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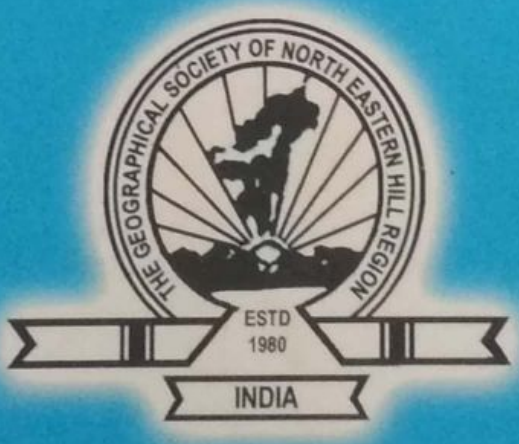

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SELECTION OF POTENTIAL SITES FOR INTEGRATED WATERSHED MANAGEMENT PROGRAMMES IN NOA BASIN, ASSAM USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT

A river basin or for that matter any water body has distinct set of landform, vegetation and climate associated with it. Availability of surface as well as ground water varies spatially and temporally depending upon land features. Presently the Integrated Watershed Management Programme is one of the most effective water controlling as well as harvesting method for checking flood and irrigation purpose. The Noa river basin suffers from acute shortage of water for development particularly in its upstream. The downstream suffers from flash floods. Watershed Management Programme can help to check the agricultural field from the shortage of water and at the same time the prevailing ecosystem of that area from the flood. Remote Sensing and Geographical Information System (RS and GIS) are useful tools for estimation of potential sites for construction of check dams in the watershed and across streams. The present study uses this tool to delineate the potential sites for water harvesting structures (check dam) in place of big river dam construction in the said river basin to save the ecosystem of the concerned area.

Key words: *Flood, watershed, ground water, runoff, land use, dam*

Introduction

Water is the lifeline of the living being. River as the most important source of water has close relationship with man since the dawn of human civilization. From the time immemorial man has been attracted to riverine areas. Out of 3 per cent fresh water on the surface of the earth, only 1per cent is used for drinking purpose (Anon, 2002). According to World Bank Report India will be in water stress zone by the year 2025 and water scare zone by

2050 (Singh, *et.al.* 2009). Precipitation is regionally varied in India. Therefore, water storage is one of the most important steps over time and space. To adjust with the shortage of precipitation or surface water becausé of over exploitation leads depletion on ground water also. North East India is one of the wettest regions of the world with an average annual rainfall of 2000mm. The region also has a dense network of drainage channel. But this has never before been tapped for agricultural purposes, because the subsistence economy of the region with a limited population and abundant cultivation did not realize the necessity of growing crops than what actually needed. But in tremendous population growth now being replaces the subsistence economy partially by modern industrial as well as commercial crops. As the study area is one of the important parts of the Brahmaputra valley it has tremendous scope for making small dam to develop the agricultural sector. The need and importance of water harvesting and water conservation has been stressed in national water policy and national agricultural policy of government of India. Water harvesting is relevant to develop the country's economy and a vital component of watershed management. Storage of water in a river basin is essential for water management by constructing suitable small dams or reservoirs. It helps reduce the risk of flood while being immensely useful in irrigating the agricultural field. This type of small construction may differ with different parameters like topography, soil, slope, precipitation, land cover and land use, settlement pattern etc. Small check dams are constructed across the ether streams to intercept runoff from local catchment and store it for optimum utilization. The small dam construction on river help to the irrigation as well as control of hydrological problems like flood, soil erosion etc is said to be the most important instance of river basin management and planning. Dam as a reservoir of water should be constructed under the scheme of Integrated Watershed Management Programme (IWMP) where the basin area is too small. It will help to minimize the flood associated problems and water deficiency problem to the poor farmers in the downstream part of the river valley. The soil quality is found in the study area are basically old alluvium in the upstream and new alluvium in the downstream part. Therefore, the construction of big river dams is not suitable in the Noa river basin. Now-a-days decision making and planning about construction of small dam on river basin required number of information which can be easily done by using sophisticated tools like Remote Sensing and GIS techniques.

Study Area

The study area is a Noa river basin situated in the districts of Darrang and Udalguri of Assam. The Noa river basin having steep slope from the south of abruptly rising Bhutan Himalaya stretching by monotonous plains in the downstream of the river and sloping very gently towards the mighty river Brahmaputra in the south. (Fig.1). The Noa River originating

at an elevation of 520m above the mean sea level near Bhutiachang in the southern slope of the Bhutan Himalaya comprises three sub-tributaries, viz., Bhola, Lakshmi and Batiamari. The middle part of this river is known as the Kuyapani. In the Rik Veda this river is known as the Anjashi River (Noa). According to some scholars this Noa River has bifurcated from the Khampajuli of Bhutan. The river after crossing Bhutiachang in the Silputa Mouza takes a slight bend eastward. The river then continues its flow to meet the Mangaldai River at its confluence before 1972. Now it is one of the independent rivers and meets with mighty Brahmaputra near NH-52 crossing. A meander could not develop, if the banks were un-erodable or if they were completely unstable (Leopold, Miller and Wolman, 1964). The Noa River is no exception to it. This is more so in the areas where the channel enters in the Silputa Mouza.

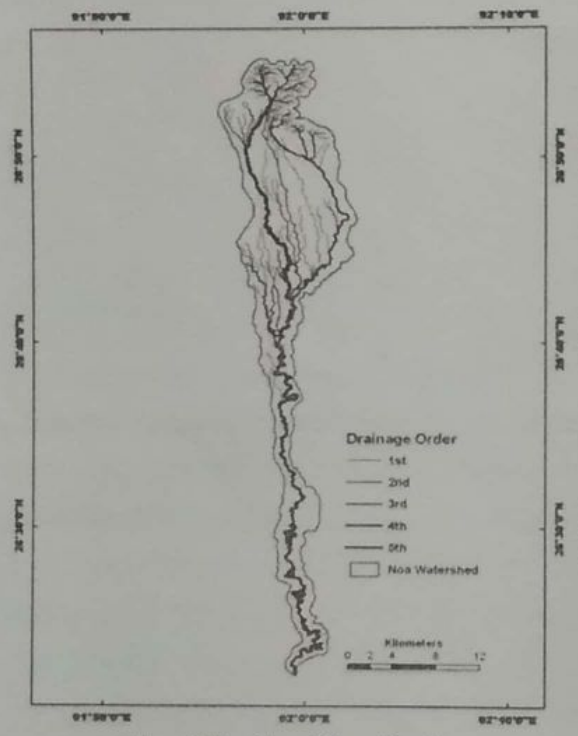

Fig. 1 The Nao River Basin

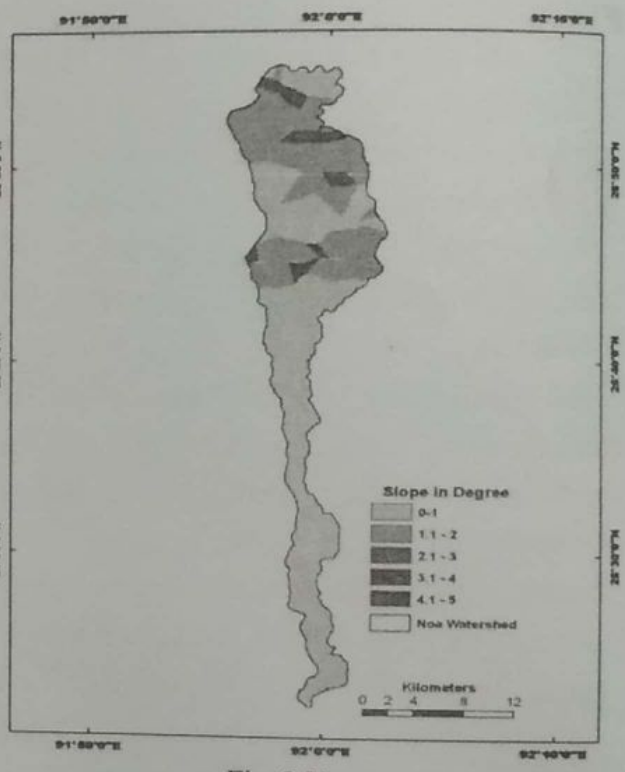

Fig. 2 Slope

Methodology and Data Base

The entire study is based on personal observation on site and data collected from Water Resource Department, Circle office Government of Assam and Central Ground Water Board, Assam. Base map and other thematic map and layers are prepared from the topographical sheets, satellite imagery LISS-III (2008) by using different types of methods (Geo-referencing of scanned image, verified with ground truth, supervising and unsupervising

the layers of the digital images). To delineate potential site for IWMP (Integrated Watershed Management Programme) digital analysis has been carried out by using different GIS software like Arc-view, Erdas etc. The polygon boundaries of the river basin accomplished using the cut polygon and clip tool which enabled the digitization of all the litho polygons.

Objectives

The main objectives of this study are to:

i) study the drainage basin pattern and characteristics,
ii) study the watershed management and land use pattern in the basin area and
iii) delineate the potential site for the construction of small check dam under IWMP (Integrated Watershed Management Programme).

Physical Characteristics of the Basin Area

The length of the river is 93.42 km and the basin area is 193.48km^2. The maximum relief between the Assam-Bhutan border and the mouth is calculated 520m along the length of 93.42 Km thus giving an average channel gradient of 5.69 m/km. The gradient of the upper, middle and lower reaches of the river are 10.86, 4.41 and 0.76 m/km respectively. The mean annual maximum discharge is 73.13 cumecs (cubic meter per second). While the mean maximum water level of this river is 58.33m from the mean sea level, it carries 166 tons of sediment per sq.km per year.

The relief of the basin has been signified by absolute relief differences with the maximum elevations of 520m, 100m and 50m on significantly identifiable low riverine terraces from north to south. The plain of the basins slopes down abruptly at the foothill of Bhutan Himalayas, while it has very low slope in the flood plain and built-up areas (Fig.2).

Geologically the basin including the adjacent plains of the Brahmaputra valley represent thick cover of recent to sub-recent alluvial deposits on the foredeep (Krishnan, 1982) or rift valley (Burrard, 1915) conforming to alluvial flats above the northward sloping pre–cambrian rock base. The Noa river watershed is dominated by compact sandstone of cambrian period. There developed minor waves, for example a fault (about 200m deep) along the river Noa

(Rao, 1976) in the western fringe of the basin. The plain of the basin below the unstable Bhutan-Himalayas has been geologically and isostatically unstable.

The relief however indicates some sort of ruggedness from east to west. These landforms are characterized by high porosity, permeability and infiltration rate and as such the ground water prospect is good (Fig.3).

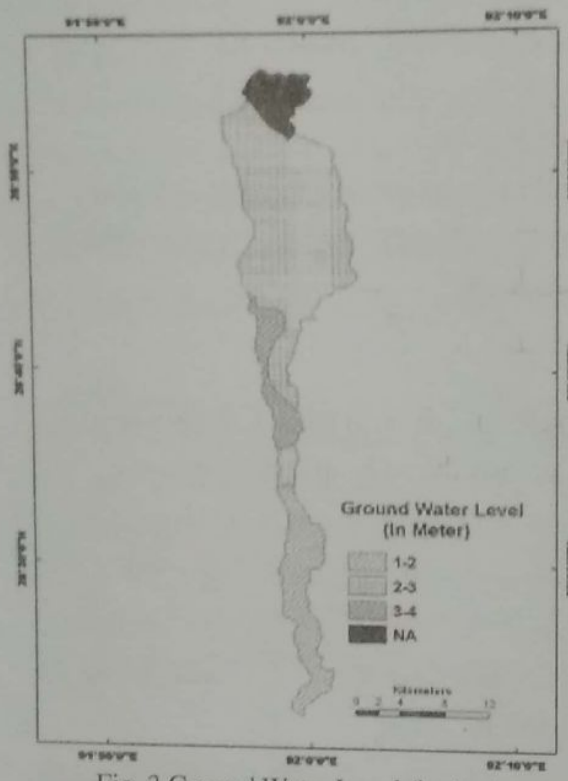

Fig. 3 Ground Water Level (in Aug).

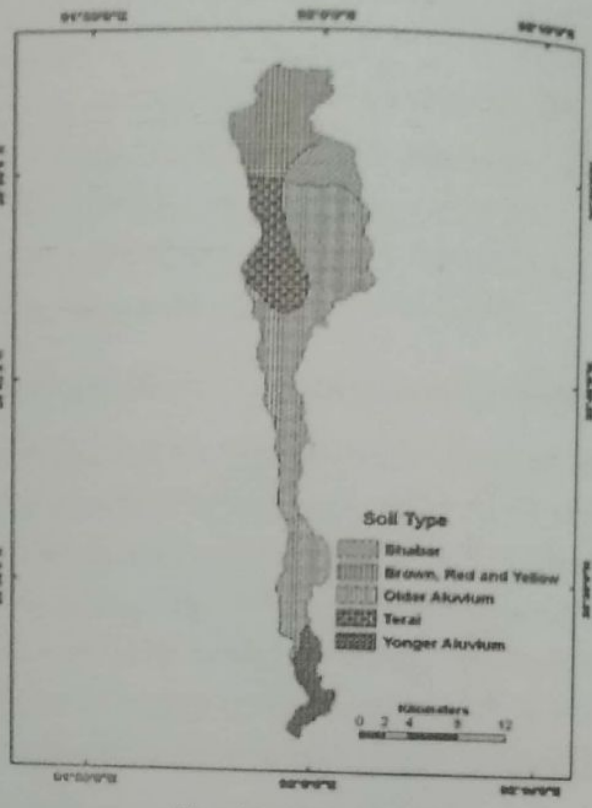

Fig. 4 Soil Types

The floodplains of the Brahmaputra valley are formed by alluvial soils of recent deposit (Goswami, 1985). The soils of the basin (fig.4) especially in their southern part have been most sensitive to erosion and floods. The Bhabar, Tarai, brown, red and yellow soils are highly erosion prone in the upper part of the basin because of sparse vegetation cover.

Landuse Pattern

The pattern of land use in the drainage basin has peculiar characteristics compared to the other river basins in the Brahmaputra valley in Assam (Fig.5). The rocks and soil of the basin area are soft and friable and hills are mainly composed by the clay, sand, sandrocks and poor sandstones etc. Obviously, with this type of geological formation the pattern of land use has been characterized in many types in the different part of the basin area. In the basin the hill and hilltop area covered by thick (Bhabar and tarai) vegetation which is quite differ from the lower part (flood plain) of the river basin.

Table. 1. Land Use and Land Cover, 2008

Category of Land use and Cover	Area in km²2008
Agriculture	128.89
Built up Area	18.60
Forest	24.01
Grassland	0.83
River	10.73
Water bodies	0.08
Tea Estate	10.34
Total	193.48

The results of the land use analysis of Noa river basin are given in table.1. It indicates that the agricultural land only 128.89percent in 2008. Similarly the built-up land constitutes 18.60 percent where the forest cover has 24.01 percent as on 2008 which is very low to check the erosion problem in the Noa river basin. The grassland in the study area is only 0.83 percent which is mainly located near the confluence of river basin. The ground grass and leaf litter cover is very poor. It is expected that this will give a significant impact on fluvial problems like degradation, soil erosion, channel shifting etc. in Noa river basin.

However, the river and water bodies in the basin having 10.73 percent and 0.08 percent respectively during 2008. In the upper part of the river basin covered with 10.34 percent of tea estate. All these land use details show highly accelerated rate of rush or flash flood in the downstream part. So depending on the various parameters like soil types, slope and land use basin needs to construct suitable small check dam to harvest rain water at appropriate sites in the Noa river basin.

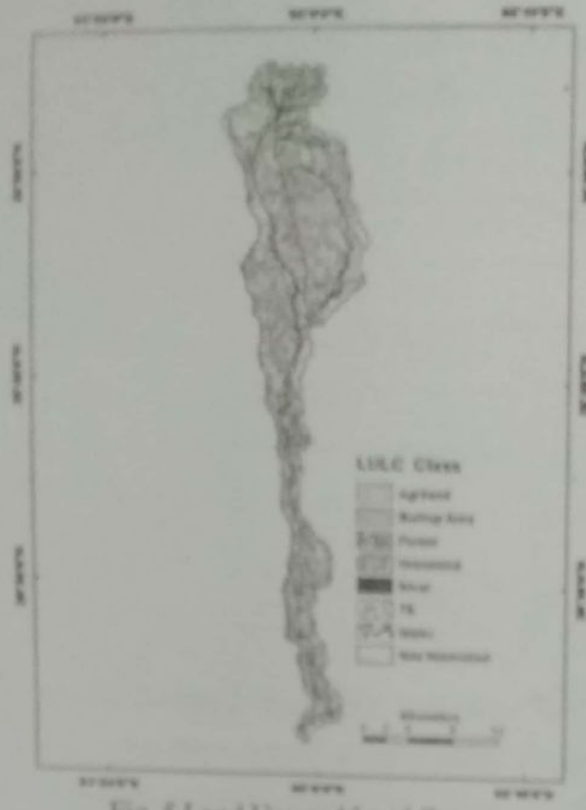

Fig. 5 Land Use and Land Cover

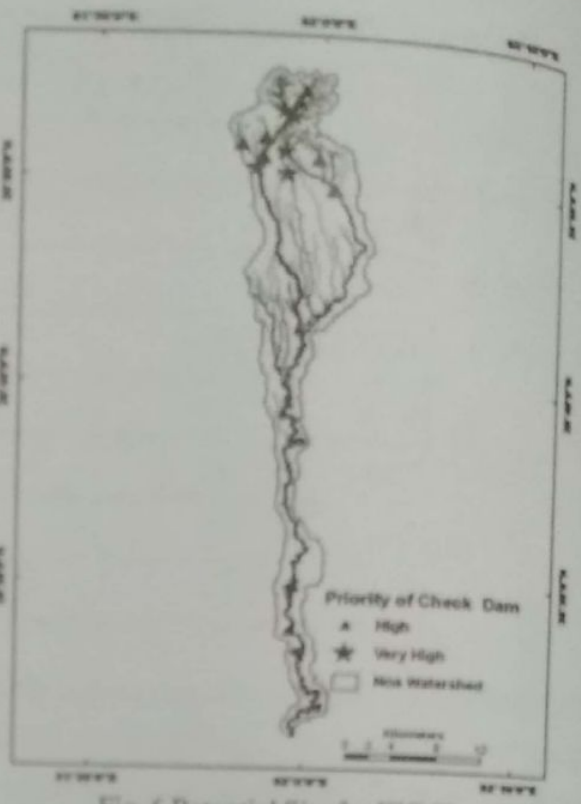

Fig. 6 Potential Site for IWMP

Potential Site for IWMP

The suitable sites for small check dam under Integrated Watershed Management Programme were identified with the application of geo-informatics tools like remote sensing and GIS software. After preparing the base map of different feature classes like drainage, land Use, soil, elevation, ground water, slope etc. are converted into raster form and different weight age point (0-250) were given to every category of respective map according to their importance. The sitting, type and purpose of a small dam will all be inter-related. Different factors will play a greater role depending on the specific situation. Small river dams must be deep enough to store sufficient volume of water, so a site with deep suitable clayey soil and it is on second and third order stream is best (Strahler, 1971). The most of the potential site for construct the check dam under the scheme of Integrated Watershed Management Programme (IWMP) are found in the hill slope area in Noa river basin. The delineated sites are bhabar, older alluvium and *tarai* soil. It is also located in thickly forest area having slope less than 5 degree. Out of total 136 villages of Noa river basin 8 villages are found suitable for making small check dam under the scheme of Integrated Watershed Management Programme. Among them seven sites are found very highly suitable and five are found highly suitable in *bhabar* and *tarai* belt in Udalguri district respectively. The proposed check dams could be very useful as supplementing irrigation during the dry season and to control the heavy rush of runoff during the peak monsoon period. The maximum holding

capability of the dam must not be increased by deepening or enlargement of the dam without verifying the geological structure of the site. It is also need to take care that dam, including dam walls and spillways must not be located in immediately upstream or immediately downstream of ecologically susceptible areas and in areas prone to erosion.

Conclusion

Water storing structures like small check dam are extremely important to protect the soil erosion, bank erosion and to control the flood problem (sheet and flash flood) in the lower part of a river basin. A dam, wall or other structure placed on, or constructed across a watercourse or drainage path for the purpose of holding back and storing the natural flow of that watercourse or the surface water runoff flowing along that drainage path is a kind of on course dam (Liddicoat, Ciganovic, and Sindicic,2009). Such types of dams are very useful to regulate the flash flood in the downstream part of a river basin like Noa. In Noa river basin good quantity of cultivable areas are converted into barren land because of high siltation due to sheet flood. During the period of winter water scarcity is one of the recurring problem. Water shortage during drought periods often causes an upsurge of interest in farm dam building, but construction under such dry conditions is fraught with problems (Nelson 1984). It is better to defer building dams until conditions are favourable because dams built in dry periods are more prone to failure.

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