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Remote Sensing Technique for Monitoring the Glacier Retreating Process and Climatic Changes Study

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Abstract:

Glacier is an important natural resource on the earth surface which appears in the solid state of water. Glaciers are formed due to accumulation of ice above snow line under extreme cold climate where the average temperature is always below freezing point during the warmest month of the year. It grow by gradual transformation of snow into granular snow, then into firn or neve and finally into solid glacial ice. About 10% of earth surface is now covered by glaciers which has the different type's i.e. continental glaciers, ice caps, highland glaciers, valley glaciers, transaction glaciers, piedmont glaciers etc. The estimated number of all types of glaciers all over the world ranges between 70,000 and 200, 000. The areas of accumulation of huge volume of ice are called 'snow fields' which generates of different dimension. [11] As far this characteristic, in this era glacier becomes a significant task of the study, because the human and environmental relationship is important issue in recent century.

The identification of glaciated areas is a harsh full and risk full because of the inaccessible nature of glacier topography. The traditional techniques are time consuming and need to a great effort for its identification which has very less precision of its actual existence areas. The changes related to glacier morphology cannot precisely noted by the conventional techniques. From the last few decades there is a concentrative view regarding the 'Climate Change' in the world wide. Thus, it has need to estimation of glaciated areas and its retraction due to Climate change activity. The technical development in the various fields has a potential source for the glacier retraction study. Remote Sensing can be defined as the collection of data about an object from a Remote distance (Air Base). Earth scientists use this technique for the monitoring and measure phenomena found on the Earth's lithosphere. Thus, it has possible today, to monitoring the changes of glacier due to climate changes by satellites imagery data.

KEY WORD:

Remote sensing, Glacier Retreating, Satellite Imagery, Climate Change.

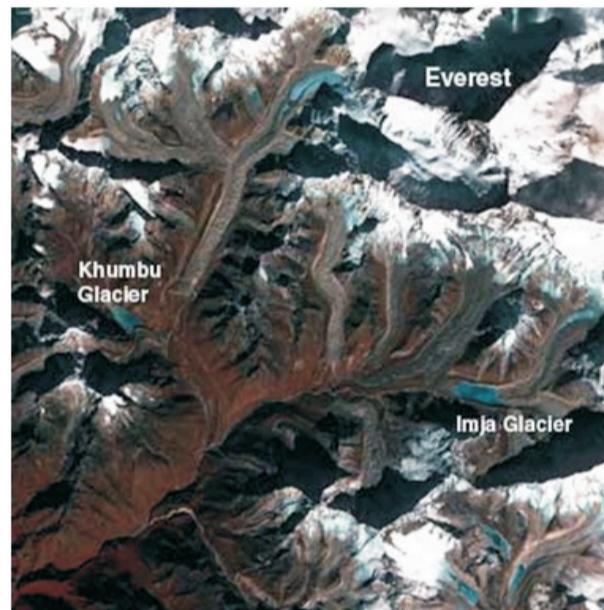
INTRODUCTION:

On the earth nearby 2.15% of the world's total water is frozen in ice as glaciers. There is the

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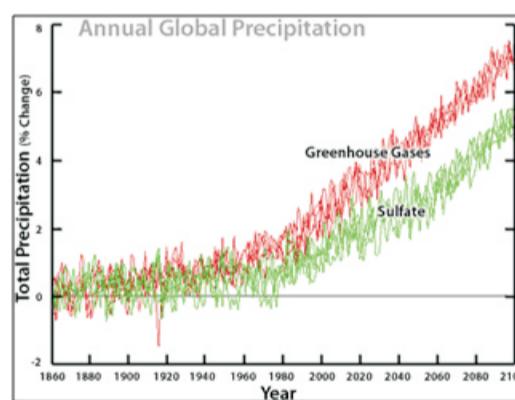


estimation that if this all ice was suddenly to melt, the sea level rise will be 60 to 90 meters. On the earth the existing glaciers cover found nearby 16 million square km which is about 11% of the land surface. The snow cover area is changed according to seasons. In winter season the coverage area extends as comparatively rainy and summer season. In summer, the glacier streams start to shrink. Thus, the expanding and shrinking of the glacier cover is depending on climate. Climate changes are creating worldwide due to the emissions of 'CFC' in the atmosphere. This climate changes impact upon the biotic and abiotic community also.



Satellite Image of Khumbu, Everest, and Imja Glaciers

Remote sensing helps for geographers, usually done with the help of mechanical devices known as remote sensors. These techniques have greatly improved the ability to receive and record information about an object without any physical contact. Often, these sensors are positioned away from the object of interest by using helicopters, planes, and satellites. Most sensing devices record information about an object by capturing an object's transmission of electromagnetic energy reflected from surface in the form of long wavelength.[10]. **Glacier has the great reflectance (50-80%) which can be identified in the remote sensing data easily.** Today, the scientific community has witnessed a growing demand for high resolution satellite imagery for investigating the human dimensions of global change from sensors such as Quick Bird (0.6m) and IKONOS (0.8m) resolution due to the quality and precision of change detection. The various types of changes in the glacier can be identified with the help of Satellite Imagery. In fact, this type of spatial information of 'Glacier Topography' is useful for the glacier Retretation, monitoring study and related further applications. [12]



Graph courtesy of the International Panel of Climate Change (IPCC)

CLIMATIC CHANGE:

Climate changes are two types, the increasing in the temperature and decreasing in the temperature from the average temperature. It is also known as the rise and fall of temperature from the actual mean temperature. Many scientists believe an increase in temperature could lead to a more intense water cycle. [11]. The rates of evaporation from soils and water, as well as transpiration from plants, could increase. The amount of precipitation could also increase due to the climate change activities which are based solely on the effects of greenhouse gases. (Ref: IPCC graph) [11].

Human actions involving biomass fuel consumption, land use changes and agricultural activities all involving direct interaction has prompted concern about the possible effect on the climate change. Changes in the land cover subsequently change the environment through its effects. Evaluations of these attribute types of land cover (types, amount, and arrangement) changes on the satellites data may allow the types of changes to identify in specific regions. According to Jeffrey Kargel, a USGS Scientist, glaciers in the Himalaya are wasting at alarming and accelerating rates, as indicated by comparisons of satellite and historic data and as shown by widespread, rapid growth of lakes on the glacier surfaces.[1]. According to 2001 report by the IPCC (Intergovernmental Panel on Climate Change) Scientists estimate that surface temperature could rise by 1.4 deg Celsius to 5.8 Celsius by the end of the century. In the world major glaciated region, researchers have found the strong correlation between increasing temperature and glacier retreat owing to melt. Satellite remote sensing is an evolving technology with the potential for contributing to study of human dimensions of global environment change by making globally comprehensive evaluations of many human actions from multispectral satellite images from sensors such as landsat (15 m) and ASTER (15 m). These are the significant source for the glacier retreating study which is caused by the global climate change. [3].

PROCESS OF GLACIER RETREATING:

Largest fresh water storages on the earth surface in the form of Glaciers. Most of the world ice is locked in two important ice sheets covering 'Antarctica' and 'Greenland', nearby 17,000 glaciers covering 17% of the Himalayan region claim a fair share. Most of them form above the permanent snow line around 4,900 meters. Evenly, the Indus, Ganga, and Brahmaputra rivers sources located in the glacier region which is the lifeline of the millions of people. [9].



The Boulder Glacier retreated 450 m from 1987-2005.



The Easton Glacier retreated 255 m from 1990-2005.

In recent decades, a magnificent retreat has been observed on most of the monitored glaciers in the world due to climate change. If this evolution is confirmed in the next coming years, it will have some important consequences in expressions of water resources, river flood management, economical development, and risk management in the surrounding areas of glaciated topography. Up to now, only a few number of the existing world mountain glaciers have been monitored, mostly by ground measurements techniques, which often provide information only once or twice a year at a few points because of the difficulty of reaching high-altitude glaciers in risky mountainous areas. [11] Acquisition and processing of remotely sensed data should provide more accurate information to improve glacier monitoring along with glacier retraction process.

Glacier	Period	Avg. Retreat of Glacier (m/year)
Triloknath, Himachal Pradesh	1969-1995	15.4
Pindari, Uttaranchal	1945-1966	135.2
Milam, Uttaranchal	1909-1984	13.2
Ponting, Uttaranchal	1906-1957	5.1
Chota Shigri, Himachal Pradesh	1986-1995	6.7
Bara Shigri, Himachal Pradesh	1977-1995	36.1
Gogotri, Uttaranchal	1977-1990	28.0
Zemu, Sikkim	1977-1984	27.7

Table: Rate of Some Retreat Glaciers of India (Ref. Climate Change-Mahendra Pandey, 5th Edition)

REMOTE SENSING DATA FOR GLACIER RETREATING STUDY:

In the glacier recession study Remote Sensing data (satellite Images) plays very significant role because of the inaccessibility of the glaciated areas. The glaciers of the various part of the world can be identified by satellite image according to reflectance tone. Today, the periodic RS data is available of the glaciated regions of the world. In fact, in this recent time there is some changes observed in the glacier especially, the retracting of glacier owing to climate change. These changes are simply identified from the various satellite images throughout its surveying, assessment, and mapping. Thus, there is capability of the Remote sensing data in the glaciers retracting study with high precision. [13].

Glacier is the large amount of body which is concentrated in the various part of the world. They have important in the all biotic and abiotic environmental system, because the changes in this large amount of glacier body impact on the environment. Flood activity can be generating due to snow melting. The direct study of the snow covered area is beyond the human capacity because of large coverage area.[1]. Generally, it is appears in the hilly region. The stream runoff patterns depend on the melting of glacier at the same time the flow of river can be rejuvenate owing to melting of snow. Most of the human life settled along the river which is the life line of people. Therefore, the mapping of the glacier of aerial extent is an important parameter for avalanche and hydrological application. The accessibility of the snow cover area is very difficult to understand by directly observation in the world.



A view Whitechuck Glacier in Glacier Peak Wilderness- 1973

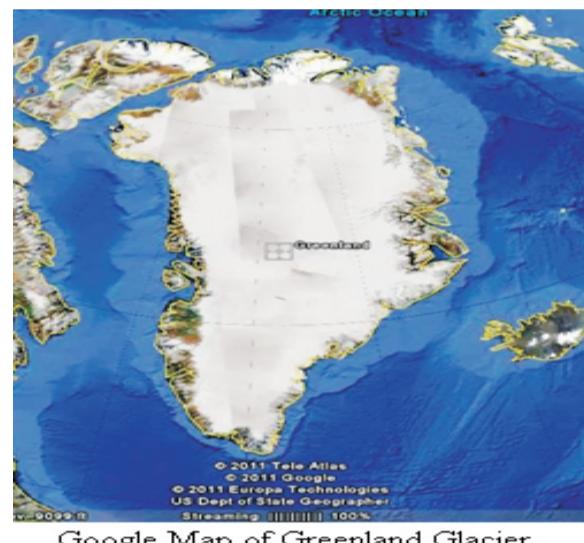


In similar view seen in 2006-glacier retreated 19 km.

or phenomena from a distance. In regards to the discipline of geography, it is the acquisition and analysis of information about the Earth (or other planetary bodies) through the use of computer and sensor systems via electromagnetic radiation. In the modern time Remote Sensing came of age in the 1970's with the refinement of satellite imaging. In 1972 the Earth Resources Technology Satellite (ERTS) was renamed to LANDSAT (NASA).[10] The sensor had an 80 m/pixel spatial resolution. In 1975, constant image download was available from LANDSAT, with an 18 day temporal resolution (passing over the same geographical area every 18 days).

MONITORING OF GLACIER RETREATING PROCESS:

The glaciers are starting to melt after the increasing in the temperature, mostly in the summer seasons. This can be notified by the various periodic remote sensing satellites images. A number of studies have been taken up for inventory, monitoring and retreat of world important glaciers.[3]. **Glacier monitoring of the Himalaya's glacier is possible by the various periodic satellites images also.** Estimation of retreat of Himalayan glaciers and Snow cover monitoring region are also completed throughout multiple research work



Google Map of Greenland Glacier

The identification of glaciers dimensions and coverage by its spectral band, reflectance tone then its mapping or measurements, changes analysis and estimation can be completed by the monitoring of the glacier in the specific region. In this period glaciers are melting due to climate change (Temperature Increasing) which has changes its dimensions, generally they tend to retraction from its actual snow line, this glacier retreat mapping can be completed by the periodic satellites image (AWiFS and Resourcesat-1 data). Monitoring of Snow cover will help to multiple spatial planning. [13], [1].

CONCLUDING REMARK:

In this attempt, shows the potential use of Remote Sensing data for the identification, monitoring, measurement, appraisal, and its periodic change detection of glaciated inaccessible regions. There is changing research trend in the field of earth science, where this technology is the crucial source for the multiple spatial planning. In the glacier retraction study satellite imagery is the extremely revealing source for glacier survey, assessment and future prediction.

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