Soil Degradation in Son-Karamnasa Interfluve in Bihar

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Abstract: ***Soils are the most valuable life supporting natural resource for the society since they produce food, fibre and fodder, which are basic to our very existence. For sustained utilization of the soil resource, it is imperative to know the nature, characteristics and extent of distribution of different soils, and their qualities, productive capacity and suitability for alternative land uses. Further, in order to assess the potential and problems of different soils and to develop rational land use for optimizing agricultural production, need consistent and comparable information about soils health. In Son-Karamnasa interfluve, due to mismanagement, the productivity of the soil, is declining because of degradation of soil. Basically, this area is under Son canal command area and due to over irrigation and over utilization of chemical fertilizer intensify this degradation. As the study area is bounded by rivers led to bank erosion is also prominent in this region.***

Keywords: Soil salinity, erosion, remote sensing, soil reaction

1. Introduction

Soil degradation is described as the rate of adverse changes in soil quality resulting in decline in productive capacity of land due to processes induced mainly by human interventions [12]. The human induced process like over irrigation, deforestation, etc. have resulted in overexploitation of natural resources. This has led to chemical problems like salinisation, alkaline, soil reaction (pH), calcareousness, etc. and accelerate physical problem like soil erosion [3]. The salinity problem of principal economic importance arises when previously non-saline soil became saline as the result of over irrigation. Such soils are often located in adjacent to streams and high irrigated area, because of the ease with which they can be irrigated, the more level areas are usually selected for cultivation. During the early development of irrigation projects, water use is frequently plentiful and there is a tendency to use it in excess. This hastens the rise of the water table. When the water table rises to within 2 or 2.5 metre of the soil surface, ground water moves upward into the root zone and to the soil surface. Under such conditions, ground water, as well as irrigation water, contributes to the salinisation of the soil [7]. Son-Karamnasa interfluve in Bihar, India is also suffering from the soil degradation problems. It is covering an area of about 10,98,393 hectares lies in four districts, i.e. Bhojpur, Buxar, Kaimur (Bhabhua) and Rohtas of Bihar. There is a well-defined natural boundary stretching between the Son river in the east and south, Karamnasa river in west and the Ganga river in north. Physiographically, Son-Karamnasa interfluve is divided into two parts, Bhojpur plain and Rohtas plateau. Bhojpur plain is a third order of Middle Ganga Plain South known as Ganga-Son Divide East (Bhojpur plain) and Rohtas plateau is geographically third order of Vindhyanchal Baghelkhand North Plateau known as Rohtas-Bijaigarh upland.

2. Literature Survey

It has been estimated that in India, on an average, 16.8 ton/ha/year (or approximately 1mm/10 years) of soil is lost through erosion. With a view to check erosion, since the early 1950s, in tackling the problem of land degradation, the approach has gradually moved from mere soil conservation to that of integrated land management. In the years that followed, the watershed, which was a compact homogeneous unit, became the obvious choice for planning and management of natural resources. The watershed concept went beyond a physical soil conservation approach to a wider perspective for development, conservation and management of land and water resources. Subsequently, watershed prioritization was taken up as a strategy for planning, and a national policy for watershed development was formulated to take into account the physical situation and availability of resources along with the needs of the people. Suresh et al. [11] has made an attempt on watershed prioritisation based on sediment production rate for adopting suitable soil conservation measures. Further, run-off potential and peak rate of run-off for individual watersheds was also carried out to provide guidelines for hydrologic design of soil conservation structures in the sub-watershed of Tarai development project area of West Bengal. Martin and Saha [4] identified the priorities of different sub-watershed areas for soil conservation measures by using the soil, land use and climatic data of Ason river watershed in Doon valley. The GIS environment was used to obtain the soil erosion loss using USLE mode. For quick appraisal of the dynamic nature of flood plain, it is necessary to use remote sensing data either in the visual or digital interpretation for correct estimates in order to make environmental assessment in an effective way [9]. Waterlogging is one of the major land degradation processes that restrict the economic and efficient utilisation of land resources. Since independence, various irrigation schemes, for providing water for agriculture and drinking have been taken up by various agencies. Obstruction of natural drainage by way of construction of roads, railways, aerodrome, various structures, etc., causes the ponding of monsoon run-off on the upstream of the structure. Intensive irrigation without adequate drainage contributes subsequently to a rising ground water table [6]. Goyal et al. [2] attempted to estimate waterlogging and salt-affected areas in the command area of Ravi-Tawi irrigation complex in Jammu region. Waterlogging and subsequent salinisation and/or alkalisation is the major land degradation problems in the irrigation commands of the semi-arid regions. Information on the nature, extent and spatial distribution of waterlogged areas is a pre-requisite for restoration of fertility in the soil. Dwivedi at al. [1] has delineated and monitored the spatial distribution pattern of waterlogged areas in Mahanadi command stage-I covering parts of Orissa by using multi-spectral, multi-temporal satellite imageries. Sequential changes in the position of bank-lines of the river due to consistent bank erosion have been studied from Survey of India topographical maps and digital satellite data by using GIS. Two broad kinds of changes have been observed, e.g. alteration of direction of flow due to neck cut-off and progressive gradual changes of the meander bends that accounts for translational, lateral, rotational, extensional and other types of movement of the meander bends. The amounts of the bank area lost due to erosion and gained due to sediment deposition has been estimated [8].

3. Methodology

The secondary sources of various government departments are Survey of India, National Remote Sensing Centre, National Bureau Soil Survey & Land Use Planning (NBSSLUP) etc. The soil related problems like soil salinity/sodicity, soil reaction (pH), calcareousness and soil erosion are assessed by published soil map of Bihar. Remote sensing based multi-date image of, Landsat, dated 24th February 1975 and IRS – P6, dated 28th October 2004, were used to assess changing configuration of river bank. The primary survey was done for the field verifications and collecting the coordinate information using Global Positioning System (GPS) and field photographs through camera. The transit survey method was used for surveying along the road network. Mapping and statistics was generated from the ArcGIS platform.

4. Result and discussion

Soil salinity / sodicity: The saline/sodic soils are mostly observed in the all the district of study area covering 5,79,048 hectares of land (Table 1). Among these 4,45,925.7 hectares of land is slightly effected by soil salinity constitute 40.6 per cent of the total area under study in WS1 to WS9 (Figure 1). The analysis also reveals that 12.1 per cent of land is slightly to moderately affected by sodicity in the eastern part of the Bhojpur and Rohtas district along river Son and the plains of Bhabhua district in WS2, WS3 and WS5 to WS9. The affected area indicates that the soil can be put under different land uses with careful management.

Table 1: Area of different soil salinity / sodicity

Salinity / Sodicity	Area (in hectare)	Area (in per cent)
Slightly salinity (Ece = 2 – 4 ds m^{-1})	4,45,925.7	40.6
Slightly sodicity (ESP = <5)	31,126.2	2.8
Moderately sodicity (ESP = 5 – 10)	1,01,996.1	9.3
Total	5,79,048	52.7

Source: Derived from NBSSLUP

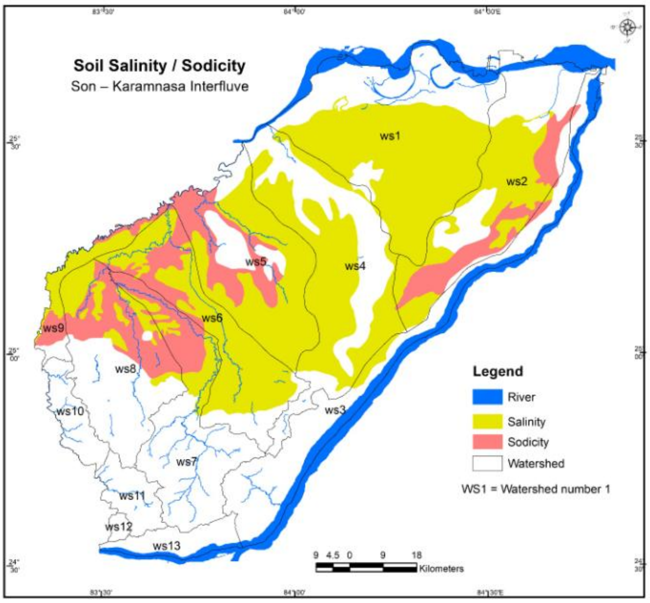

Figure 1: Soil Salinity / Sodicity map

Soil reaction (pH): Soil reaction indicates the level of acidity / alkalinity which in other words influence soil environment. This soil environment indirectly governs the availability of different plant nutrients. It has been found that soils having neutral pH (6.5 – 7.5) are ideal for crop growth in terms of available plant nutrient covering small patches in WS1, WS2, WS4 and WS13 constitute only 5.3 per cent of the total area (Table 2). The analysis also shows that the maximum land in the study area is effected by alkalinity covering 64.9 per cent of the total area. Among these 52.1 per cent area is effected by slightly alkaline in the entire watershed, except plateau region. The 12.8 per cent of the total area is effected by moderate alkalinity in WS5 to WS9 in the western part of the Bhabhua district in plains. The soil in the watershed is also effected by slightly acidic which are found in Bhabhua and Rohtas district. The analysis also reveals that 26.5 per cent of the total area is effected by slightly acidic condition, covering in the hilly terrain of Rohtas and Kaimur plateau. It is also found in the WS4 along river (Figure 2).

Table 2: Area of different soil reaction classes

Soil reaction	pH	Area (in hectare)	Area (in %)
Slightly acidic	5.5 - 6.5	2,91,179.6	26.5
Neutral	6.5 - 7.5	58,276.4	5.3
Slightly alkaline	7.5 - 8.5	5,71,990.5	52.1
Moderate alkaline	8.5 - 9.5	1,40,103.0	12.8
Total		10,61,549.6	96.7

Source: Derived from NBSSLUP

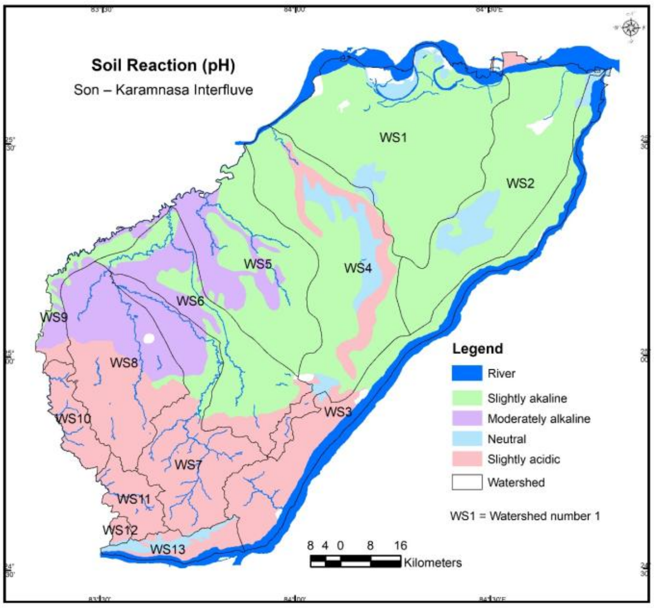

Figure 2: Soil Reaction

Calcareousness: Calcareousness influences the pH as well as the availability of macro and micro nutrients in the soil for the growth of plants. The physical conditions of soils are also greatly influenced by the quantity and the size of lime concentration present in the soil. The analysis shows that 16.3 per cent of the total area affected by the calcareousness (Table 3), where up to 15 per cent of $CaCO_3$ is found. Calcareous soils are found in the lower plain of the study area along the river Ganga, Son Karamnasa and their tributaries in the central part of the Bhojpur and Buxar districts covered in WS1 to WS5 (Figure 3).

Table 3: Area of different calcareousness

Calcareousness	Area (in hectare)	Area (in percent)
Slight ($CaCO_3$ = < 5%)	11,093.8	1.0
Moderately ($CaCO_3$ = 5 - 15%)	1,68,411.1	15.3
Total	1,79,504.9	16.3

Source: Derived from NBSSLUP

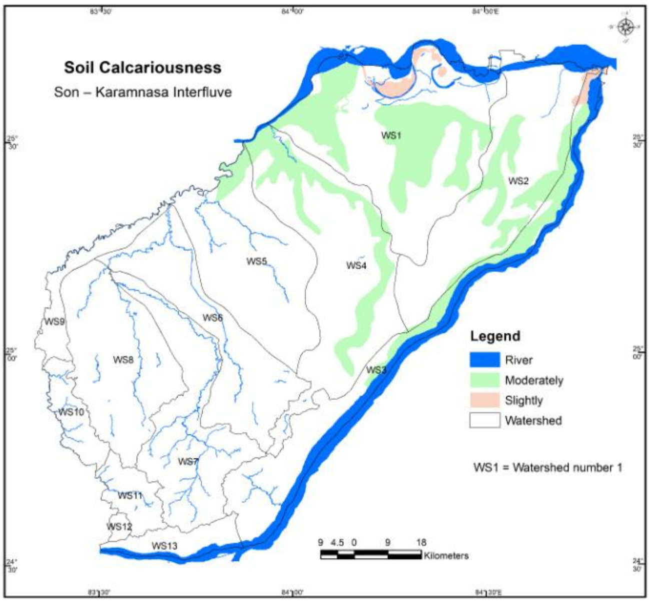

Figure 3: Soil Calcariousness

Soil erosion: Soil erosion refers to wearing away of the earth's surface by the forces resulting due to wind, water and ice. Erosion is the prime process responsible for the variation in topography as it erodes elevated surfaces and simultaneously constructs the alluvial plains in the valley. Soil erosion is aggravated due to human intervention through indiscriminate cutting of trees, mining and overgrazing etc., thus affecting natural ecosystem. The soils of the study area have been grouped under five erosion classes from very slightly to very severe erosion condition. The data reveals that 10,61,548.8 hectares of land is affected by the soil erosion (Table 4). Among these 50,159.4 hectares of land is effected by severe to very severe soil erosion around plateau region and their steep slopes in WS3 and WS6 to WS10 (Figure 4). These area needs immediate attention for soil conservation measures like binding, contour farming, gully plugging, farm forestry and water harvesting, etc. The moderate erosion area is found in the plateau regions of Rohtas and Kaimur covering 2,16,601.8 hectares of land which constitute 19.7 per cent of the total area. The alluvial plains of the study area are also prone to the erosion, but the rate of erosion is slight to very slight, covering 7,94,787.6 hectares of total land which constitute 72.4 per cent of the total area.

Table 4: Area of different erosion classes

Erosion	**Area** (in hectare)	**Area** (in per cent)
Very slight	3,68,942.3	33.6
Slight	4,25,845.3	38.8
Moderate	2,16,601.8	19.7
Severe	49,753.2	4.5
Very severe	406.3	0.04
Total	10,61,548.8	96.7

Source: Derived from NBSSLUP

The analysis of multi date image of, Landsat, dated 24th February 1975 and IRS – P6, dated 28th October 2004, the part of river Ganga in the study area also shows that river Ganga is changing their course continuously in the period of thirty years (1975 – 2004).

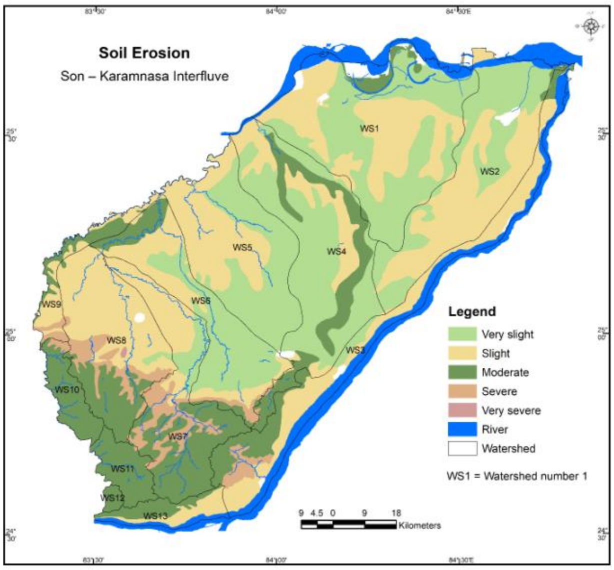

Figure 4: Soil Erosion

These shifting pattern characteristics of the river Ganga has also increase the bank erosion (Figure 5 and 6). The erosion is also found in the banks of river Son due to shifting pattern of the river course.

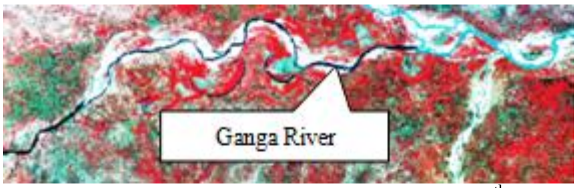

Figure 5: Landsat image of river Ganga dated 24th February 1975

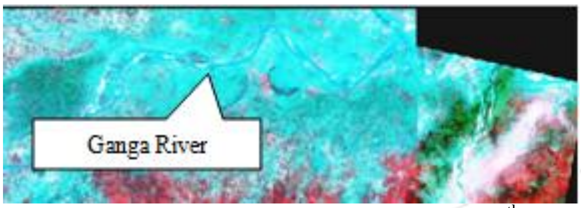

Figure 6: IRS – P6 image of river Ganga dated 28th October 2004

Conservation, Management and Development of soil

The main principle in reclamation of alkali soils requires the removal of a part of or most of the exchangeable sodium and its replacement by calcium. The required amount of soluble calcium can be added by using some amendments such as gypsum which contain 70 to 80 per cent calcium sulphate. There is various chemical amendments and organic materials which are generally used for reclamation i.e. gypsum, pyrites, press-mud, rice-husk, farm yard manure, etc. Alkali tolerant crops and grasses, can be grown in the rainy season which can help in getting some crop yield in first year. However, gradually the roots establish and create a better atmosphere around them by dissolving calcium carbonate and improve the soil physical condition and thus ultimately help in reclamation within a few years [5]. The saline area can be used by using the salt tolerant species of crops with the help of agriculture department in the district. The shifting pattern of the river can be minimized by making the wire and stone bund along the rivers. The mechanical and agronomical measures should be applied for the conservation, management and development of soil. The first line of action is to install rainwater harvesting structures for soil conservation according to the various drainage order. The agronomic measures as second line of action like choice of crops, crop management, crop geometry, mixed cropping, strip cropping and proper crop rotation as time to time recommended by agricultural department.

5. Conclusion

The study area is facing the problem of land degradation due to the mismanagement in soil utilization. The son command area is suffering from the soil salinity, alkalinity, calcareousness, very less neutral pH and soil erosion near foot hills and bank erosion along the river due to shifting pattern of river. The northern central part of study area has moderately calcareous. Most of gangatic plain is slightly alkaline and plateau region is slightly acidic. Soil salinity and sodicity are found in whole gangatic plain except along the river where bank erosion is more prominent feature. The proper management of soil by using mechanical and agronomical measures can reduce this problem by using the private-public participation.

6. Future Scope

The result of the above will be of immense value in formulation of micro-level plan and implementing the same. In addition, it is of value in monitoring the development efforts as well as improving the environmental conditions of the study area for the sustainable development.

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Author Profile

Dr. Dilip Kumar (M.A, M.Phil, Ph.D.) is an Assistant Professor at the University of Delhi in India, where he teaches at the Department of Geography of Shaheed Bhagat Singh (Evening) College. He has more than 15 years of an experience and specialized in Remote Sensing and Geographic Information System (GIS) applications in Geography. He also teaches Physical Geography, Geomorphology, Climatology and Geography of Natural resources. Recently, he and co-author Dr. Ranjeet Kaur published a book 'Remote Sensing' with A.K. Publications in New Delhi, India. Dr. Kumar also co-authored three volumes in the 'Rainwater Harvesting and Utilisation, Blue Drop Series' for the United Nations Human Settlements Programme (UN-HABITAT). He has credited more than 15 research papers in leading International and national journals and books related to remote sensing and GIS applications. As a consultant on Geographic Information System and Remote Sensing Dr. Kumar has contributed to many research projects and coordinated several workshops and conferences. He has also participated and presented several research papers on spatial information technology at International and national platforms in India and abroad. For over 13 years, he has a life membership of prestigious associations including the Indian Society of Remote Sensing (ISRS), the Association of Geographic Society (AGS) and the National Association of Geographers (NAGI) in India.