RESEARCHERID
THOMSON REUTERS
[COTII- 2018]
ISSN 2348 – 8034
Impact Factor- 5.070
GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

COMPARATIVE STUDY OF ARCHAEOLOGICAL RESIDUES USING DIFFERENT REMOTE SENSING TECHNIQUES

Sakcham Saxena[*1], O.P. Singh[2] & G.R. Mishra[3]
[*1]Department of Electronics and Communication Engineering
[2]Amity School of Engineering and Technology (ASET)
[3]AMITY UNIVERSITY, Uttar Pradesh, Lucknow Campus, Lucknow

ABSTRACT

Remote sensing is a technique that can be utilized in monitoring and analysis of archaeological residues. There are different methods of collecting data of the archaeological residues such as ground based aerial photography and satellite based etc. In this paper the effort has been made to analyze these techniques in Indian prospective/scenario. Basically there are large number of spectrum in which these studies are being done such as ultraviolet, infrared and microwave etc. In each band spectrum, there are sensor specific applications for studying the changes occurred on the surface of the earth with the help of properties of overlying materials such as soil and vegetation canopy. On the basis of some parameters such as soil moisture, temperature and scattering coefficient, monitoring of archaeological residues can be predicted.

Keywords: *Synthetic aperture radar (SAR) , Archaeology , SAR intensity, INSAR.*

I. INTRODUCTION

Remote sensing techniques is defined as a part of science that used to gain the information which is related to the earth's surface without being physical content of object .It is usually done by sensing and recording, reflected, analyzing and connecting that information [1].

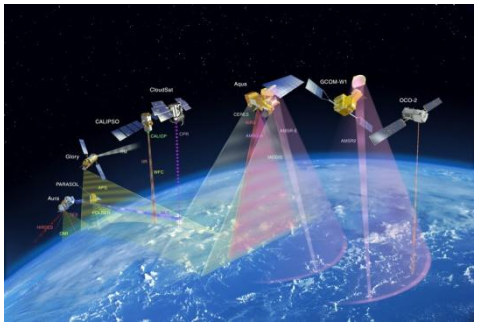

Fig.1

There is need for remote sensing which is as follows:

1. Proper collection of data.
2. Repeatability
3. Unable to reach in area.
4. Large number of information

There are certain uses of remote sensing which are as follows:

1. The researchers who want to measure the changes on the earth surface that has to be focused
2. The man who lives in forest need knowledge about the plant or trees which are growing and he also see if they are affected by any type of disease or other unnecessary effects
3. The naturalist want to detect or want to see the conditions of pollutants as oil sticks in the ocean

ISSN 2348 – 8034
Impact Factor- 5.070

4. The topography who is interested to finding out the number of valuable minerals.
5. The farmers who want to see what is the condition of his crops that he had grown earlier or they are affected by any cause either it is natural disaster cause or any man made cause.
6. The leader of the ship will find a best route through eastern costal ice packs.
7. In the fighter plane who send his team that will give the information about the size and the movement of forest.
8. The study of human settlement and their process for transformation in the remote sensing

The basic concept /principle of happening of remote sensing in any field of application has been shown in figure (A). The corresponding block diagram is shown in figure (b)

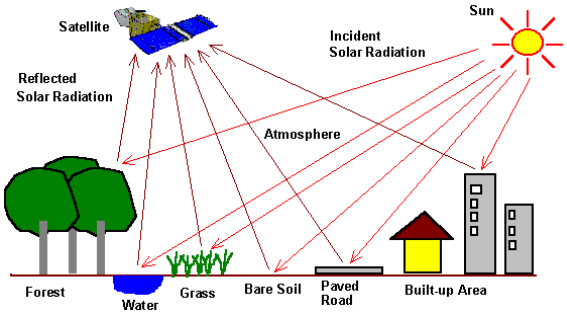

Fig (a)

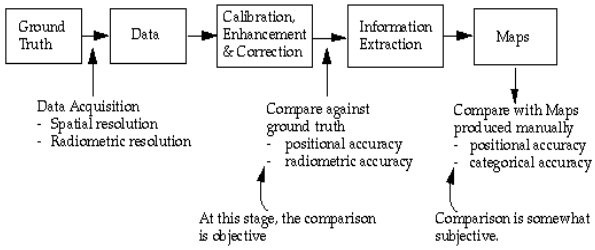

Fig (b)

Fig,2. a) Remote sensing process, b) its block diagram

The first and most important condition for remote sensing is energy produced by source or produced by electromagnetic wave. This may take place via as energy moves from target to the sensor. When the interaction with the target by atmosphere through energy is done then it may interact with the radiation of energy through atmosphere. The energy which is emitted or targeted in which the sensor, capture the electromagnetic radiation in this process [1,2,3,4]. The energy which is captured by sensor needs to be transmitted in electronics form and use for the image processing of the set of data [4,5].

The principle of remote sensing techniques tells us that the energy which is reached to the earth surface by electromagnetic wave which is reflected, transmitted or absorbed by the atmosphere. The advantage of this incident radiation is described by spectral response of the target. Then the different types of soil may vary with its impurities under various species. Electromagnetic radiation like radio waves, heat wave which are used to travel through space then the wave contains about a certain shape and its definite length then the light which our eyes "REMOTE SENSING SENSORS" which can detected by spectrum of electromagnetic in its visible manner.

ISSN 2348 – 8034
Impact Factor- 5.070

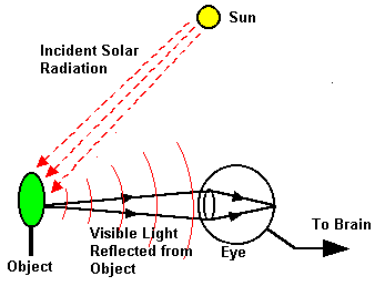

Fig.3 How remote sensing principle works

Electromagnetic Spectrum:

Electromagnetic-spectrum is that type of distribution in electromagnetic radiation through its frequency or wavelength. In all electromagnetic waves travel at the speed of light in a vaccum, in high range of frequencies, wavelengths, and photon energies...The…electromagnetic spectrum consists all electromagnetic radiation and have many sub-ranges, commonly referred to as portions, such as visible light or ultraviolet radiation. The various portions bear different names based on differences in behaviour in the emission, transmission, and absorption of the corresponding waves and also based on their different practical applications. There are no precise accepted boundaries between any of these contiguous portions, but their ranges can be overlap. The entire electromagnetic spectrum, from the lowest to the highest frequency (highest to lowest-wavelength),which-includes-all-radio-waves.Examples-:Commercial radio and television, microwaves, radar), infrared, visible light, ultraviolet radiation, X-rays,and gamma rays. Nearly all frequencies and wavelengths of electromagnetic radiation can be used for spectroscopy [6,7,8].

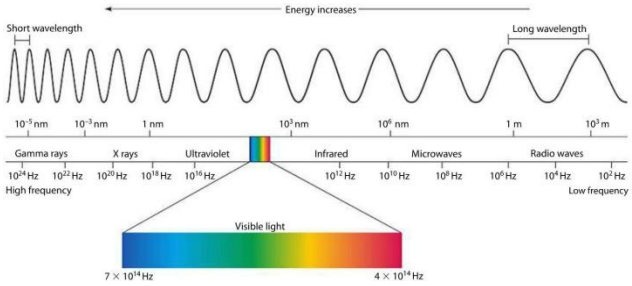

Fig.4 Electromagnetic Spectrum chart

II. ARCHAEOLOGICAL RESIDUES

The archaeological structures which is used to change the properties of the extra material will be buried by the surface and then this type of include pits, post holes ditches and other earthwork or construction which is done by building materials (e.g. bricks, stones) [2,3,4,5]. The structures may changes in to the above material as soil of vegetation in the soil which is growing in proper manner. It also effect the presence of snow and vegetated bare soil. Archaeological structures has left the topographic traces on the surface then this type of features has change the overlying soil to activate the detection of soil marks. There are ploughing activities which is commonly used in the top soil of dip depth of archaeological structure that produces in soil. The may changes in to its chemical properties in the form of organic matter and anthrosols. Ploughing actions brought a certain amount of fragments construction and man-made artifacts about the top soil [6].

ISSN 2348 – 8034
Impact Factor- 5.070

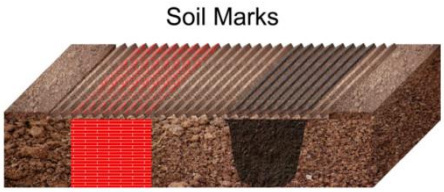

Fig.5

A buried archaeological structures which is overload vegetation is as crop mark. A crop mark is that mark which has abundant growth which are caused by underlying structures which is slightly the depth and composition of soil in that zone. Drought can increase such differential vegetation growth over archaeological structures which are and gives the deeper roots of vegetation in moisture. Crop marks have lot of factors including vegetation soil and city environmental pollution and morphology surfaces. Crop marks can be more useful in period of rainfall season [3,5]. On the basis of archaeological residues soil marks may be detected on sensed images which are not present on ground. Archaeological residue can be observed remote platforms. The large reflection of NIR radiation produces healthy green trees or plants which can be buried due to differential vegetation. The range of active visible radiation which gives 400 to 700nm will absorb the photosynthetic plants which is related to which has a lot of difference in vegetation[8,9]. The multispectral and the hyper spectral which are used for the increase in crop marks by exploiting multiple image band of electromagnetic spectrum and the thermal infrared

The thermal infrared is used for the detection of the heat signature which can used to calculate day night thermal inertia. The advantage of microwave remote sensing has the capability for the solar illumination that use for the archaeological residues then in the desert region the microwave system has the capability to enter in to dry sand and can detect in to its structures. In the temperate regions the vegetated soil has the imaging capability in current synthetic aperture radar (SAR) sensors. SAR has its own properties that for the detection of residues of archaeological structures and then the resolution of microwave to dielectric constant changes to the moisture of soil. Another main constituent of SAR that means it depend on roughness and geometry then these type of properties it use for detection of archaeological structure. However inter ferrometric (SAR) has capable of measuring high topographic variations. As large time of series of in-parallel effect can be minimum with technique as SBAS (small baseline subsets) which is used to measure displacement velocities. So according to the surface is to detect vegetated data using SAR. The analysis of backscatter intensity is on the use of polariemetric SAR (POLSAR). In some cases SAR as DEM in digital elevation models which used to detect in topographic surface. This are the uses of both amplitude and phase of SAR signals to detect surface residues which is above in 27 CSK spotlight imagery is used. In the multi temporal filtering of backscatter the calculations arises between images acquistions and SBAS DEM generation. Then the analysis of results has taken by inter ferrometric coherence and potential soil moisture deficit (PSMD) data.

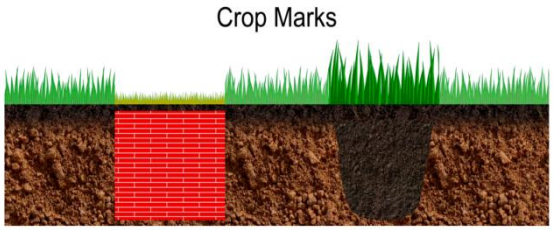

Fig.6

The SAR information is of 3 types which are created in the surface of residues through archaeological structures which was detected and analysed. These are the features which are as follows -:

III. MULTITEMPORAL SPECKLE FILTERED σ^0 BACKSCATTER:

The single look complex (SLC) has a certain number of strip map images which is used to settle of each AOI and certain number of spotlight due to SLC images in Prenetina. The AOI stacks are combined with SRTM 1 arc-second. DEM since the images are multiplied by a factor of 1x1 which is used to remove the phase component and then images will be converted from SLC to detected.

1. **Interferometric coherence:**
   It is a small scale randomness of the phase difference between coherently and SAR signals so there will be no random difference due to high coherence while low coherence will produce a random difference there are many factor which produce small scale random movement of image acquisitions of individual scattering element such as leaves in vegetation blown by wind. This is reffered as temporal decorrelation.
   This type of coherence can be measured between consecutive images acquisitions covering each AOI then the CSK spotlight data is done between images and temporal baselines.
2. **DEM:**
   The coherent system which is used in this is SAR then the phase difference between SAR images are removed by a perpendicular line which are used for accurate terrain measurement. In these decorelations it banned over the vegetated areas which are INSAR in DEM generation. The disadvantage of this can be removed by SBAS. SBAS techniquewhich select the spatial temporary baselines and also generated the interference and avoid in parallel effects. Then this type of technique is primary and can be used for DEM generation.

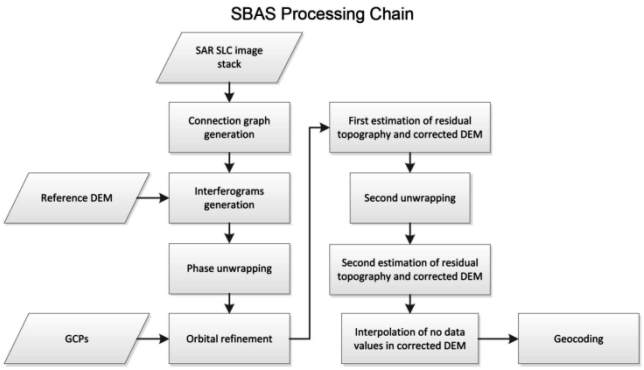

Fig.7

3. **GIS:**
   The geographic information system were imported by all SAR products which have the comparison between the archaeological charts, optical image and DEMs and then the comparison between GIS and SAR images will be superimposed.
4. **PSMD (potential soil moisture deficit):**
   The SAR is sensitive to variations of relative permittivity which give the presence of moisture. The more quantity of moisture in soil gives the large relative permittivity which is used to produce SAR scatter. The differential crop growth may be effect by roughness off SAR wavelength. Then the most important factor of archaeological crop marks in moisture in a particular differential growth increases. The water which is available to plant used to measure by PSMD so it has the difference between potential evaporation-transpiration and rainfall of actual soil moisture deficit (SMD) which know the knowledge about soil and moisture so it is a type meterological concept so here the difference between local potential evapo-transpiration using the formula known as Monteith formula.

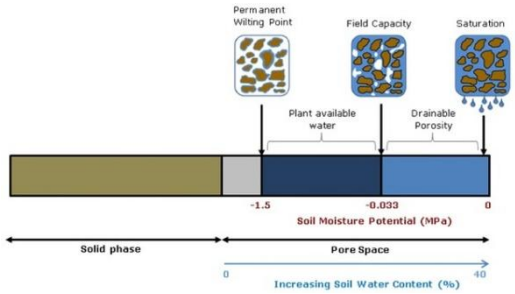

Fig.8

IV. RSD FOR VISUALIZING AND INTERPRETING ARCHAEOLOGICAL LANDSCAPES

A. Aerial Photography:

The well-established technique is remote sensing that has archaeological research has been already done. This type of technique is few at specific **aerial photography** which is clear at visuals and infrared component of electromagnetic spectrum. Sensor technology has been improved that means archaeologists can dis-balance the sensed imagery from different electromagnetic wavelength and platform. So the potential is high to area of study. The aerial photography is widely used in remote sensing techniques for visualizing the archaeological sites and landscapes which is on low amplitude using less film sensitive at optical and close to infrared wavelength for the archaeological reconnaissance and mapping which is all over the world that depend on both oblique and vertical aerial photography. Nowadays, aerial photography is accepted as cost effective non-invasive techniques that may used for exploration and the survey of monuments. Remoting sensing will not seen only as image for visual part only. Sensor technology has led to be advanced over range of ground, airbrone and space brone . The imaging devices that are applicable for archaeological and heritage problems as Systems (GIS) and image processing has to enter through sensed imagery. The majority of modern imagery of global technologies comes to be already established.

B. Airborne Remote Sensing:

In this sensing the archaeological structures as buildings, walls and ditches which are on air photography at proper length and angle then two marks which are unable to detect as soil marks and crop marks. The crop marks will show on vegetation type, soil conditions, sun sensor and film sensitivity which is hard to get photographs under suitable conditions. One of the sensor which is multispectral sensor address some problem because they are on different wavelength which are sensitive to vegetation and soil status of photography film. The photoelectric sensing devices in which image data is recorded in digital has a range about (350-1100nm). The discrete number of narrow band in EM radiation are called as multispectral then the absorption and reflectance are the properties of narrow band spectral imaging then the multispectral sensors are sensitive to vegetation growth soil variations moisture and temperature. So one of the advantage of multispectral sensors imaging is that data which is in digital form that use computer based imaging processing. The only effect of image increase is to allow the user in different parts of images only. According to digital data computer increases for archaeological feature has less dependency. Multispectral will give rapid and cost effective tool for to see such change in environment. The multispectral data will increase on image processing including as contrast, stretching, density slicing and color composite reduction. The thermal infrared region detects unless reflected on ground surface. So these are thermal images which is used to locate in morphological feature as relict fluvial channels on potential peat deposits so then the thermal prospection techniques has important application in geology, archaeology and environmental monitoring. There are two images which can be combined during heat capacity as **Pre-dawn** and **midday.**

ISSN 2348 – 8034
Impact Factor- 5.070

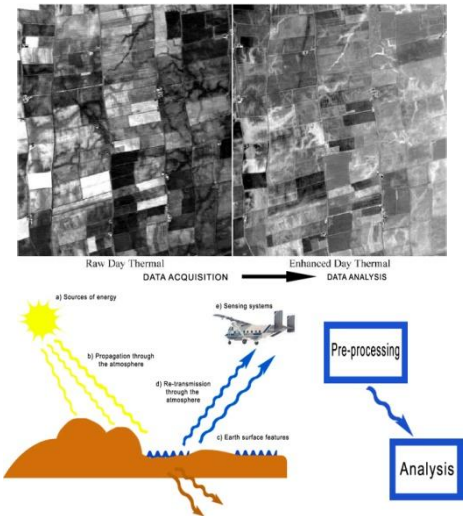

Fig.9 a) Pre-dawn and midday b) Data Acquisition and analysis.

C. SATELLITE IMAGERY

The sensors which are orbiting satellites use conventional digital imaging devices. The low spatial resolution is on optical satellite imagery has a few use for archaeological prospection. The important environment information of satellite imagery has the capability used in archaeological landscape grounds then there are two high resolution satellite imagery as military satellite photography and commercial availability so these Both satellite are capable to take the image sensor in stereoscopic data. The most important component is satellite imagery in archaeological manner then the CORONA imagery is the earlier imagery which was recorded to an effectively intact land with minimal destruction disturbance on archaeological residues by latest technology of agriculture. So there will be IKONOS imagery also collected on demand in geo-referred format use by digital environment. So there are two different types of environmental zone such as basalt zone and marl zone. In the image processing panchromatic and multispectral data will increase as contrast stretching, density silicing on color composite production etc. Imagery has a range of 11 bits in the structure of data. So in basalt zone archaeological zone has a palimpsest field boundaries structures ranges from 0.5 to 8m. The spatial resolution of sensor is much important in that zone.

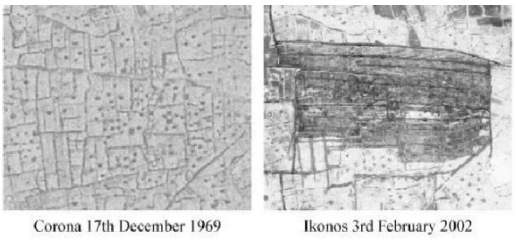

Fig.10 a) Difference b/w corona and Ikonos imagery

V. CONCLUSION

In this paper, comparative study of archaeological residues by using different remote sensing techniques have been done. This approach will provide a quick procedure about a different remote sensing techniques that we are using nowadays. That means you will know how the remote sensing techniques are useful for landscapes on soil and crop marks by these techniques. The different SAR data types that are using nowadays by using a potential soil moisture deficit have been studied. But in that some issue were there about Multi-sensor remote sensing so to overcome these issues a ARCTIS toolbox was implemented in MATLAB. This toolbox will helpful in implementing the archaeology in hyper spectral data sets. The data sets as follows:

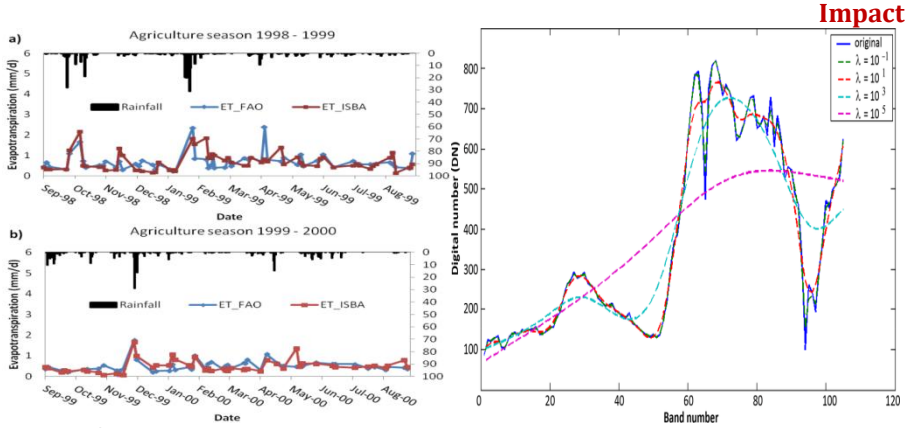

fig.11a) multi-sensor remote sensing b) graph done by ARCTIS toolbox

REFERENCES

1. Dhwani shah, for remote sensing techniques
2. Jones R Evans R soil and crop marks in the recognition of archaeological sites by air photography.
3. Stanjek, H. Fassbinder J soil aspects affecting archaeological details in the aerial photography .
4. Wilson , D.R. Air photo interpretation for archaeologists ;tempus publishing.
5. Lasaponara R Masini N satellite Remote sensing :a new tool of archaeology.
6. Evans ;R,; Jones R. crop marks and soils at archaeological sites in England.
7. Agapiou,,A.;,Alexakis,,D.D.;Hadjimitsis for Remote sensing techniques for visual data interpretation to a digital data manipulation
8. Kaimaris D, Patias M best period for high spatial resolution satellite images used for the detection of archaeological residues.
9. Gates D.M biophysical ecology springer.
10. Crawford , O.G.S Air survey and archaeology.
11. Allan .j Richard used for the archaeology of satellite in visualizing the imagery.
12. Aerial archaeology developing future practice by R.H Bewley and W. bewley.
13. Zink, M.; Bachmann, M.; Brautigam, B.; Fritz, T.; Hajnsek, I.; Moreira, A.; Wessel, B.; Krieger, G. Tandem-X: The new global dem takes shape. IEEE Geosci. Remote Sens. Mag. 2014
14. Erasmi, S.; Rosenbauer, R.; Buchbach, R.; Busche, T.; Rutishauser, S. Evaluating the quality and accuracy of Tandem-X digital elevation models at archaeological sites in the Cilician Plain, Turkey. Remote.Sens. 2014,
15. Ward-Perkins, J.B. Veii: The historical topography of the ancient city
16. Rosa, P. Carta Topografica del Lazio; Archaeological Chart of Lazio
17. Meiggs, R. Roman Ostia, 2nd ed.; Oxford University Press: Oxford, UK, 1973
18. Woodhouse, I.H. Introduction to Microwave Remote Sensing; CRC Press: Boca Raton, FL, USA, 2005 .