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Research Article

ADVANCED GEOGRAPHICAL INFORMATION SYSTEM (GIS) FOR THE MANAGEMENT OF FLOODS OR SOIL EROSION BASED ON SOIL SHEAR STRENGTH IN EAST GODAVARI REGION

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ABSTRACT
Flood is a temporary inundation of large area/ regions as a result of an increase in reservoir or of rivers flooding their banks because of heavy rains or dam bursts. Erosion of soil from the catchments involves the process of detachment of soil from the soil surface and its transport by rainfall and runoff. Water from a raindrop acts both as a wetting source and as an energy source causing detachment. The shear strength of soil decreases with increasing wetness. The aim of this paper is to identify soil shear strength based on direct shear test with altering soil constituent like Q (Quartz), C (Calcite), KF (K-Feldspar), Pl (Plagioclase), I/S (Illite/Smectite), I (Illite), K (Kaolinite) and Ch (Chlorite) and their ratios normal soil and treated soil of in East Godavari region. Treated soil has with increased levels of Kaolinite showed high shear strength when compared to other soil constituents. Soil mineral information may be liked with Geographical Information Systems (GIS) and Remote Sensing (RS) techniques and it can manage or avoid flood or soil erosion. Current challenge is using GIS and RS technique for flood management may need to enhance for identification of soil mineral composition.

Keywords: *Management of Floods, Soil Erosion, Soil Shear Strength*

INTRODUCTION
Flood is an excess flowing or overflowing of water, especially over land which is not normally submerged (Condie, 1993). The flow is markedly higher than the usual and this also cause inundation of lowland. In other words, flood is defined as “a relatively high flow or stage in a river, markedly higher than usual and thus inundating lowland. It is a body of water, rising, swelling and over flowing land, not usually thus covered” (Barroca *et al.,* 2006). Most of the rivers in India rise in hills, flows towards plain after traversing certain distance and continue towards outfall into sea or other river (Bronstert, 2003). It is known that change in river bed and/or bank takes place due to imbalance in supply and transport capacity of sediment that varies as power of flow velocity. Further changes in the river bed also take place if the soils forming banks are weaker against the erosive actions of flow velocity (Huang *et al.,* 2008). Protection is required at such location for safety of adjoining villages, fields and establishment (Konadu and Fosu, 2009). The process of deriving such measures starts from identification of erosion area that can be carried out through analysis of bank line data collected from satellite. The findings are to be confirmed through ground truth verification.
It has been believed for some time that weathering of some minerals, especially clays, may over time reduce the strength of soil and cause landslides (Weichselgartner, 2001). Nevertheless, the kaolinite structure possesses great advantages in many processes due to its high chemical stability and low expansion coefficient. As a consequence of adsorption, the kaolinite structure and the soil solution pH will change. Seasonal changes of stability of slopes may be closely related to the content and type of clay in the slope, especially to the content of montmorillonite, the acidity of rain water in addition to the traditional factor of pore water pressure (Yi *et al.,* 2010).
Several methodologies have been developed to assess the risks associated with flooding by using ground measurements such as precipitation, water flow or level (Warner, 2009). Satellite remote sensing data have been utilized for flood assessment because of their high spatial resolution and capacity to provide information for areas of poor accessibility or lacking in ground measurements (Weeks *et al.,* 2007). High resolution satellite data is particularly useful for the spatial analysis of water pixels. When data before and

after a flood event are available (Yankson *et al.*, 2004; Yehboah, 2000), it is possible to classify land cover change, and thus, identify which areas are flooded (Kundzewicz *et al.*, 2010).

MATERIALS AND METHODS

Direct Shear Test

The direct shear test is the oldest and simplest form of shear test arrangement. The test equipment consists of a metal shear box in which the soil specimen is placed. The soil specimen may be square or circular in plan. The size of the specimens generally used is about 51mm x 5L mm or102mm x 102mm (2in.x2in.or4in. x 4in.) across and about 2-5 mm (1 in.) high. The box is split horizontally into halves (Liu *et al.*, 2005). Normal force on the specimen is applied from the top of the shear box. The normal stress on the specimens can be as great as 10-50 kN/m2 (150 lb/in.r). Shear force is applied by moving one-half of the box relative to the other to cause failure in the soil specimen (Dhillon, 2005). Depending on the equipment, the shear test can be either stress controlled or strain controlled. In stress-controlled tests, the shear force is applied in equal increments until the specimen fails. The failure occurs along the plane of split of the shear box. After the application of each incremental load, the shear displacement of the top half of the box is measured by a horizontal dial gauge. The change in the height of the specimen (and thus the volume change of the specimen) during the test can be obtained from the readings of a dial gauge that measures the vertical movement of the upper loading plate.

$$\boldsymbol{\sigma} = \frac{\textbf{Normal Force}}{\textbf{Cross} - \textbf{sectional area of the specimen}}$$

Shear displacement can calculated by

$$\boldsymbol{\tau} = \textbf{Shear stress} = \frac{\textbf{Resisting shear force}}{\textbf{Cross} - \textbf{sectional area of the specimen}}$$

Study Area

The study area is situated in the East Godavari District, in Andhra Pradesh (Figure 1). The area lies between the 16.98°N 81.78°E.

Experimental Study

Different rations of soil constituents like Q (Quartz), C (Calcite), KF (K-Feldspar), Pl (Plagioclase), I/S (Illite/Smectite), I (Illite), K (Kaolinite) and Ch (Chlorite) were prepared based on their shear strength. Along with these ratios normal soil was taken as control.

RESULTS AND DISCUSSION

Flood depth is one of most important parameters used in the determination of flood risk indices (Jeyaseelan, 2003). The concept of flood hazard is therefore very important in flood management especially in the determination of flood risk (Crichton, 2002).

GIS has been defined in different ways, perhaps the most commonly used in effective and efficient response thus minimizing and or mitigating the after flood effects (Lavado and Taboada, 1988). There has been wide spread development or updating and use of hydrological models with a flood prediction component (Patrick and Mahapatra, 1968). These models are in most cases either loosely or tightly coupled with GIS and remotely sensed data (Taboada and Lavado, 1986).

Flood extent was then simulated based on the derived drainage lines, their depth and capacity to hold rainfall run-off. The flood level contours derived for the selected flood water levels of 0.5, 1, 1.5 or 2 meters were used to indicate areas that could face possible inundation in the event of any flood (Taboada and Lavado, 1993). Treated soil has with increased levels of Kaolinite showed high shear strength when compared to other soil constituents. This may provide ideal information for generating temporal data input required for the RS and GIS order to simulate runoffs and thus floods. GIS tools have been imbedded in the hydrological models to facilitate in data analysis, querying and presentation of

information in a more simplified way, thus they form critical part of the distributed hydrological models used for flood prediction with soil constituents identification.
Among other challenges they have pointed out include high cost of digitization and raw data collection, the intrinsic complexity of predictive models, lack of appropriate raw data, inadequacy of hardware technology to handle large spatial data sets and the difficulty in GIS to manage historical data necessary for some natural hazard assessments.

Table 1: Rations of Soil Constituents Used for the Study

Q	C	KF	Pl	I/S	I	K	Ch
1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1
1	1	2	1	1	1	1	1
1	1	1	2	1	1	1	1
1	1	1	1	2	1	1	1
1	1	1	1	1	2	1	1
1	1	1	1	1	1	**2**	1
1	1	1	1	1	1	1	2

Q (Quartz), C (Calcite), KF (K-Feldspar), Pl (Plagioclase), I/S (Illite/Smectite), I (Illite), K (Kaolinite) and Ch (Chlorite) calculations performed by using a method after Schultz (1964) with their (Wt%)

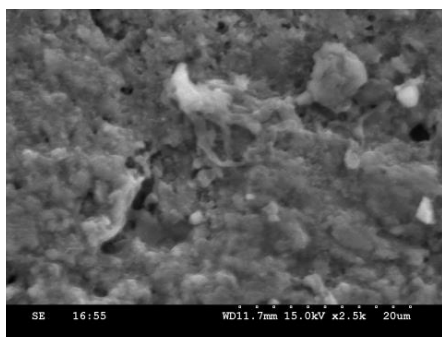

Figure 1: SEM Image of the Kaolinite 2µg (Wt%)

Conclusion

Flood or erosion of soil from the catchments involves the process of detachment of soil from the soil surface and its transport by rainfall and runoff. Deposition of detached material takes place when the transport capacity of flow is smaller than the quantity of material being transported. The impacts due to erosion have severe effects on the reservoir sedimentation and to certain extent on floods. Finally it concluded that Treated soil can avoid the floods or erosion of soil by providing data to the GIS. In this way GIS tools have been imbedded to facilitate in data analysis, querying and presentation of information in a more simplified way used for flood prediction with soil constituents identification.

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