RESEARCH PLAN PROPOSAL

GEOENVIRONMENTAL PROFILING OF ECOLOGICALLY RESTORED CHAKSU BLOCK OF RAJASTHAN THROUGH GEOSPATIAL TECHNOLOGY

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INTRODUCTION

Ecosystems vary greatly in size. Some are generally robust and do not get affected even by minimum level of human disturbance, whereas some are very fragile and are quickly destroyed by human activities which have disturbed the balance of the ecosystem and have produced serious effects eventually.

Traditional management of ecological systems focuses on products or services desired by people, with emphasis on marketable commodities. As a result, ecosystems are overusedand poorly understood by man. Realizing the urgency to conserve our nature,a different perspective and sustainable approach to ecosystem management is required which will not only lead to a better environment but will help us to get back to the old yet similar situation.

Restoration Ecology

According toWilson (1992), "Here is the means to end the great extinction spasm. The next century will, I believe, be the era of restoration in ecology."

The most recent and effective approach to this kind of disturbance is the practice of ecological restoration which is defined as *a practical management strategy that restores ecological processes to maintain ecosystem composition, structure and function.*Ecological restoration is the scientific study of renovating damaged ecosystems through human interference. Anthropogenic disturbances can modify or change natural habitat conditions and/or ecological functions; and can even disturb natural events and cycles (like suppression of wildfires and prevention of periodic flooding).

Ecological restoration aims to rebuild, initiate or speed up the recovery of an ecosystem which has been damaged or degraded. Restoration activities may be designed to replicate a pre-disturbed ecosystem or to create a new ecosystem where it had not previously occurred.Successful restoration requires a full understanding of the ecological paucity in the ecosystem, a defined course of scientific study through experimental management and the development of a program for carrying out restoration.

Restoration can be achieved by conservation of biodiversity through the application of religious values which has often proved to be an effective means to protect biodiversity and to conserve the natural integrity of the environment. Religiously safeguarded forests continue even today, in some of the remote corners of the country (Gadgil, 1985).

The other efficient strategy is the adoption of joint forest management which is a collective endeavour of the people and the government in the protection and management of forests.

Restoration ecology is the study of renewing a degraded, damaged, or destroyed ecosystem through active human intervention. Restoration ecology particularly refers to the scientific study that has evolved recently in the 1980s. Land managers, common people,*etc* have been practicing restoration for many years (Anderson, 2005).

It was defined as an attempt to create an ecosystem similar to the original or predisturbed ecosystem. It can include introduced species that respond similarly to the native species which they replace (Wade and Chambers 1992). A general dictionary definition of restoration (Woolf, 1977) is: “A bringing back to a former position or condition”.The Society for Ecological Restoration defines ecological restoration as an “intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability” (SER, 2004).

According to Cairns(1988) restoration means returning of pre-disturbed aquatic functions and its related physical, chemical, and biological features, with theintention of imitating a natural and a self -regulating/perpetuating system which integrates ecologically with the surroundings and the functions of the wetlands.One of the major consequences of degradation is the habitat loss which leads to elimination of the species and pose a serious threat to their survival. Loss of habitat is the major cause of both species extinctions (Wilson, 1988) and ecosystem service decline (Daily *et al*. 1997). Conservation of currently viable habitat and restoration of degraded habitats are the two ways to undo the process of habitat loss. In addition, the degree of degradation sets practical limits on what types of restoration goals are practical (Werner, 1987).If the factor that cause the system degradation does not cease, *e.g*., if atmospheric deposition continues, then the best that can be hoped for is system rehabilitation, rather than complete restoration (Lenz and Haber, 1992).

The goal of ecological rehabilitation is to use native species to re-establish a stable ecosystem capable of replacing the ecological functions of the original (Newton, 1992).The goal is to follow the structure, function, diversity and dynamics of the specified ecosystem" (Newton, 1992). Planting for conservation or restoration objectives is done for the same reasons as planting for timber production or other objectives as it allows greater control of species composition and spacing, and can result in a forested area more rapidly than in case of no action being taken (Bradshaw 1987, Harmer and Kerr,1995).
The practice of ecological restoration includes broad range of tasks such as control of soil erosion, reforestation, eradication of non-native species and weeds, re-vegetation of disturbed areas, reintroduction of native species and habitat improvement for targeted species. The study of restoration ecology has become a popular and a separate discipline in the last twenty years (Young *et al*., 2005).
Restoration activities may also be designed to re- establish natural disturbance regimes.The objective for any restoration program should be rational and should target individual areas, definite to degradation problems. The restoration program should direct all aspects of the ecosystems, including habitat restoration, elimination of undesirable species, and restoration of native species, from the ecosystem perspective. This often requires reconstruction of the physical conditions-chemical adjustment of the soil and water, biological manipulation, reintroduction of native flora and fauna.

Such a phenomenon has been observed in the Chaksu block of Jaipur district where a number of villages have been restored after the land became degraded when it was hit by flood in 1981 by the action ofDhundriver.Forest department played a pivot role along with the natives in the restoration process in order to improve the socio-economic condition of the people and to live in a more sustained and reformed environment.

As the conventional methods of extracting information are time consuming and expensive, theadvancement in theremote sensing technology allows data to be collected and analyzed accurately at high spatial and temporal resolution with repetitive coverage. Moreover, it can be used as a monitoring tool to assess the effectiveness of restoration and conservation programs of the areas, where direct and regular physical monitoring is difficult. Thus,pre and post restoration data can be compared effectively through geospatial technology.

GEOSPATIAL TECHNOLOGY

Geomatics also known as geospatial technology/geomatics engineering is the study of gathering, storing, processing and delivering geographic information or spatially referenced information. It includes tools and techniques used in land surveying, remote sensing, cartography, Geographical Information System (GIS), Global Positioning System (GPS), galileo, compass, photogrammetry, geography and other related forms of earth mapping.

In our study, we are making use of the two most popular tools and techniques to study the geo-environment which are known to be remote sensing and GIS. Geo- environment or environmental geology is the is the scientific study of humans interacting with geological environment.

Geographical Information System (GIS) is a system designed to capture, store, manipulate, analyze, manage and present all types of geographical data. It is an information system that integrates, store, edit, analyze, share and display geographic information for informing decision making

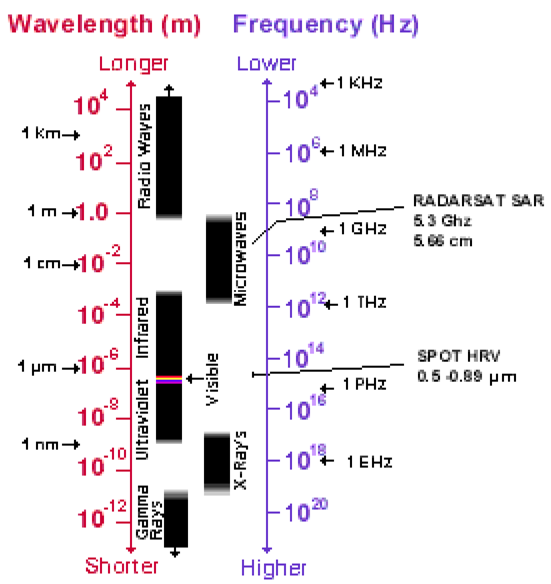
Remote Sensing “is the technology of measuring the characteristics of an object or the surface from a distance”. In the case of earth resource monitoring, the object or surface is on the land mass or the sea, and the observing sensor is in the air or space. Remotesensing is the acquisition of information about an object or phenomenon without coming into physical contact with the object. It generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals *e.g* electromagnetic radiation emitted from aircraft or satellites (Schowengerdt, 2007, Schott,2007)**.**
To acquire knowledge about a remote object by an observing sensor, there must be a flow of information between the object and the observer. In remote sensing case, the carrier is the ElectroMagnetic Radiation (EMR). The main elements in the process of data collection in remote sensing are the object to be studied, the observer or sensor, the EMR that passes between these two, and the source of the EMR. The process of remote sensing involves an interaction between incident radiation and the target of the interest, it also involves the sensing of emitted energy and the use of non- imaging sensors.

Passive and Active Sensing

There are two kinds of remote sensing (Liu and Mason, 2009)

- ✓ Passive sensors sense natural radiation that is emitted or reflected by the object or surrounding area being observed. The most common source of radiation measured by passive sensors is the reflected sunlight. In environmental remote sensing, the sensors used are adjusted to specific wavelengths from far infra-red(IR) through visible light frequencies to far ultra violet(UV). The outputs of data analysis from remote sensing are false colour images which differentiate small differences in the radiation characteristics of the environment being monitored.

- ✓ Active remote sensing emits energy and uses active sensor to detect and measure the radiation that is reflected or backscattered from the target. LIDAR is often used to acquire information about the topography of an area, especially when the area is large and manual surveying would be expensive or difficult. Different parts of the electromagnetic spectrum can be used in the remote sensing. One of the most popular and common region is -*Visible wavelengths and reflected infrared (imaging spectrometer)*: Remote sensing in the visible and near infrared (VNIR) wavelengths usually falls into the passive category. In this case, the sun is the source of the irradiance on the object being observed. The sensor gathers the solar radiation which is reflected by the object. Active remote sensing occurs at these wavelengths only in the rare case where an aircraft carries a laser as the source of illumination.



Each part of the spectrum has different characteristics and gives rather different information about earth's surface. Different surface covers (vegetation, water, soil, etc) absorb and reflect differently in different parts of the spectrum. Different wavebands in the electromagnetic spectrum therefore tend to be useful for different purposes. The sensor may be sensitive to a single portion of the electromagnetic spectrum (*e.g*. the visible part of the spectrum, like panchromatic film which is sensitive to the same wavebands as our eyes). On the other hand, it may be able to detect several parts of the spectrum simultaneously which is called multispectral sensing.
The process of remote sensing involves the interaction of the target(object, event, surface or phenomenon) with the radiation.

<u>Radiation target interaction</u>

Radiation which is not absorbed or is scattered in the atmosphere can reach and interact with the earth's surface. There are three forms of interaction that can take place when energy strikes, or is incident upon the surface. These are absorption, transmission and reflection. The total incident energy will interact with the surface in one or more of these three ways. The proportions of each will depend on the wavelength of the energy and the material and condition of the element. Absorption occurs when radiation is absorbed into the target, while transmission occurs when radiation passes through the target. Reflection occurs when radiation rebounds off the target and is redirected. Measuring the radiation reflected from targets is most important in remote sensing.

This technology helps to study geo-environment of an area whose basic components include the water, soil and vegetationof the area.

Vegetation

Chlorophyll strongly absorbs radiation in the red and blue wavelengths but reflects green wavelengths. Leaves appear "greenest'' in the summer, when chlorophyll content is at its maximum. In autumn, there is less chlorophyll in the leaves, so there is less absorption and proportionately more reflection of the red wavelengths, making the leaves appear red or yellow (yellow is a combination of red and green wavelengths). The internal structure of healthy leaves act as excellent diffuse reflectors of near-infrared wavelengths. If our eyes were sensitive to near-infrared, trees would appear extremely bright to us at these wavelengths. In fact, measuring and monitoring the near-IR (NIR) reflectance is one way that scientists can determine how healthy or unhealthy vegetation is.Vegetation could be differentiated using NIR sensors, *e.g.* deciduous trees have a higher reflectance than the coniferous in NIR.

Water

The transmission of the water is significant in the visible region of the spectrum and both the absorption and the reflection are low in this region. The absorption of water rises rapidly in the NIR where both transmission and reflection are low.

Soil

Soil has very different characteristics in the visible and near infra-red wavelength region(VNIR). The increase of reflection with wavelength in the visible region is consistent with the human eye's observation that soils can have a red or brown colour to them.

By measuring the energy that is reflected or emitted by targets on the earth's surface over a variety of different wavelengths, a spectral response for that object can be built. By comparing the response patterns of different features in different wavebands, we may be able to distinguish between them. For example, water and vegetation may reflect somewhat similarly in the visible wavelengths but are almost

always separable in the infrared. Spectral response can be quite variable, even for the same target type, and can also vary with time (*e.g.* "greenness" of leaves) and location.
This study aims at assessing the geo-environment of Chaksu area before and after restoration. In conclusion, remote sensing and GIS technologies coupled with computer modelling are useful tools in providing a solution for future geo-environmental resource planning and management to government especially in formulating policy related to their quality.

OBJECTIVE OF THE STUDY

- ✓ To find out the impact of 1981 flood on the geo-environment of Chaksu.
- ✓ To analyse the impact of restoration on the geo-environment of the study area.
- ✓ To comparatively analyze the post disaster and post restoration data obtained through geospatial technology.
- ✓ To analyse the physico-chemical parameters of the restored soil and compare them with the geospatial data of the unrestored soil.

METHODOLOGY

Study area

Chaksu (also known as **Chatsu**) is a city and a municipality in Jaipur district in the state of Rajasthan, India. Chaksu is located at [26.60°N 75.95°E](). It has an average elevation of 297 m (974 ft).

Identification of the area on the toposheet

- ✓ It involves the marking of the area to be studied on 1:50,000 scale toposheet/topographical sheet by Survey of India.

Site visit

- ✓ Visit to the site is done to select the most ideal restored village which is the best representative of the restoration work carried out there. Two model villages will be selected for the study.

Soil sample collection

- ✓ Soil sample will be collected at various depths(10-60 cm), in pre-sterilized polypropylene lock bags. The soil sample will be analyzed for various physico-chemical characteristics like pH, electrical conductivity, organic carbon, organic matter, available phosphorous, available potassium and available nitrogen to get a comprehensive insight of the restored area.

Physico-chemical characterization

- ✓ The area under restoration will be analyzed for soil physico-chemical characteristics like pH,electrical conductivity, organic carbon, organic matter, available phosphorous, available sodium and potassium and available nitrogen. Organic carbon will be measured by the procedure given byWalkley and Black(1934), exchangeable potassium and sodium by flame photometry method,calcium and magnesium of the soil using theVersenate method, total nitrogen content by the Kjeldahl method(AOAC,1980), phosphorous uptake by Sodium Bicarbonate (Olsen *et al.*1954) method,soil pH will be measured by the Bates procedure(1954).Physical parameters like water holding capacity, texture and moisture content (Oven method) will be too analysed. These characteristics of soil will give us an idea about the soil fertility(Woomer*et al.*1984).

Interpretation of the post disaster data

- ✓ Study of the old data of the soil, surface water (potential sites) and vegetation, through geocoded data/georeferenced data of early eighties period,after the flood devastation. Ground water data for pre-restoration period will be procured from Central Ground Water Board(CGWB), Jaipur.

Construction of maps of post flood period

- ✓ The preparation of the soil, vegetation cover and surface and ground water table maps of the pre-restoration period for better understanding will beobtained by the satellite data.

Interpretation of the latest available data (post restoration)

- ✓ The study of the latest data through IRS-1C satellite imagery preferably for post restoration period (Indian Remote Sensing satellite series designed byIndian Space Research Organization (ISRO)).This satellite has resolution of 5.8 m in panchromatic region (Black and white) and LISS-III sensor which has a resolution of 23.6m. Panchromatic data with LISS-III data will be used for the study.

Construction of maps of post restoration period

- ✓ Preparation of the maps on vegetation cover,soil quality, ground water and surface water, for post restoration period.

Comparative analysis

- ✓ Analysis and interpretation of the results will be done by comparing pre and post restoration data.

Thesis writing

- ✓ Compilation of the above mentioned information and results in the form of writing as thesis.

Schematic representation of the work plan with time duration:

Marking of the area to bestudied on 1:50,000 scale toposheet.Visit to the site. (*2 months*)

⇓

Collection of the soil sample.Physico-chemical analysis of the soil and study of the potential site of the surface water procured through geocoded data (*3 months*)

⇓

Study of the old data of soil, surface water (potential sites) and vegetation obtained, through geocoded/ georeferenced data of early eighties period, after the flood devastation(ground water data for pre restoration period will be procured from CGWB) (*3 months*)

⇓

Preparation of the soil, vegetation cover and surface and ground watertable maps of the pre-restoration periods of the study area (*2 months*)

⇓

Study of the latest available data obtained, through IRS-1C satelliteimagery (preferably Panchromaticdata having 5.8 m resolution and LISS-III sensor having 23.6m resolution) for post restoration period (*3*

⇓

Preparation of the vegetation cover, soil, surface and ground water table maps of the post restoration period (*2 months*)

⇓

Comparison of pre and post-restorationdata. Analysis of results obtained-*3 months*

Writing of thesis (*5months*)

REVIEW OF LITERATURE

Restoration Ecology

- The beginning of the restoration ecology dates back to 1997 when Bradshaw quantified that mining causes soil damage and its destruction by the removal of the desired mineral material. This led to the loss of original soils and propagated the need of restoration. He proposed that the process of natural succession helps in achieving restoration and building up functioning soils for *e.g.*some species which can fix and accumulate nitrogen.Moreover, introducing plant species artificially for the restoration process will be required. He further added that in mined terrains, extreme soil conditions prevent plant growth which must be recognized first; otherwise the whole restoration process may either not begin, or may not succeed after few years.

- This type of work was further carried on by Harrington(1999) who claimed that many of the earliest large-scale tree plantings which were made were now referred to as "restoration or conservation" goals and said that the forest restoration activities may be needed when ecosystems are disturbed by either natural or anthropogenic forces. He emphasisedalthough forest restoration projects can include many activities, planting is almost always a key component.

- Bradshaw (2000) further supported his views through his study and conveyed that the damage to soil and vegetation caused by mining, is usually extreme, unless prevented by careful planning, because the original ecosystems have had to be grossly disturbed or buried by the mining process. He even declared that in nature this takes place by the well-known processes of primary succession, without human assistance which is in the interest of economy and leads to the maintenance of our natural resources. Knowing this we are then able to include a natural approach in land reclamation effectively.

- In addition,Antonio and Meyerson(2002) suggested the idea of introducingexotic species during restoration and they advocated consideration of exotic species in the greater context of community structure and succession. A greater understanding of the ecological role of introduced species might help to reduce debate surrounding their purposeful use in restoration.

- The turning point came whenSelvam*et al*. (2003) made the use of remote sensing to analyze the impact of restoration of the degraded areas of*Pichavaram* mangrove wetland by comparingthematic mapper (TM) digital data of 1986 (before restoration)and LISS III digital data of 2002 (after restoration).The analysis indicated that the area under the mangroveforest cover has increased by about 90% which was made a success by the sciencebased,communitycentred and process-oriented approach in collaboration with the ForestDepartment, Government of Tamil Nadu and participationof local mangrove user-communities.

- Further expanding the work, Walsh *et al***.**(2005) did a remarkable study on the restoration of streams degraded by urbanization.

- The mining industry in China is responsible for producing large amount of wasteland, water pollution as well as other environmental changes. Li(2006)explained that metal mined derelict land is more metal toxic, deficient of macronutrients and is tougher for re-vegetation. To achieve the restoration of the mined land, several amelioration techniques were proposed and tolerant plant species were tested for reclamation process. Five hyper-accumulator species have been reported in China for potential use in phytoremediation.

- Ecological stream restoration is bringing back of the stream ecosystems structure and function to a state which is reflective of its pre-disturbed form. Murdock(2008) focussed on applying ecological engineering principles which are used in stream restoration projects. He laid emphasis on understanding the physical, chemical and biological constraints on developing stream's communities and understanding the importance of stream organism in implementing and constructing a successful restoration project.

- The concept of using remote sensing became strong when Malmstrom*etal.* (2008) explored its use tocompute the effects of native grass seeding and recommendedburns on ecosystem forage provisioning services within aCalifornia (U.S.A.) rangeland landscape.Remote sensing analysis documented gains and lossesin forage provisioning services due to restoration efforts. The results demonstrated the degree to whichinvaded grasslands can be resistant to change and suggestedthat increasing the functional complexity of restorationmight help to increase forage availability and reduceopportunities for weed reinvasion.

- Laub and Palmer (2009)have drawn the attention of the people towards the degraded condition of the rivers and have stated the need of restoration ecology in the management of rivers worldwide. They discussed three steps: planning, implementation and monitoring for river restoration in human- dominated systems.

<u>Geospatial technology</u>

Water

- Bhavsar (1984)recognized the importance of using remote sensing technology in India to gather information quickly in many fields of resource management. It is particularly useful in surface water resources, flood plain mapping, monitoring of sediment, water pollution, water management and ground water targeting.

- The aim of the study conducted by Gupta *et al.*(1997) was to develop a water harvesting strategy in the semiarid area of Rajasthan, India using the geographic information system(GIS). Information on topography and soils had been digitized to form GIS database. Land cover information was derived from remote sensing satellite data(IRS-1A) in the form of the Normalized Difference Vegetation Index(NDVI). Six basins were delineated using a Digital Elevation Model(DEM) and total acreage in different slope classes were estimated. These maps were used as an input to derive a modified Soil Conservation Service(SCS) runoff curve number and this SCS runoff curve number model was applied to estimate runoff depth of individual storms and summed up to derive annual runoff potential for each basin. Subsequently, basin for rain water harvesting were prioritized based on runoff generation potential, availability of agricultural land, the suitability for constructing water harvesting structures etc. The results demonstrated the capability of GIS and its application for water harvesting planning over large semiarid areas.

- The research work conducted by Jain(1998) concentrates on locating favourable zones for ground water targetingusing IRS-LISS-II data. Hydromorphological lineament, lineament density and ground water prospect maps were prepared through visual interpretation of geocoded images on 1:50,000 scale and Survey of India topographical sheet/maps of the same scale. The resulting base line information was integrated for evaluating ground water potential of mapping units.

- The work conductedbyAsadi*et al.* (2007)on thegroundwater quality in Hyderabad hold a special significance and needs great attention of all concerned since it is the major alternate source of domestic, industrial and drinking water supply. The study monitors the ground water quality, relates it to the land use / land cover and maps such quality using Remote sensing and GIS techniques for a part of the city. Remote sensing and GIS are effective tools for water quality mapping and land cover mapping essential for monitoring, modelling and environmental change detection .GIS can be a powerful tool for developing solutions for water resources problems for assessing water quality, determining water availability, preventing flooding, understanding the natural environment, and managing water resources on a local or regional scale.

- Ramakrishanan*et al.*(2007) did a valuable work on the efficacy of remote sensing and GIS tools for identifying suitable sites for check dams, percolation ponds and subsurface dykes for watershed management. Thematic layers such as landuse/landcover, lithology, soils, slope, rainfall and drainage were generated using LISS-III, PAN (IRS-1D), LANDSAT Thematic Mapper(TM) and collateral data. Runoff potential for different combinations of land use and hydraulic soil groups was computed and classified into 3 classes. A potential site suitability map for water harvesting/ recharging structures was derived following an analytical hierarchy process. The analytically derived potential site suitability map was confirmed in the field and the accuracy of the prediction was estimated on the basis of proximity between derived and field validated sites. The sites derived for check dam, percolation pond and subsurface dyke were found to be accurate in 75% of the cases.

- This kind of work was further carried on by Kumar *et al.*(2008) who did a comprehensive study in Bakhar watershed of Mirzapur district, Uttar Pradesh to find the potential sites for construction of rain water harvesting structures due to increasing scarcity of the water. Various thematic maps such as land use/land cover, geomorphology and lineaments etc were prepared using remote sensing and these layers were integrated using GIS to derive suitable water harvesting site.

- To address any nation's water-relates issues, it is important to characterize and quantify renewable water resources for better management in the arid and semiarid areas. Yan *et al.* (2010) developed an integrated, remote sensing based approach to improve estimation of renewable water resources. The approach incorporated 1) extraction of spatial and temporal data using recently developed models from remote sensing data sets like Landsat Thematic Mapper, ASTER, AVHRR etc,2) also integration of the data to determine precipitation, soil moisture, reservoir volume and stages and flows in large river channels which are the key components in hydrologic processes,3) development and application of hydrologic model that simulates hydrologic processes, water usage for production and agricultural activities with GIS capability to interpret and implement multiple satellite based sensor data for model input and model caliberation. It resulted in providing estimates for potential water resources which could be used as a tool for future management optimization.

- Due to increasing demand of water, the potential sources of water are needed to be searched for and in this regard ground water resources are gaining much attention in the arid and semi-arid regions. Abdalla (2012) did a study in the eastern desert of Egypt to determine the groundwater potential in the area and the contributing parameters indicating its presence with the use of GIS and remote sensing. The result demonstrated different zones of groundwater potential and based on chemical analysis concluded that the groundwater in the area is not suitable for drinking purpose but for irrigation under special conditions.

- To further expand the work on water quality,Hammouri*et al.*(2012) carried out the studyto assess the potential sites for groundwater exploration in central parts of Jordan using Remote Sensing (RS)and Geographic Information System (GIS) tools as these can be used to detect areas with high potential for groundwater exploration. In this study, an integrated approach was implemented using GIS and remote sensing technique for locating promising areas for groundwater exploration. The main advantages of using remote sensing and GIS techniques for groundwater exploration are the reduction of cost and time needed, the fast extraction of information on the occurrence of groundwater and the selection of promising areas for further groundwater exploration This method is based on evaluating a set of hydro-logical, geological and topographical parameters that influence the natural occurrence of groundwater. As a result, a Ground water Potential Map (GPM) was generated by modelling these parameters.

- Arkoprovo*et al.*(2012) have mentioned in their study the importance of water in the development of an area. They have also talked about the scarcity of surface water resources and in this regard, productivity of ground water is high and they should be properly exploited. For this purpose, they attempted to select and delineate various ground water potential zones for the assessment of ground water availability in the coastal part of Ganjamdistrict,Orissa using RS and GIS techniques. Satellite IRS-1C LISS-III, Landsat Thematic Mapper digital and SRTM data were used to prepare thematic maps viz. Geomorphological, geological, slope, drainage density, lineament density map. It can be concluded from the work that integrated approach using RS and GIS techniques can be successfully used in identifying potential ground water zones.

SOIL

- Jackson (1993) in his study came up with the idea of using passive microwave remote sensing for measuring soil moisture. He also described soil moisture estimation algorithm and a microwave simulation model.

- Microwave remote sensing offers a distinctive capability for soil moisture observation. Remote measurements provide the possibility of obtaining frequent, universal sampling of soil moisture over large fraction of earth's surface. Microwave measurements have the potential of being largely unaffected by solar radiation and cloud cover, but accurate soil moisture estimates are limited to regions of bare soil or low to moderate amount of vegetation cover. The benefit of using passive microwave sensors is that soil moisture is the principal effect on the received signal even in the absence of significant vegetation cover. The spatial resolutions of passive microwave sensors are in the range of 10-20km. The most useful frequency range for soil moisture sensing is 1-5GHz (Njoku and Entekhabi,1994).

- Mattikalli and Engman(1997) employed the use of passive microwave remote sensing and GIS for monitoring and quantifying spatial and temporal variability of surface soil moisture over little Washita Drainage Basin, Oklahoma, USA. Daily microwave measurements were obtained from airborne ESTAR instrument at a ground resolution of 200m. Surface soil moisture values were derived from brightness temperature. For spatial analysis and to quantify temporal variations of soil moisture during the dry-down period, the data was georeferenced by GIS. Analysis of soil moisture changes with digital soils data revealed a direct relationship between changes in soil moisture and soil texture.

- Soil being the valuable resource is linked with our survival on the earth. Manchanda*et al.* (2002) have described in their paper the role of remote sensing and geographical information system (GIS) for mapping and characterizing soils at various scales. They have also discussed the spectral behaviour of soil and its components for deriving information on soil surveys.

- Barnes *et al*. in 2003further added that the increasing awareness of the spatial variability in crop production with the growing availability of yield monitors can be related to different soil properties *eg*- texture, organic matter, salinity levels and nutrient status. High spatial resolution soil property maps are needed to develop management approaches for this variability. Some of the soil properties inferred from spectral response or remotely sensed measurements include soil texture, nitrate level, organic matter content and salinity level. Ground based sensors have been used to assess soil properties. "on the go'' sensors have been developed to map soil organic matter content, electric conductivity (EC), nitrate content and compaction. Ground and image based data sources have been integrated to maximize information for soil property mapping by statistical and other models**.**

- In the study conducted by Gomez *et al.*(2008) in the Narrabri region of North Western South Wales, Australia, soil organic carbon was predicted using visible and near infra red reflectance (vis-NIR) hyperspectral proximal and remote sensing data. Soil samples were collected with an Agri spec portable spectrometer (350-2500nm) and remotely from Hyperion hyperspectral sensor on board satellite (400-2500nm). Soil organic carbon was predicted by partial least –square regression (PLSR) using both proximal and remote sensing spectra. Soil organic carbon map predicted using Hyperion data showed similarity with field observations and predictions of soil organic carbon by Agri spec data were more accurate than by Hyperion spectra at same resolution. These techniques will facilitate the operation of digital soil sampling.

- Surface soil moisture is one of the essential variables in hydrological processes, which exerts a great influence on the exchange of water and energy fluxes at land surface/atmosphere interface. Accurate estimate of the spatial and temporal variation of soil moisture is important for environmental studies. Recent technological advancement in satellite remote sensing has shown that soil moisture can be measured by variety of remote sensing techniques ranging from optical, thermal, passive microwave and active microwave measurements(Wang and Qu,2009).

- The use of remote sensing to survey the saline soil distribution for the proper management and wise use of the saline soil in Yinchuan plain of China has been performed with the use of China's HJ-1B satellite by combining the texture features using support vector classification. The result demonstrated three types of saline area – severely affected, moderately affected and mildly affected. The underlying causes were analyzed and control measures were discussed(Meimei*et al*.2011).

- Mulder *et al.*(2011) in their paper reviewed the use of optical and microwave remote sensing data for soil and terrain mapping with emphasis on applications at regional and coarser scales. Remote sensing imagery helps to support segmented landscape into homogenous soil-landscape units for mapping soil composition. The soil properties being inferred from optical and microwave data using physically based and empirical methods include mineralogy, texture, soil iron, soil moisture, soil organic carbon, soil salinity and carbonate content. In sparsely vegetated areas, successful use of space-borne, air-borne and in situ measurements using passive, optical and active microwave instruments have been reported whereas, in densely vegetated areas soil data acquisition relies on indirect retrievals using soil indicators such as plant functional groups, productivity changes and Ellenberg indicator values.

- In his paper, Saha(2011) has mentioned that traditional methods of soil quality characterization has limitation and because of it spatial and temporal variations of soil quality is required for soil's sustainable development and management. Saha has discussed the potential of microwave remote sensing for spatial estimation of various soil properties (except soil moisture) such as soil salinity, soil erosion, soil physical properties (soil texture and hydraulic properties, drainage condition) and soil surface roughness.

Vegetation

- Iverson *et al.*(1994) in their study applied a combination of landsat thematic mapper (TM), AVHRR imagery and other biogeographic data to estimate forest cover over large areas. In this method, thematic mapper data was used to classify a small area (caliberation centre) into forest or non-forest. The resulting forest cover map was then used in combination with AVHRR pixel spectral signature and the resultant regression relationship between AVHRR band values and percent forest cover is then used to extrapolate forest cover for severalhunderedkms beyond original TMcaliberation centre. The method was tested over two large regions in eastern United States.

- White *et al*. (1996)observed that burned forested areas with patterns of varying burn severity were detected and mapped by using satellite data. Middle Infrared wavelengths were useful for mapping burn severity because the land cover changes connected with burning increase reflectance in this part of electromagnetic spectrum (EMS) and other information like rate of recovery of vegetation foliage and variation of burn severity on different vegetation types could also be obtained through satellite data. The use of landsat thematic mapper data defined varying classes of burn severity because of changes in canopy cover, biomass removal and soil chemical composition. Maps of burn severity were produced and changes in satellite reflectance revealed the dynamics of vegetation and fire severity as low burn areas have lower changes in reflectance relative to high burn areas. This results as in how much site was altered due to burn and how much space is available for vegetation recovery. This satellite based technology is useful for mapping severely burned areas and the ecological consequences before and after fire**.**

- The main parameter in quantifying vegetation by remote sensing is Leaf AreaIndex (LAI) which is widely used for modelling vegetation. This study focuses on using landsat thematic mapper data and it is necessary to examine as to how vegetation index reacts to the change in climate as its applicability is subjected to local climate in different regions. Univariate and multivariate linear and non linear models were established for LAI from various vegetation indices through regression analysis. The non-linear regression models include logarithmic, exponential, power and polynomial regression (Kia-Li *et al*.2005).

- Karthikeyan*et al*. in 2010 examined that vegetation is characterized by strong absorption in the visible red wave length region and high reflectance in the near infrared region wavelengths of electromagnetic spectrum (EMR). The multi-spectral imagery generated from various vegetation indices like Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI) etc provides valuable information about an area. It is important to monitor vegetation vigour changes with respect to soil background conditions as the latter exerts considerable influence on partial canopy spectra and calculated indices. In this study, soil adjusted vegetation index (SAVI) was selected and applied for study and the analysis for the change in vegetation vigour was done for different time series. The MODIS vegetation index images were generated for red and black soils with reference to that SAVI model was created and executed in ERDAS platform.

SIGNIFICANCE OF THE STUDY

The proposed research plan embarks upon the pre and post restoration impact on the geo-environment of the study area and will enable us to have a clear picture of the impact of restoration of the degraded land.The study will also aid in comparison of the pre and post restoration data for better understanding of the effectiveness of the restoration programs.It will also help us to gain insight of the present soil characteristics to determine its quality. The study will facilitate in analysis of the post disaster and post restoration data obtained through geospatial technology. This technology has its own advantages over the conventional methods to extract information which can be used for further research projects.

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