local crops.

5. Materials and Methods Used for Estimating Soil Erosion

The availability of current data with up-to-date and accurate soil information is always beneficial and crucial for monitoring soil erosion. Mapping exactly through satellite is always useful what extent soil is being lost in selective area can be useful for agricultural planning and land usage. Soil also needs to map with moisture content or other broad characteristics of soil which we intent to study. Remote sensing by capturing the image is great useful in determining which particular areas are more prone to drought and highly deserted. It can show erosion patterns and soil characteristics with high ended accuracy.

Soil always emits specific wavelengths or combined spectral bands with ranging from chemical to physical characteristics. This definitely helps to recognize the satellite to discriminate between

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different soil surfaces and infer their soil characteristics. Soil is self radiating element of various properties through soil surfaces like soil moisture, organic matter, surface texture and content of iron and other possible behavior which is useful in determining soil health as well as risk erosion possibilities.

6. Data Sets of Soil for Estimating and Predicting Soil Erosion

Collection of data is carried out in rainy season of June to September of 2019. It is nominal data extracted from spatial characteristics from satellite images. To collect data we had taken help from National Agency of Land Imaging New Delhi, Land usage mapping Bengaluru and panchayat members & staff including PDO and Tahsildar of different zones.

Table 3: Number of mapping units under different soil series

Sl.No	Sampling place	No of Mapping Units	Total Area(Ha)	Total Area (%)
1	Nagenhalli	12	494	34.2
2	Harohalli	10	3564	18.6
3	Gantiganahalli	8	3320	34.2
4	Snhalli	9	14003	25.6
5	Avalahalli	12	2750	28.5
6	Sane	5	963	10.1
7	Hasarghatta	12	690	14.2
8	Rajankunte	16	558	31.2
9	Byatha	9	2460	16.3
10	Dibbur	12	1003	12.1

(Indicative of Sample Size only

Table 4: Distribution of area (ha) under different depth classes

Sl.No	Depth Classes	Total Area	Area(%)
1	Shallow soils(d2)	4961	16.64
2	Moderately deep soils(d3)	9454	31`72
3	Deep Soils(d4)	9435	31.66
4	Very Deep Soils(d5)	2492	8.36
5	Misc	3463	11.62
Total		29805	100

Table 5: Data Indicators of Distribution of area under different slope classes

Sl.No	Slope classes	Total Area(Ha)	Total Area(%)
1	Very gentle slope with terraced slope (0-3%)	494	34.2
2	Very gentle slope (1-3%)	3564	18.6
3	Gentle slope(0-5%)	3320	34.2
4	Gentle slope (3-5%)	14003	25.6
5	Moderate slope (5-10%)	2750	28.5
6	Strong slope (10-15%)	963	10.1
7	Gentle slope (3-5%)	690	14.2
8	Moderately steep slope(	558	31.2
9	Steep Slope (25-33%)	2460	16.3
10	Misc	1003	12.1

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Total	**29805**	**100**

Table 4: Data Indicators of distribution of area under different erosion classes.

Sl.No	Errosion Classes	Total Area	Area(%)
1	Soil Erosion [e1]	3814	12`80
2	Moderate Erosion[e2]	18502	62.08
3	Sever Erosion[e3]	4026	13.51
4	Misc	3463	11.62
Total		29805	100

Table 5: Tabular distribution of series with soil and water health parameters

Sl.No	Sampling place	Range of pH		Range of Ec		Range of ESP	
1	Nagenhalli	Value	Rating	V	R	V	R
	Surface Subsurface	6.58	Acidic Alkalin	0`05	norm	1.24	Non salin
2	Harohalli	5`74	Acidic Alkalin	0`01	norm	2.55	Non salin
	Surface Subsurface	6.71	Acidic Alkalin	0`03	norm	0.70	Non salin
3	Gantiganahalli	4.86	Acidic Alkalin	0`05	norm	1.75	Non salin
	Surface Subsurface	5.28	Acidic Alkalin	0`02	norm	0.47	Non salin
4	Snhalli	7.65	Acidic Alkalin	0`01	norm	0.87	Non salin
	Surface Subsurface	6.16	Acidic Alkalin	0`04	norm	0.91	Non salin
5	Avalahalli	4.87	Acidic Alkalin	0`01	norm	0.92	Non salin
	Surface Subsurface	7.06	Acidic Alkalin	0`02	norm	1.23	Non salin

7. Tool Used

In this paper we used Weka [Term can be expanded like Waikato Exploring Knowledge Analysis] was used for conducting and running tests on various data sets. Basically this tool helps various statistical analyses within the specified environment. Graphical GUI compatibility is good and more suitable to use and apply various data pre-processing and applying Data mining Algorithms. In our case data collected is not massive a small amount data is processed for available data of water profiles. Following some advantages we come across and few are

1) An effective data handling in pre-processing and converting csv into ARFF formats.

2) Various filter Algorithms that filters unwanted data into purfied chamber for running sample data

8. Result and Conclusion

In order to assess firmly about the soil erosion risk factor in study area includes several applications and various analysis were implemented. The most important factor is regression relationship and it was established before estimating exact rainfall of erosive index which is average annual precipitation and elevation with R2 of 0.967. The Final thematic map of particular study area is shown in Figure 2. The standard error of estimate between the point and the surface of k factor is somewhere 0.005t hr/ha M. In this reader may surprise what Data Mining Algorithms are doing here. One of most dynamic algorithm like K-NN is used to predict as expected soil water profiles and suitable characters we labeled to know which soil is suitable for which crop and density of soil erosion properties. Confusion matrix for K-NN analyses is done like prediction range with high, low and medium.

Table 6: Confusion Matrix for various Algorithms run and its class Error indication table

Predictions	High	Low	Medium	Class Error
K-Means	**18**	**12**	**6**	**0.100000**
Optimized K-Means	**3**	**5**	**8**	**0.142856**
Random forest	**3**	**2**	**5**	**0.084231**

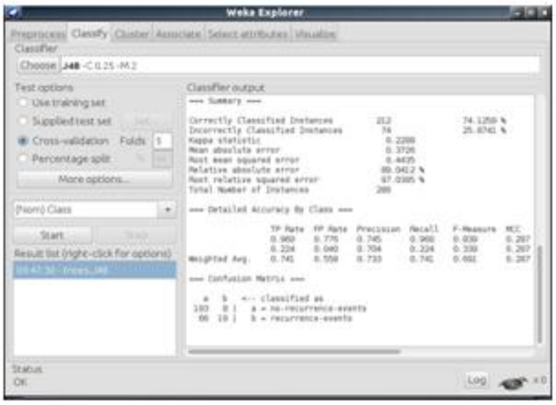

Figure 7: Screen template data exploration with weka

In overall we can say analysis showed by the models made by random forest and KNN algorithms performance is very indicative as per our expected result. However there are many gaps which we need to indentify the rationalization of various attributes and labeling test data on sampling of water profiles to determine soil erosion patterns. There are some misconceptions about handling agricultural data that it never produces accuracy of prediction but in our case we are bit relieved as profile prediction, soil erosion and level of water potential in slope area is accurate and deficiency traced and recorded for the correction to identify the soil erosion. Finally we conclude random forest can be better than the KNN algorithms.

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