



# REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS FOR ENGINEERING APPLICATIONS

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**Abstract—** Remote sensing technology's increasing accessibility helps us observe research and learn about our globe in ways we could only imagine a generation ago. Guides to profound knowledge of historical, conceptual and practical uses of remote sensing which is increasing GIS technology. This paper will go briefly through remote sensing benefits, history, technology and the GIS and remote sensing integration and their applications. Remote sensing (RS) is used in mapping the predicted and actual species and dominates the ecosystem canopy.

**Keywords—** GIS; Remote Sensing; GPS; Mapping; Microwave;

## I. INTRODUCTION

Sensing an object without being in physical contact with it, is the literal meaning of the term 'Remote Sensing'. In that sense even humans possess remote sensing abilities of sight, sound and smell. Sensing of any object is with respect to observing, capturing and documenting places and objects from a remote or faraway place. In the case of satellite remote sensing, the objects or places being captured are on earth's surface and atmosphere while the sensors are on airborne carriers like aircrafts or space borne carriers like satellites and space shuttles.

Since the observation has to be relayed over a considerable distance, the medium of carrier is electromagnetic radiation. The expected output is usually in the form of an image which further requires processing to decipher the information required. In case of satellite remote sensing, the sensors are separated from the earth's surface by a layer of atmosphere which causes scattering and absorption of the electromagnetic radiation travelling from the earth. This will create poor quality images and need correction before subjecting it for final analysis.

Remote sensing can be categorized on the basis of the type of radiation measured by the sensors as

1. Optical remote sensing and infrared remote sensing
2. Microwave remote sensing

In Optical remote sensing, sensors mounted on satellites measure or detect solar radiation reflected from earth forming images. The wavelength region used for this is in between visible and infrared regions. Different materials reflect light in different ways and the interpretation of this requires knowledge of spectral reflectance of materials. Infrared remote sensors measure the thermal infrared radiations from which temperature of the reflecting surface can be measured.

## II. BACKGROUND

The utilization of Geographic Information System (GIS) and remote detecting for evaluating the effect of land-use changes to water turbidity in numerous watersheds. In this investigation, essential informational indexes speaking to land utilizes, hydrology, climate, soils, rise, and surface qualities were incorporated into a GIS in forbidden, vector and network positions. The land use maps that were gotten from Landsat-5 TM symbolism utilizing a mix of various characterization methodologies gave a normal precision of 95 %. Results from information investigation had demonstrated that there exists a cozy relationship existed between the degree of open territory and sedimentation stacking rate. Be that as it may, the silt stacking rates were observed to be non-straight extending from 1.47 to 2.13 tons per millimeter of precipitation for every kilometer-square increment of open zones, contingent upon their area of open regions as for variables, for example, accessibility of dregs, soil type, incline length, and slant steepness, and so on.

Demin Xiong et. al., proposed six noteworthy undertakings: 1) Undertake field study in two phases, first to gather ground-truth information preceding picture examination, and afterward to assess the picture investigation results against "this present reality." 2) Compile and assess accessible picture information and breaker these information to make the most ideal asset for picture information examination. 3) Characterize land use and land spread in the area by utilizing ERDAS's IMAGINE imaging preparing programming and altered programming methodology for land spread grouping on the picture information. 4) Integrate the land use and land spread portrayal from the past assignment with geographic data frameworks (GIS) and other information to give land use/land spread and transportation pictures, and related examination, to help the NEPA procedure. 5) Develop gauges and analyze the cost, worth, and handiness of data created utilizing regular NEPA-study techniques with those created in this venture. 6) Document the methodology, examination, and discoveries to organize innovation move ventures for future NEPA investigations.

Chudamani Joshi et. al., proposed significant commitment towards the remote detecting and GIS. The significant utilization of remote detecting and GIS is mapping the real and anticipating the potential dissemination of intrusive species. Differentiation is made into four classifications of intrusive species dependent on whether they show up in and overwhelm the biological system shelter or not. High utilization of spectral resolution imagery doesn't require for whole biological systems framing a monotypic thick canopy.

## III. MICROWAVE REMOTE SENSING

In this kind of remote sensing, radiation in the microwave wavelength is used to gather information. These are of several kinds like:

- Lidar, a light detection and ranging sensor that transmits light through a laser radar and detectors measure the scattered light.
- A radar altimeter which uses the principle of measuring the time elapsed between transmission and reception of signals to determine the altitude of any terrain,
- A wind scatterometer records the wind speed from the scattered microwave across the ocean surface.
- Synthetic Aperture Radar utilizes the radar principle for forming images by utilizing the time delay in receiving the transmitted signals from spacecrafts. As microwaves can pass through the cloud cover to give high resolution images, these are most preferred to cover regions with constant cloud cover.

The images obtained from remote sensing are digital images, wherein two dimensional arrays of pixels in rows and columns with intensity value giving the physical feature and address giving the link between geographical coordinate and column-row location. Image processing using algorithms reveal specific areas which are then interspersed with other data of the test area to create a complete analysis.

## IV. APPLICATIONS OF REMOTE SENSING

The benefits of satellite remote sensing can be summed up as

- The data is available for large expanses of land and sea
- Data is available on regular basis and can be collected at regular intervals
- The data collected is without human interface
- The digital form of data helps in overlaying other data to suit varied problems

To this effect the applications in which remote sensing finds use are

### Agricultural

In terms of crop health monitoring and management – this can be done to create an inventory of crop growth pattern and extent to predict production and economy. Passive remote sensing is used for this. Also merging of SAR imagery with multi—spectral imagery can facilitate further interpretation.

### Land use Monitoring

Land use in terms of residential, industrial, agricultural, forest cover etc can be established. Governments can use this data either for revenue generation, monitoring of development schemes and control of forest cover for any particular area. Mapping of forest lands in particular is of importance and is carried out using either RADAR or LIDAR to understand the tree type, height and concentration. This data can be further used to observe the change in forest cover, deforestation patterns, soil erosion, behavior of wildfire etc.

### Hydrology

Applications in hydraulic and hydrological area are immense and affect humankind at a very existential level. The variables like precipitation, surface and underground water, water in the capillary pores can be mapped. Creating database on Wetlands, river meandering, irrigation networks, leaks and watershed can further the work towards sustainable water management. Effective flood prediction, glacier movement is possible by using overlay maps of different topographical and atmospheric/weather related data.

### Weather monitoring

RS is used to monitor the weather patterns by superimposing weather records from past and present to track the weather patterns and movement trend across different biological areas. Other topographical records can be superimposed with weather data to forecast weather.

### Biodiversity

Sustained development of all the existing and endangered species is the need of the hour. Conservation of ecosystems, resources and habitats requires informed planning and regular monitoring at spatial and terrestrial levels to adopt mitigation strategies. This can be accurately achieved by having access to field data in consultation with ecologist, RS analyst and model experts. Monitoring, understanding biodiversity patterns as well as its susceptibility to changes in ecosystems is an area well under the purview of field of remote sensing.

## V. APPLICATIONS IN CIVIL ENGINEERING DOMAIN

All of the applications discussed above find relevance and connect to Civil Engineering domain, however following are some of the industry specific usages in recent times

### 1. Town Planning

RS is used in assimilation of demographic, resource, weather and topographical data to plan development of towns and cities.

### 2. Site investigation and feasibility study

Remote sensing aids in Pre-planning of any project such as reservoirs, bridges, pipelines, highways, airports etc which require extensive collection of data in terms of geology, hydrology and topography and co-relate it to future project utility.

### 3. Structural Health Monitoring

During the construction phase and along the useful life span of the building, health of a structure can be ascertained with the help of sensors embedded in concrete or in cables along structure. These sensors use light signals to transmit information for timely detection and management of defects.

### 4. Hydraulic engineering

Images from satellites can be used to locate ground water, manage, distribute and disposal of waste water. These are also helpful in controlling damages from floods and droughts by careful processing of bands of high resolution. Different utilizations of remote detecting which might be gathered into the accompanying:

- Resource Investigation
- Environmental Examination
- Land utilize
- Site Examination
- Archaeological Examination

Asset Investigation: Geologists utilize remote detecting to examine the development of sedimentary shales and recognize stores of different minerals distinguish oil fields and recognize underground stockpiling of water. Remote detecting is utilized for distinguishing potential angling zone, coral reef mapping and to discover other riches from sea. Ecological Investigation: Remote detecting is utilized to think about cloud movement and anticipate downpours. With satellite information it is conceivable to contemplate water release from different ventures to discover scattering and hurtful impacts, assuming any, on living creatures. Oil spillage and oil spills can be contemplated utilizing remote detecting.

**Land Use:** By remote detecting, mapping of bigger territories is conceivable in brief time. Woodland territory, farming region, private and mechanical region can be estimated routinely and observed. It is conceivable to discover zones of various harvests.

**Site Examination:** Remote detecting is utilized broadly in site examinations for dams, spans, pipelines. It tends to be utilized to find development materials like sand and rock for the new undertakings.

**Archeological Examination:** Numerous structures of old time are presently covered under the ground and are not known. Be that as it may, by considering changes in dampness content and different qualities of the covered items and upper new layer, remote sensors can perceive the covered structures of archeological significance.

**Common Peril Study:** Utilizing remote detecting the accompanying normal dangers can be anticipated to some degree and risks limited:

- Earthquake
- Volcanoes
- Landslides
- Floods and
- Hurricane and Violent winds

## VI. GPS

The task of making maps and projecting information through them which are used for further analysis was part of the older way of geographical data processing. Whereas with the advent of Geographical Information System (GIS), the same tasks are carried out with minimum amount of human intervention not only with more accuracy but also in a faster manner. Computers are used to handle/process (manage) data collected from spatial sources, which are further analyzed and presented by experts. The output can be used to create maps, form overlay of information, form solutions by picturing complicated situations to provide solutions.

Geographical details are represented in GIS using certain Data models, which are of two kinds; Raster and Vector. In both the models, points, lines and polygons are used to communicate the location, length and the features of the area under study. Raster Model uses cells marked by coordinates to project a feature on the ground. Vector model uses lines and points to indicate locations. This model is preferred over raster model as it is more accurate, faster and convenient. The data of similar nature are represented in individual layers to be accessed independently or in conjunction with other layers. These layers may be for features such as grasslands, rivers, buildings, bridges etc.

GPS is an acronym for Global Positioning System. This is one of the numerous ways that are utilized to pinpoint a correct area on the world's surface. This is made conceivable by a huge system of satellites that are situated in space and which transfer data on the ground with respect to particular arranges on the world's surface. The satellites work so that they hand-off radio signs from space to GPS beneficiaries on the ground utilizing a procedure alluded to as trilateration. Particular areas on earth can likewise be found utilizing a tremendous system of a few satellites and recipients joined.

GPS consists of three main segments:

- The Space Segment
- The Control Segment
- The user segment

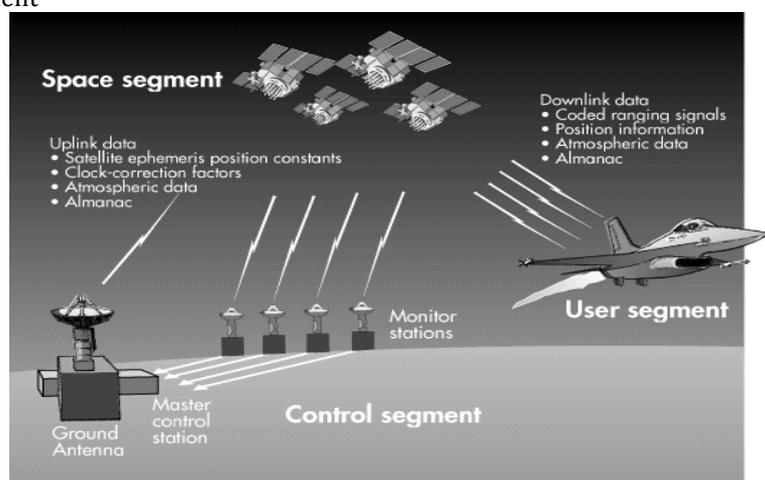


Fig.1 GPS segments

### The salience of GPS is

- The control segment – are stations on earth which can send as well as collect information's required for monitoring the satellites and also for time corrections and detection of non functioning satellites.
- The space segment – are 24 satellites navigating on 6 planes within a distance of 60 degrees which orbit every 12 hours. They are attached with atomic clocks and microprocessors for self regulation.
- The user segment – are the users with receivers made of antenna, signal microprocessor control and display units receiving signal from available satellites every second.
- Global Positioning System gives location accuracy both horizontally and vertically which aids in GIS data location and navigation. This is accomplished with by a group of satellites orbiting the earth. This is done in the following manner
  - Triangulation to calculate distances based on travel time of radio messages
  - A clock to measure travel time
  - The relative distance of the satellite based on travel time is ascertained

Signal delay due to atmospheric layers is factored in GPS is an acronym for Global Positioning System. This is one of the numerous ways that are utilized to pinpoint a correct area on the world's surface. This is made conceivable by a huge system of satellites that are situated in space and which transfer data on the ground with respect to particular arranges on the world's surface. The satellites work so that they hand-off radio signs from space to GPS beneficiaries on the ground utilizing a procedure alluded to as trilateration. Particular areas on earth can likewise be found utilizing a tremendous system of a few satellites and recipients joined.

The GPS innovation was produced for use by the US military in the 1960s yet it has ended up being a progressive development that characterizes the manner in which individuals live consistently. Today, GPS innovation is utilized in relatively every aspect of day by day lives. It has been utilized in the flight business (plane, rambles), tourism, and notwithstanding mapping. A standout amongst the most well-known utilizations of GPS is in mapping and studying

## VII. USES OF GPS

GPS innovation can be utilized in the accompanying regions:

1. Finding positions: This is the most well-known utilization of GPS. This applies to circumstances where you might travel an obscure goal and you have to discover your way around. GPS will enable you to find each zone inside the area and will even give the best courses to use to arrive.
2. Gaining admittance to crisis roadside bolster: in the event that you end up stranded in an obscure area and need crisis enable, you to can basically call a crisis number from your Cell phone and crisis administrations will naturally find you without you sharing your area.
3. Counteracting auto and other vehicle robbery: Autos are fitted with GPS trackers to enable monitor the correct area of your auto consistently so that regardless of whether the auto is stolen you will have the capacity to follow it.
4. Mapping and reviewing: Utilizing GPS innovation to overview positions and areas on the earth isn't just less expensive yet in addition spares a considerable measure of time. You can without much of stretch pinpoint areas on a guide or interstate

## VIII. GEOGRAPHIC INFORMATION SYSTEM (GIS)

A geographic Information System framework (GIS) is a framework intended to catch, store, control, examine, oversee, and present spatial or geographic information. GIS applications are instruments that enable clients to make intuitive inquiries (client made ventures), examine spatial data, alter information in maps, and present the after effects of every one of these activities. GIS at times alludes to geographic data science (GIScience), the science hidden geographic ideas, applications, and frameworks[4].

GIS can allude to various diverse innovations, procedures, and techniques. It is connected to numerous tasks and has numerous applications identified with designing, arranging, administration, transport/ coordinations, protection, media communications, and business. Consequently, GIS and area knowledge applications can be the establishment for some, area empowered administrations that depend on examination and perception[6].

GIS can relate disconnected data by utilizing area as the key list variable. Areas or degrees in the Earth space– time might be recorded as dates/times of event, and x, y, and z organizes speaking to, longitude, scope, and height, individually. All Earth-based spatial– transient area and degree references ought to be relatable to each other and eventually to a "genuine" physical area or degree. This key normal for GIS has started to open new roads of logical request

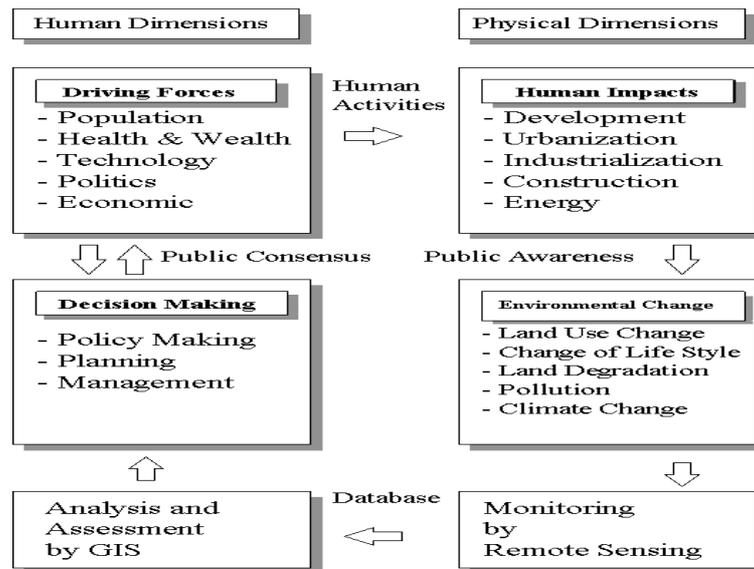


Fig. 2 Cycle chain analysis of GIS[7]

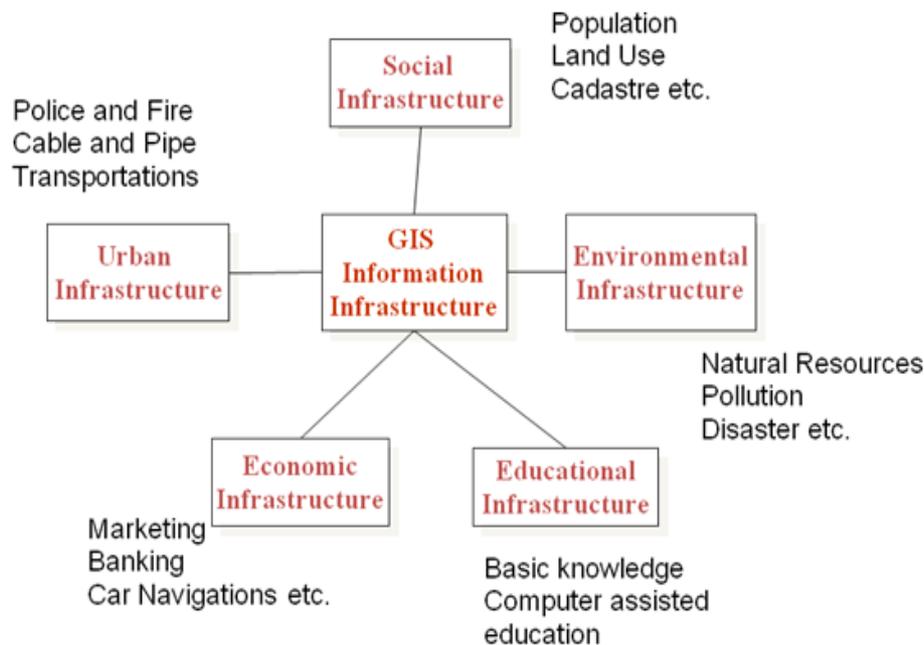


Fig.3 GIS Information Infrastructure[9]

GIS exactness relies on source information, and how it is encoded to be information referenced. Land surveyors have possessed the capacity to give an abnormal state of positional precision using the GPS-determined positions. High-goals advanced landscape and flying imagery powerful PCs and Web innovation are changing the quality, utility, and desires for GIS to serve society on a terrific scale, however by the by there are other source information that influence generally GIS precision like paper maps, however these might be of restricted use in accomplishing the coveted exactness.

In building up an advanced topographic database for a GIS, land maps are the fundamental source, and airborne photography and satellite symbolism are additional hotspots for gathering information and recognizing traits which can be mapped in layers over an area copy of scale. The size of a guide and land rendering region portrayal type are imperative perspectives since the data content depends for the most part on the scale set and coming about floatability of the guide's portrayals. With the end goal to digitize a guide, the guide must be checked inside hypothetical measurements, at that point filtered into a raster design, and coming about raster information must be given a hypothetical measurement by an elastic sheeting/twisting innovation process. A quantitative investigation of maps brings exactness issues into core interest. The electronic and other gear used to make estimations for GIS is significantly more exact than the machines of regular guide examination. Every land datum is characteristically wrong, and these mistakes will proliferate through GIS activities in manners that are hard to foresee[8].

Remote sensing is the obtaining of data around a question or wonder without reaching the protest and in this manner rather than on location perception, particularly the Earth. Remote detecting is utilized in various fields, including topography, arrive reviewing and most Earth Science disciplines (for instance, hydrology, environment, meteorology, oceanography, glaciology, geography); it likewise has military, knowledge, business, monetary, arranging, and helpful applications. Satellites have assumed an enormous job being developed of numerous advancements, for example, world mapping, GPS, and so on. In any case, their applications are not constrained as imaging gadgets as it were. To be completely forthright, they are entire much something beyond imaging gadgets. Remote Detecting is one of the numerous developments that were conceivable, on account of these satellites meandering around the earth. In this article we will talk about different utilizations of this innovation called Remote Detecting. In the wake of perusing these applications your view towards satellites will change. Following are some significant regions in which remote detecting are helpful:

- Agriculture
- Forestry
- Weather
- Biodiversity

**Arial photography for military observation:** Bavarian pigeon corps was utilized by German military with the end goal to keep an eye on foe positions o achieve their grimy work. In any case, this strategy was not demonstrated so productive and left behind some hard exercises for Germans. Evaluation of state of country streets: Provincial street conditions are presently conceivable to be surveyed utilizing different Remote Detecting methods and GIS system with inch to inch exactness. It spares entire a considerable measure time and cash of transporters.

**Appraisal of mileage:** Satellites have now turned out to be fit for estimating vehicle discharges including CO, HC, NO, and so on absent much obstruction from the space. Governments are utilizing this procedure for putting weight on vehicle proprietors to influence them to pursue discharge measures. Evaluation of prepare strength: In interferometer innovation, scene disfigurement is estimated with sensors utilizing stage contrasts. This strategy is generally utilized in divisions of oil and gas with the end goal to gauge prepares innovation.

**Ascertaining snow pack:** To comprehend snow dissolve proportion, NASA utilizes LIDAR alongside a spectrometer with the end goal to quantify the assimilation of daylight. This can be effectively comprehended by utilizing Remote Detecting innovation. Gathering earth's photos from space: NASA has a 75 page accumulation containing pictures of earth. Intriguing patters of earth's geometry including seas, environment, arrive, and so on can be found in it. EO-1, Land and Land sat are utilized to gather this information. Finish perspective of land: Satellite symbolism and Remote Detecting innovation is helpful for clients wanting to purchase another home. They can check close-by schools, shopping areas, parks and each other thing they are hoping to be close. Rationing lakes and streams: Lush zones alongside the waters are the last line of barrier continually shielding lakes and waterways from running off. There riparian zones likewise need some support. High goals satellites are utilized to watch them since they are spread on whole globe.

**Controlling backwoods fires:** Information procured by satellites utilizing Remote Detecting empowers firefighters to be dispatched on time and over precise areas so the harm from such flames can be diminished to insignificant. Tallying polar bears: Polar bears are on the best in the rundown of creatures that would wiped out because of a dangerous atmospheric deviation. Scientists utilize satellite pictures as a trusted and essential hotspot for checking them for their survival

**Making programmed street systems:** Exceptional information with respect to street systems are critical for crisis administrations, urban arranging and route frameworks also. Multispectral picture detecting innovation and protest base characterization innovation is utilized to create computerized street organizes that serve valuable data for gatherings portrayed previously.

**Outlining watersheds:** DEMs (computerized rise display) are readied utilizing hydrologists' Remote Detecting innovation that speaks to the stream and area of water body. Inferring factors contributing in destitution: Numerous legislatures have executed Remote Detecting methods with the end goal to acquire a get an unmistakable picture of territories loaded with neediness so they can enhance what's missing to enhance the circumstance.

Recognizing land cover and land utilize: Remote Detecting advancements are utilized to decide different physical properties of soil (arrive cover) and furthermore how it is being used or what it is being utilized for (arrive utilize). Spatial investigation lab is doing these exercises since years now.

**Creating biodiversity in parks:** Remote Detecting innovation is vital for keeping up parks since it can outline changes. Mapping biodiversity, obtrusive species and foreseeing fire dangers are a portion of the principle stop Remote Detecting applications.



**Creating web based mapping administrations:** It is elusive a man who has not yet utilized Google earth, Bing maps or Open road maps. These advancements are excessively founded on Remote Detecting innovation. They furnish an interface with avant-garde fanciful without costing us a solitary penny. It makes it very productive to look at areas you will visit or discover a few areas alongside the bearings to go there. GPS too utilize this framework for giving UI on the screen.

**Finding antiquated archeological locales:** Remote Detecting procedures, for example, infrared symbolism and stereo symbolism are utilized in archeological field. Old Mayan and Egyptian human progress are the best models of such revelations

**Height and shapes inference:** Remote Detecting innovation named photogrammetry is utilized in form mapping, creating surface models, leading volumetric studies and creating 3d maps. This equivalent strategy is likewise utilized in wrongdoing scene mapping, archaic exploration and engineering.

**Assessing timberland supplies:** AVHRR, MODIS and SPOT are consistently used to quantify the addition/decrement in worldwide backwoods since woods are wellspring of important materials, for example, paper, bundling, development material, and so forth.

**Evaluating surface rise:** NASA's SRTM (carry radar geography mission) is equipped for checking whole globe in horse 11 days. A Remote Detecting innovation named between aerometric manufactured opening radar is utilized in it.

**Investigating and exploring cold:** Ice is conceivable the last boondocks of human advancement with different nations guaranteeing for it. There are performed hard core assignment utilizing Remote Detecting advancements, for example, ice observing, send following, national protection, and so forth.

**Extricating mineral stores:** Earth holds in excess of 4000 regular components, each with their novel synthetic arrangement and ghostly reflectance. Hyper spectral remote detecting innovation constructs potential guide of these minerals.

**Enhancing aviation authority:** Satellite based GPS framework is utilized to keep up the stream of air movement. It maintains a strategic distance from the utilization of ground based radar so cash is spared and courses are enhanced close by with enhanced wellbeing.

**Expanding exactness in cultivating:** Soundness of yields is estimated utilizing remote detecting applications so that just about 10 percent of manure can be spared. Cash and time contributed on that compost would likewise be at last spared.

**Assessing and relocating winged animal commonness:** Light weight GPS telemetry strategies are utilized to determine movement area of feathered creatures. Remote detecting advances, for example, LIDAR, multispectral and radar are likewise valuable in such procedures.

**Keeping stock on burial grounds:** UAVs were utilized to delineate graveyards of wide territories. It is a shoddy system to outline graves, be that as it may, exact and simpler than useful mapping.

**Lift water system framework:** An extensive variety of information is required to configuration lift water system frameworks for enhancing water supplies for farming and different enterprises. Full perspective of the ground can be obtained with satellite before development starts

**Overseeing City resources and wellbeing:** LIDAR is utilized by numerous organizations to manage their advantages and furthermore to guarantee security. LIDAR information and city information are contrasted with ensure that each development is allowed and safe.

**Mapping out sea depths:** ESA's Cryostat-2 and NASA's Jason1 are engaged with the movement of mapping out mountains and objects of sea depths utilizing remote detecting applications uncovering ocean bottom geology also.

**Mapping soil composes:** Universal soil asset and data focus utilizes MODIS symbolism remote detecting innovation to delineate sorts for horticultural forecasts and intending to enhance the future outcomes

**Estimating ocean levels:** This is a standout amongst the most expansive scale uses of remote detecting innovation. Remote detecting information is utilized by satellites with the end goal to quantify ocean levels with exactness of inches. There would be no prerequisite of setting off to the ocean shore and estimating the ocean level with you measure scale.

**Estimating wind speed and course:** NASA's Snappy SCAT disperse meter and wind LIDAR make huge scale twist tasks for giving exact breeze data to golfers, ranchers, pilots, designers and turbine organizers. There are two types of remote sensing technology, active and passive remote sensing. Active sensors discharge vitality with the end goal to check items and territories whereupon a sensor at that point identifies and measures the radiation that is reflected or backscattered from the objective. RADAR and LiDAR are precedents of dynamic remote detecting where the time delay among outflow and return is estimated, building up the area, speed and heading of a protest. Passive sensors accumulate radiation that is discharged or reflected by the protest or encompassing territories. Reflected daylight is the most widely recognized wellspring of radiation estimated by uninvolved sensors. Precedents of uninvolved remote sensors incorporate film photography, infrared, charge-coupled gadgets, and radiometers

## IX. CONCLUSION

There is a clear need for mixed use of remote sensing, GIS and specialist expertise to improve the outcome of invasion mapping. In identifying, mapping and evaluating the effect of invasion on an region or entire ecosystem and species-level characteristics, there are opportunities to generate in-depth data. The research region is in the hilly region, where the altitude of the surface shifts, which has some effect on the pixel value of the picture and eventually leads to inaccuracy of the outcomes of the classification. Thus, the precision of the expected situations can be improved by enhancing the quality of the input information and setting associated parameters. The research given useful insights into choosing a suitable classification technique as well as an suitable form of imagery to increase classification precision, reduce complexity, improve computational effectiveness, and maximize cost efficiency.

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