J. Hum. Ecol., 14(6): 451-455 (2003)
PRINT: ISSN 0970-9274 ONLINE: 2456-6608
DOI: 10.31901/24566608.2003/14.06.06

Remote Sensing Based Management of Degraded Soil Due to Brick Industry for Sustainable Development – A Case Study

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INTRODUCTION

Soil is basic to life on earth. Increasing population and human interventions are responsible factors for environmental degradation via fast urbanisation, and industrialisation. Brick kiln industry prevailing in SSW of Jawaharlal Nehru University (JNU), New Campus, New Delhi, is a major factor for land and soil degradation in the area. Soil degradation is defined as a decrease in soil quality as measured by changes in soil properties and processes, and the consequent decline in productivity in terms of production now and in the foreseeable future while land degradation is a composite term describing the aggregate diminution of productive potential of land. A degraded land may be productive for another aspect e.g. as an economic resource, depending upon site but this is not true for degraded soil. Soil degradation affects composition of fertile top-soil and changes soil properties which are inter-linked. Average fertile top soil composition by volume is: mineral-45 % plus organic matter-5 % makes solid portion; and air-25 % plus water- 25 % constitute pore space. There are many brick kilns in the study area. These brick kilns appear as semi-circular white patches in the SPOT imagery because of maximum reflectance from dry soil due to repeated heating (Yadav, 1994). Soil is supposed to have increased reflectance between 0.4 to 1.1 micrometer wavelengths (Prasad, 1990). Land and soil degradation processes are site specific. So, it is essential to characterise and map the degraded areas because of site-specific development (Raina, 1994) and management plans could be made.

Fire alters soil properties, nutrients (Christensen,1995) and parameters which results from several processes, including vaporization, gasification (oxidation), ash convection, soil leaching, and accelerated erosion. Consequently, changes in vegetation, soil constituents, hydrology, and geomorphic processes occurs. Repeated thermal impact of fire alters soil microbiology which is essential aspect in soil fertility. The extent of such changes depend on fire intensity, soil drainage, topography, climate, and patterns of recovery. Fire strongly influence the cover of species (Howe, 1995). Degradation affects the productivity (Lutz, 1994) and this may be assessed in a number of ways. First, nutrients are lost in sediment and run-off. Generally, those nutrients associated with organic matter (N and P) and the cation exchange of soil colloids (K and Ca) are most at risk (Stocking, 1995). For normal fertile agricultural soil, N, P and K values are 0.5-1.5 %, 0.01-0.2 % and 0.02-0.2 % (Allen, 1989) respectively. pH of organic soil (normal fertile soil) has range between 5.5 to 6.8. Secondly, water is lost to the soil. As soil degrades, its infiltration capacity worsens and consequently, there is drastic change in depth to water level. Few selected herb and shurb species can grow on burnt soil due to brick industry (Yadav, 1997). Removal of plants cover and litter exposes soil to increased kinetic energy of rain drops, causing soil movement. Soil fertility signifies the inherent capacity of a soil to supply nutrients to plants in required chemical forms, adequate amounts and proper proportion.

Sustainable development is defined as development of natural resources to meet the immediate need of the present population and the requirements of future generations without any way endangering the ecology and environment. Sustainable development of natural resources is based on maintaining the fragile balance between productivity functions and conservation practices through monitoring and identification of problem of area (Rao, 1991). Mapping and assessment of degraded soil opens way for its management. Sustainable development process ensures in reduced degradation of the land, soil capabilities

(Kale,1992). Domestic waste can be filled in brick klin pits and greenary can develope with little effort. Bricks from fly-ash,usar soils (Salt affected) and flood prone area are some of the alternatives for restoration and management.

STUDY AREA

The area of study lies, in South Delhi, between latitudes 28^0 30’ 00’’ to 28^0 32’ 30’’ E and longitudes 77^0 7’ 30’’ to 77^0 10’ 00’’ N. The study area falls in the survey of India topographical sheet No. 53 H/2. The physiogeographic conditions of the area are influenced by River Yamuna and Aravalli range mainly. The topography of the area is highly uneven with developed drainage system.

DATA USED AND METHODOLOGY

Data used in the study are (i) SPOT Multispectral F.C.C. on 1:25,000 scale (Path:207; Row:293; Date: 09-11-1987) (ii) SPOT Multispectral C.C.T. (Path:207; Row:293;

Fig.1 Environs of South Delhi Region
(Inferred by Spot data with limited field checks)

Legen

S	BURRIED PEDIMENT PLAIN (SHALLOW)	B	BURRIED PEDIMENT PLAIN (medium)
B	BARREN LAND	PL	PEDIMENT INSELBERG
CL	CLAY	V	VEGETATION
WL	WATER LOGGED		BRICK KILN
W	WATER BODY		BUILT UP AREA
	ROAD		RIVULETS
	FOLD		LINEAMENT
DH	DENUDATION HILL		

Date:09-11-1987) (iii) Survey of India topographical sheet No. 53 H/2 on 1:25,000 scale (iv) Delhi guide map on 1:25,000 scale and intensive field surveys.

SPOT F.C.C data, was visually interpreted based on the image interpretation elements, like tone, texture, pattern, association, etc., to study the biogeological aspects of the area, which was correlated with digital enhanced SPOT C.C.T. data. The interpreted information finally transferred to the base maps prepared from Survey of India topographical sheet No.53H/2 on 1:25,000 scale. Delhi guide map was used for field traverses for collection of ground water depth data and soil samples.Total NPK content and pH were estimated as described by Okalebo et al. (1993) for soil samples collected from 20 sites adjecent to 5 brick kilns (numbered 1 to 5 in Fig. 1) in brick kiln complex.

RESULTS

Remote sensing techniques using satellite imagery coupled with soil analysis and field studies were followed for assessment and management of soil degradation due to brick kiln industry through physiographical approach and direct approach. Interpratation of SPOT F.C.C. imagery of South Delhi region shows 42 white patches as brick kilns (main factor for soil degradation) in the south of JNU, new campus and east of Delhi Ridge (Fig.1). Each brick kiln appears as semicircular with very high albedo. The albedo (white patches) are areas of disused and used brick kilns which are in operation since last 50 years approximately as is evidenced by survey of India toposheet also. The mean dimension for each brick kiln is 87 m x 28 m x 9 m. Thus, brick kilns occupied an area of approximately 4.29 square Km. where soil is completely burnt, and about 3.2 square Km. area around these kilns is also adversely affected. Hence, brick kiln complex covers about an area of 7.5 square Km. In degraded soil, moisture content as well as infiltration capacity has changed as it is inferred in hydromorphpgeological map. Soil is completely degraded in this area. Few selected herbaceous and shurbaceous species like *Boerhavia, Calotropis, Croton sparsiflorum, Cynodon dactylon, Datura, Eragrostiella, Euphorbia hirta, Ichnocarpus, Pycreus, Saccharum, Tephrosia, Triantchema portulacastrum, Tribulus terrestris* occur as secondary succession on burnt soil. The random digging of soil around brick kilns for brick making was found up to a depth of 5 to 15 feets. Additionally, an area of about 1.8 square Km. adjacent to brick industry is also affected but crops like jowar and vegetables are grown, though production is almost half in comparision to the normal fertile soil.

Soil degradation, in turn, affects productivity. As soil is degraded, crop yields decline. Depletion of nutrients, damage to physical and chemical properties of soil, or reductions in its capacity to retain moisture reduce fertility and productivity. The effect of nutrient loss on productivity, for example, depends on the initial stock of nutrients and on their rate of regeneration. Total NPK content has been estimated in and around five brick kilns (numbered 1 to 5 in Fig. 1) and found highly reduced (Table 1) in the brick kiln complex as compared to normal agriculture soil (organic soil). Same is true for other nutrients (elements) also. Because of phyco-chemical changes, pH has changed to alkaline.

Changed soil texture because of repeated heating doesn't permit the rain water to infiltrate to form the groundwater. There is no sustainable development without groundwater management. Hundreds of small groundwater structures like bore wells and dug wells are constructed for the supply of water in brick kilns and their labours, consequently, this further extracts the least available ground water formed by recharge from a distant area. The resultant effect is lowering down of depth to water level and the area emerged as unfertile land which was highly productive and fertile area prior to brick kiln industry. Water depth level in and around study area has gone down. It is evident by the depth to water level data of R. K. Puram (sector IV) where water level has gone down from 4.58 m. to 10.59 m. below ground level from 1978 to 1987. Similarly, in Munirka area water level has gone down from 15.90 m. to 20.76 m. and in Masudpur, which is SSW of these areas, from 5.53 m. to 8.93 m.

Pits created by brick industry can be filled with solid waste generated in and around areas. Economics for management depends on many factors like extend and intensity of degradation, location of degraded site etc. To fulfil 42 brick kiln

Table 1: Estimated NPK content and pH of soil in dis-used brick kilns

Brick kiln No.	*Sub-sites**	*Total N (%)*	*Total P (%)*	*Total K (%)*	*pH*
1	I	0.166	0.041	0.017	8.32
	II	0.183	0.081	0.013	8.00
	III	0.166	0.105	0.175	7.77
	IV	0.266	0.117	0.243	7.40
2	I	0.163	0.039	0.031	7.98
	II	0.190	0.033	0.019	8.01
	III	0.216	0.117	0.113	7.77
	IV	0.193	0.091	0.189	7.32
3	I	0.166	0.071	0.039	8.42
	II	0.187	0.017	0.190	8.05
	III	0.211	0.088	0.247	7.59
	IV	0.266	0.133	0.243	7.34
4	I	0.161	0.010	0.011	8.01
	II	0.201	0.093	0.070	7.81
	III	0.197	0.131	0.181	7.87
	IV	0.270	0.181	0.211	7.11
5	I	0.169	0.089	0.027	8.13
	II	0.193	0.073	0.133	7.93
	III	0.246	0.093	0.171	7.42
	IV	0.203	0.133	0.198	7.01
Normal organic soil		0.5-1.5	0.01-0.2	0.02-0.2	5.5-6.8

* Sub-site I is inside the brick kiln.
Sub-site II is 30 m. far from centre of brick kiln.
Sub-site III is 50 m. far from centre of brick kiln.
Sub-site IV is 100 m. far from centre of brick kiln.

pits (each with dimension 87 m x 28 m x 9 m), 21924 cubic meter solid waste is required; and if one truck with capacity of 18 cubic meter solid waste costs Rs. 100, then a total amount of Rs. 121800 is required to fulfil all 42 dis-used brick kiln pits with general domestic solid waste which is not harmful to cause ground water pollution. This waste may be acidic or basic in nature and further research is required. Some plant species like *Anogeissus pendule, Prosopis juliflora, Eucalyptus camaldulensis* etc. are recommended in the area because these species can grow well in acidic as well as basic soils.

Fertile soil from adjacent area which are under compulsion and unavoidable for construction can also be spread in 3 to 4 feet thick layer over some brick kilns and crops like wheat and some vegetables etc. can grow with resonable effort and proper water management. If fertile soil of about one meter thick from other site is spread then 2436 cubic meter soil is required; and cost will depend upon the location of site from where fertile soil has to be taken. This process was done for two brick kilns successfully in study area. Other alternatives for this degraded soil management include bricks from fly-ash, usar soils (salt affected), flood prone areas and strict administration is required aginst brick industry as it destroy soil fertility and productivity.

CONCLUSION

Mapping of satellite data is basic and essential requirement for management of degraded soil due to brick industry which prevails SSW of Jawaharlal Nehru University, New Delhi (India). Remote Sensing data coupled with analytical and field based data are useful in proper planning for management of degraded soils. Interpretation of satellite imagery recognises brick kilns spatially that open way for management using other data towards sustainable development in the area. Such interdisciplinary approach for management of degraded soil could be useful for any area/ location.

KEY WORDS Soil Management. Remote Sensing Data. Sustainable Development.

ABSTRACT Increasing population is degrading land and soil resources by industrialisation, urabanisation etc. This paper emphasises on soil degradation due to brick industry and possible alternatives for sustainable development. SPOT data is useful for identification, mapping and thus for management of degraded soil due to 42 brick kilns in SSW of Jawaharlal Nehru University (JNU), New Delhi. Repeated heating by brick industry has reduced soil fertility. NPK (nitrogen-phosphorus-potassium) content has been estimated and found highly reduced due to gasification. Due to thermal effect by brick industry, N, P and K values have highly declined as low as 0.161 %, 0.010 % and 0.011 % respectively. Fertile acidic soil has changed into infertile alkaline soil. Water level has been gone down because of operational impact of brick kilns. Reduced soil moisture content too allow succession of limited herb and shurb species. Preventive measures for degraded soil is also one approach towards management of degraded soil. Domestic waste dumping in disused brick kiln pits and greenary development, bricks from usar soils (salt affected), fly-ash, flood prone area etc. are some possible alternatives for sustainable development in study area. Some plant species can grow well in acidic and alkaline soils to manage degraded soil due to brick industry.

ACKNOWLEDGEMENT

The author wish to thank Prof. (Dr.) M. Bhattacharya, Head, Department of Community Health Administration and Col. (Prof.) M. C. Kapilashrami, Director, National Institute of

Health and Family Welfare (NIHFW), New Delhi for inspiration and encouragement.

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