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Remote Sensing Applications for Collecting Data from Inaccessible Areas

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Abstract

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on site observation. Remote sensing is used in numerous fields, including geography and most Earth Science disciplines (for example, hydrology, ecology, oceanography, glaciology, geology); it also has military, intelligence, commercial, economic, planning, and humanitarian applications. In this paper we will discuss the applications of remote sensing and also how remote sensing makes it possible to collect data of dangerous or inaccessible areas.

Keywords: *Remote Sensing, Remote Sensing Applications,*

INTRODUCTION

In modern usage, the term 'Remote Sensing' 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). It may be split into active remote sensing (when a signal is first emitted from aircraft or satellites) or passive (e.g. sunlight) when information is merely recorded. The era of satellite remote sensing was open in the 1960s when cameras and electronic sensors were mounted on spacecraft. Nowadays there is a big assortment of satellite systems actively recording information about the Earth. A wide variety of imagery is available from satellites. Both active and passive sensors, operating from the microwave to the ultraviolet regions of the electromagnetic spectrum collect a large amount of

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information about the earth's surface every day.

OVERVIEW

Remote sensing makes it possible to collect data of dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, glacial features in Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the Cold War made use of stand-off collection of data about dangerous border areas. Remote sensing also replaces costly and slow data collection on the ground, ensuring in the process that areas or objects are not disturbed.

APPLICATIONS OF REMOTE SENSING

Remote sensing in many fields of scientific and research has extensive applications. Some of them are as follows:

1. **Determining soil moisture content using active and passive sensors from space**

Soil moisture contributes so much to understanding Earth sciences… the water cycle, weather forecasting, drought and floods. There are two ways to derive soil moisture from space.

a) Active sensors like Radarsat-2 illuminate their target and measures backscatter – resulting in high spatial resolution but low accuracy.

b) Passive sensors like SMOS measures naturally emitted microwave radiation – highly accurate but poor spatial resolution. How can we get the best of both worlds? This is what SMAP is trying to achieve – Soil Moisture Active Passive.

2. **Mapping with laser precision using Light Detection and Ranging technology**

LiDAR measures the distance from the airborne platform to the earth surface using laser beams. This is how LiDAR got its name – "Light Detection and Ranging". What makes LiDAR so special is its densely sampled points at laser accuracy. Digital surface models, digital elevation models and light intensity models can all be derived from LiDAR.

3. **Catching tax-evaders red-handed by locating new construction and building alterations**

If you thought you could hide your home addition or swimming pool from your tax return without the city noticing… If you lived in Athens, Greece, you'd be wrong. The tax revenue agency in Athens, Greece

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is looking for signs of wealth using satellite data. Not a bad idea where more than 15,000 swimming pools went unclaimed to tax authorities in 2010. The money-strapped country is looking at increasing their tax revenues using remote sensing applications using satellite imagery.

4. Spinning the globe with mapping services like Google Earth, Bing Maps and OpenStreetMaps

Google Earth gives us an interface with updated satellite and aerial imagery at our fingertips for free. The convenience of knowing your location before you go with street view is mind-blowing.

5. Predicting retail earnings and market share by counting cars in parking lot

Investors find using satellite imagery at big box store parking lots gives the most bangs for their buck. The number of vehicles gives a snapshot of earnings, conversion rates and market share. It's a simple high-tech strategy that can give market analysts the information needed.

6. Snapping aerial photos for military surveillance using messenger pigeons in World War II

No matter what the occasion is, a wedding, birthdays and times of war. Pigeons almost never follow their flight path and almost never return cameras to their owners. These were the hard lessons learned when the German military used the Bavarian Pigeon Corps to do their dirty work and spy on enemies.

7. Charging higher insurance premiums in flood-prone areas using radar

Some of the remote sensing applications insurance companies are using include radar and hydrological modelling. Geographers can map out areas more prone to flooding, how often these areas would flood and how badly the damage could be.

8. Doing the detective work for fraudulent crop insurance claims

As climate becomes less predictable and more destructive (such as droughts and floods), farmers have to adapt to this new reality. In these cases, crop insurance can help farmers supplement their income when their fields don't get seeded. Insurance companies and the United States Geological Survey (USGS) are teaming to up to fight crop insurance fraud. The USGS measures vegetation growth using Landsat's red, infrared channels in combination with NDVI. Using this information, crop insurance companies can verify seeded crops and catch fraud.

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9. Searching for aircrafts and saving lives after fatal crashes

Of all remote sensing applications, there may be no other that touches the heart as much as saving another life through search and rescue. Hundreds of satellites orbit the Earth each day. Each one has its own live-saving ability – but only if it's in the right time and place.

10. Detecting oil spills for marine life and environmental preservation

Oil spills have profound effects on marine life and the surrounding environment. An oil spill requires a quick response so the oil doesn't disperse. Satellites can maximize the search for oil slicks. Not only can satellites determine the extent of the oil spills, they can identify the direction and rate of oil movement. This computer model uses current, ocean and weather forecasts, also obtained by remote sensing.

11. Counting polar bears to ensure sustainable population levels

The sad story about the polar bear is that it is listed as one of the first animals that will become extinct because of global warming. Ecologists are turning to satellites as their primary source of information because they need a firm count on polar bears for their survival.

12. Uncovering habitat suitability and fragmentation for panda bears in protected areas

Giant pandas eat bamboo for 99% of their diet making them the ultimate bamboo-holic of the animal kingdom. Habitat is important for pandas. This makes roads and infrastructure ecological armageddon for pandas. Fragmentation and corridor mapping are remote sensing applications being used to protect the endangered panda.

13. Identifying forest stands and tallying their area to estimate forest supplies

Global forest supplies are being monitored because they not only provide valuable materials but they also absorb roughly one-third of carbon dioxide emissions. AVHRR, MODIS and SPOT quantitatively measure the loss and gain of our global forests.

14. Navigating ships safely with the most optimal route

Icebergs still threaten ships 100 years after the Titanic sunk. Ship navigation has improved. GPS is not the only ship navigation tool. Other remote sensing applications in ship navigation include routing analysis, wind and wave information and ship proximity.

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15. Measuring wind speed and direction for wind farms, weather forecasting and surfers

Golfers, farmers, pilots, engineers and wind turbine planners need accurate wind information. Weather balloons and GPS are a good way to do this. But it's not the only way. NASA's QuickSCAT scatterometer and wind LiDAR are making these large-scale wind observations too.

16. Spying on enemies with reconnaissance satellites

Militaries are harnessing the power of satellite imagery to retrieve intelligence on enemies. As for remote sensing applications, reconnaissance satellites go all the way back to the 1950's US Corona Program. Its purpose was to spy on the Soviet Union and China after the war. But satellites have come a long way from taking photographs and parachuting down to the surface.

17. Delineating and assessing the health of riparian zones to conserve lakes and rivers

Riparian zones are the wooded areas along the water's edge. They are the last line of environmental defence from nutrient runoff for our lakes and rivers. Of all remote sensing applications in environment, riparian zones perhaps require the highest spatial resolution because of its small width. A Landsat-8 pixel might not be able to do the job here. As water spans the entire globe, riparian zones are there too serving their duty.

18. Estimating surface elevation with the Shuttle Radar Topography Mission

Imagine you are a surveyor and your crew chief asks you to survey the whole world. You need to map 30 meter grid cells and are given only 11 days. What would you say? This is essentially what NASA's Shuttle Radar Topography Mission (SRTM) did in 11 days. The secret to its success is Interferometric Synthetic Aperture Radar.

19. Extracting mineral deposits with hyperspectral remote sensing

There are over 4000 natural minerals on Earth. Each one has their own chemical composition. This is the equivalent to saying that each composition has its own spectral reflectance. Having more spectral bands like hyperspectral sensors gives potential to map more minerals. There is some predictability with remote sensing applications for geology and minerals. After spotting one mineral, almost certainly other specific minerals accompany it.

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20. Watching algae grow as an indicator of environmental health

Watching algae grow is about as much fun as watching paint dry. But you can learn a lot about a lake's health by studying algae. It's an indicator of the amount of nitrogen and phosphorous is being fed into the lake. Reducing nutrients is important because if affects local economies like fisheries and tourism. This is why NASA is using hyperspectral sensors to learn biochemical properties of algae blooms and even predict their locations.

21. Forecasting weather to warn about natural disasters

Remote sensing applications like weather forecasting and monitoring are fundamentally important for businesses, athletes and tourists. In 1975, the Geostationary Operational Environment Satellite (GOES-1) was launched to collect wind, temperature and other atmospheric data. But GOES-1 was limited to a small portion of the Earth. A lot has changed since then. We are now on GOES-12, 13, 14 and 15 with improving temporal, spectral, spatial and radiometric resolution.

22. Detecting land cover/use types for decision making

'Land cover' is the physical property of the surface. 'Land use' explains how land is being utilized. A Landsat pixel spans multiple parcel boundaries and is not a realistic representation of tree canopy. The Spatial Analysis Laboratory (SAL) of Vermont compared the National Land Cover with object-based classification and found it was significantly underestimated (11% vs 39%).

23. Monitoring the environment with the ESA's Copernicus Program

As for remote sensing applications in environment goes, the European Space Agency's (ESA) Copernicus Program may be the most ambitious yet. The goal is to achieve a completely autonomous monitoring system. Its purpose is simple – understand the health of the Earth. Copernicus' six Sentinel satellites collect comprehensive pictures of the following themes: land, ocean, emergency response, atmosphere, security and climate change.

24. Mapping soil types for agriculture planning

Over time, rocks break down into small pieces and become soil. With soil, water and sunlight, together they give plants and other organisms a place to live. But not all soils were built the same. The need for accurate soil information around the world

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is soaring because of population growth and food security. This is why the International Soil Resource and Information Centre (ISRIC) has placed soil mapping as a key priority. ISRIC has developed a methodology to predict spatial soil properties in 1 km grid cells at a global level. A global spatial prediction model was developed using covariates such as climatic indices (based on MODIS imagery) and conventional soil surveys.

25. Preventing the spread of forest disease types

Billions of people depend on healthy forests for their livelihood. The rapid spread of forest disease can have catastrophic effects on ecosystem health and local or national economies. The mountain pine beetle has infested over 17.5 hectares of forests. These infestations are characterized by distinct color changes. Forest diseases such as the mountain pine beetle can be controlled because remote sensing applications and monitoring. Learn more: Tiny Beetles Take a Large Bite Out of the Forest

26. Fighting wildfires by planning fire fighter dispatch

Wildfires cause serious damage to property and even loss of life. For these reasons, there is a need to control wildfires and lessen their impact. Satellite data enables firefighters to be dispatched with pinpoint accuracy. Operational satellites like AVHRR and MODIS are best suited because of their mid-infrared and thermal bands.

27. Monitoring air quality in the lower atmosphere

Some cities are so polluted that it's the equivalent of smoking a package of cigarettes each day. 80% of these over-polluted cities are in China. One of the major pollutants is carbon monoxide. Carbon monoxide is color less to the human eye but not for MOPITT (Measurements of Pollution in the Troposphere) on NASA's Terra satellite. MOPITT uses a spectrometer to measure upwelling infrared radiation in the lower atmosphere.

28. Assessing terrain stability using interferometry in the oil and gas sector

Active sensors use phase difference to measure landscape deformation. This technique is called interferometry (abbreviated inSAR for Synthetic Aperture Radar). Industries like the oil and gas sector monitors terrain stability using remote sensing applications like this. Continual satellite data means higher safety and ensures pipeline productivity.

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29. Unearthing ancient archaeological sites like the Mayans and ancient Egypt

Unearthing ancient archaeological sites must be one of the neatest remote sensing applications on the list. Remote sensing applications in archaeology include infrared and stereo imagery. Infrared radiation has longer wavelengths and can penetrate around a meter of depth in the surface. Stereo imagery shows subtle variations in elevation on the ground. It was a bit of a surprise when archaeologists found square patterns on the ground over vegetation growth. These square patterns are of course ancient buildings and pyramids. Ancient Mayan and Egyptian civilizations have already been discovered using remote sensing applications like photogrammetry and infrared.

30. Pinpointing your position on Earth with Global Positioning Satellites

In May 2000, the GPS switch (also known as selective availability) was flicked. Suddenly, accuracy has changed from the size of an airport to the size of a small shed. GPS has led the way to great innovative products like car navigation systems and unmanned aerial vehicles. It's no wonder why the GPS has been ranked one of the top 50 greatest breakthroughs since the wheel.

31. Optimizing solar panel energy output with global horizontal irradiance

Energize your search for endless solar panel input. If you were going to choose a single location anywhere on Earth to install a solar panel, it would have to be the Global Horizontal Irradiance (GHI) map. GHI measures the rate of total incoming solar energy at the Earth's surface in watts per square kilometer. Decades of satellite data (derived from GOES and Meteosat) has generated this data with a standard error of only 5%. This remote sensing data brings some serious heat.

32. Finding the driving factors that contribute to poverty

Remote sensing is exploring some of the driving factors that contribute to poverty. Governments can get a clear picture of poverty and provide concentrated support to those in need. Studies have shown how agricultural use, natural resources and other environmentally-determined factors were linked to poverty. All these contributor factors can be assessed with remote sensing applications.

33. Observing the flow of ocean currents and circulation

70% of the Earth is covered by water with most of it in oceans. All oceans are

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connected by the flow of current. At the surface of the ocean currents are mainly driven by winds. But deep below the surface, currents are controlled by salinity and temperature. Satellites can achieve an enormous wealth of information on ocean currents and circulation. Ocean Surface Current Analyses – Real Time (OSCAR) is a near real-time global ocean circulation dataset based on NOAA and NASA's sea level altimetry, surface winds and sea surface temperature.

34. Studying glacier melts and effects on sea levels

Glaciers hold the largest freshwater reservoir on Earth. 99% of glaciers are found in the Polar Regions. NASA's GRACE satellite showed that the Alaskan glaciers were losing mass at about 20.6 gigatonnes per year. But the scary takeaway is the rapid melting ice and its profound effects on sea levels.

35. Providing a basemap for visual reference and assisting orient the map reader

Orthoimagery provides an extreme amount of detail of the focus and surrounding areas. Maps are designed to communicate a message. As maps are location-based, aerial imagery assists readers orient themselves. It provides context and reference information and can instantly provide the lay of the land. And nowadays, there are so many sources to choose from: Bing, Google, Open Street Maps, NASA's Globeview.

36. Snorkeling in an oasis of marine vegetation with the coastal channel

Snorkel in an oasis of marine vegetation using Worldview's coastal channel. Because of its finer level of spectral penetration in coastal areas, underwater reefs and bathymetric mapping makes for some unique remote sensing applications.

37. Tracking hazards for better response and recovery

There's been a clear upward trend in the number of disasters over the years. This means better preparedness for mitigation as well as response and recovery. The integration of Earth observation data and GIS in hazard situations has become the main tools in disaster managements. Remote sensing applications for hazards include assessing the extent of damage and assisting dispatch.

38. Keeping tabs on the shift from rural to urban growth

We've experienced an increasing number of people migrating from rural to urban areas. Urbanization is linked to

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industrialization. 50% of people are now living in urban areas and according to the United Nations, this pattern will continue. Urbanization is an interesting phenomenon that can be clearly seen as impervious surfaces from satellites.

39. Quantifying crop conditions with Normalized Difference Vegetation Index (NDVI)

The global food supply is being monitored with satellite imagery and the Normalized Difference Vegetation Index (NDVI). Near-infrared radiation is being used to detect healthy vegetation in agriculture. Healthy vegetation reflects green light and absorbs red and blue light. The green light that our eyes see is chlorophyll created by plants during photosynthesis. Chlorophyll will reflect more light in the green and near infrared spectrum compared to other wavelengths. This is why near infrared radiation in combination with NDVI is one of the primary remote sensing applications in agriculture and the environment.

40. Preventing the degradation and loss of wetland ecosystems

Once seen as a nuisance in agriculture, wetlands are being drained and lost. Suddenly, they have become a rare precious resource. Wetlands serve many purposes. They help purify water, control flooding and improve shoreline stability. This is why remote sensing applications to inventory wetlands have grown so much over the years.

41. Tracking sediment transport into rivers and lakes

Sediment loading is one of the most profound anthropogenic factors on aquatic systems. It affects industries like tourism, fisheries and ecological functioning. It would be useful to understand exactly where suspended solids enter and leave. The reflectance of water in satellite imagery increases with more suspended solids. But in order to monitor nutrient loading, there needs to be repeated coverage and temporal analysis.

42. Saving money and time on the farm with precision farming

Precision farming is like a hidden goldmine in agricultural production. Savings estimate 10% in fertilizer. On top of that, crop yields are also improved. Precision farming uses different wavelengths of light to see how healthy crops are. Variable amounts of fertilizer are worked out keeping money in farmer's pockets.

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43. Reversing illegal rainforest cutting in Brazil

The Surui tribe in Brazil has teamed up with Google to reverse rainforest deforestation. The Surui tribe are equipped with high-tech tools like Google Earth, smart phones and GPS. They keep a watchful eye on illegal mining and logging. The good news is that miners and loggers have retreated and illegal activities are at their lowest levels in history. The information potential with satellites for understanding illegal rainforest cutting is enormous. Learn more: Google Earth Outreach to Surui Tribe

44. Putting illegal boat dumping under the microscope

When a boat was dumped illegally with all identification removed in Santa Rosa County, crime investigators took their search to Google Maps. Using historic aerial and satellite imagery, they went on a hunt for its rightful owner. What crime investigators found was the same boat and the address of the illegal dumper. Case closed.

45. Inventorying and assessing rural road conditions with UAVs

How safe are your roads? Transportation planners have been taking some down to Earth advice on unpaved roads. With the integration of remote sensing and GIS, unmanned aerial vehicles are providing answers on pothole detection, washboard analysis and crown conditions for unpaved roads. With centimeter accuracy, rural road conditions can be assessed and inventoried saving time and money.

46. Driving with no hands (autonomous vehicles)

If Google's self-driving car got pulled over by the cops, how would it react? The first secret behind the car is the LiDAR which detects pedestrians, cyclists, stop signs and other obstacles. Put this together with a GPS, inertial measurements and a really sophisticated piece of software, and you have a self-driving car.

47. Measuring gravity with the GRACE satellites

This may be one of the neatest remote sensing applications on the list – measuring gravity. GRACE stands for Gravity Recovery and Climate Experiment. GRACE consists of two satellites in the same orbit approximately 220 kilometers apart. When the leading satellite increases speed, this means there is a greater gravitational pull. If the leading satellite slows down, this means there is less gravitational pull. These pulls in gravity are measured using microwave pulses

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from one satellite to the other. The end result is the most accurate measurements of gravity to this date. Learn more: NASA's Gravity Recovery and Climate Experiment (GRACE)

48. Deriving elevation and contours using photogrammetry

Photogrammetry dates back to the mid-nineteenth century. It is used to find the geometric properties of objects by measuring distances between objects. Some of its derived products in GIS include contour mapping, surface models, volumetric surveys and 3d mapping. It's also used in other fields such as for crime scene mapping, archaeological excavations and architecture.

49. Watching the aurora borealis from another angle

When charged particles from the sun get caught in the Earth's magnetic field, they slam into the gases of our atmosphere. The different colors we see are from the different gases. If you've watched the Aurora Borealis from the ground, you might want try from up above. One of the most surreal videos is watching the International Space Station's view of the Aurora Borealis.

50. Comparing the past and present with human impact change

The Landsat missions are the longest-running Earth observation missions ever. Its digital records date back to the 1970s. If we want to understand landscape change, the Landsat missions give us a snapshot back in time. We can learn from the past for future generations. Oil spills, deforestation, wars, chemical spills, dead zones, smog are unnatural, man-made disasters. All are preventable and can be viewed from space.

51. Planning an optimal telecom network capacity

It's estimated that 87% of the world population now use mobile devices. The astounding rate of growth in this industry requires extensive planning for optimal network capacity. Telecommunications companies are using remote sensing as a cost-effective way to optimize capacity requirements. Radio frequency coverage can be augmented with the appropriate antenna type, location and direction. Satellite-derived terrain, land use and other environmental factors can be modeled to achieve optimal network capacity.

52. Tracking displaced refugees to help deliver aid and services

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A solution to tracking refugees and camp conditions is with satellite imagery. The United Nations High Commissioner of Refugees (UNHCR) wanted to deliver aid and services to Sudanese refugees in Tongo. They needed a clear understanding of the situation at Tongo refugee camps. UNHCR mapped the influx of refugees, agriculture, waterways and infrastructure using satellite imagery. As a result, UNHCR was able to better manage and deliver aid where needed.

53. Covering the most ground in search of road cracks

Some constructive advice is to cover more ground with remote sensing data. The city of Solvang, California is taking their road management issues very seriously. In one complete shot, public works used satellite images to locate damaged paving. The public is served best as crews know exactly which roads are in desperate need of repair.

54. Getting a top-down view when purchasing real estate

When you're in the market to purchase a home you want the complete view of the property and surrounding area. Schools, shopping districts and parks are all things that potential buyers are interested in knowing before their home purchase. This is why the use of satellite imagery in real estate has been a real growth segment. It also allows everyone in the home buying process a top-down view. Appraisers, insurance companies and lenders can get a quick glimpse of the home through the convenience of the internet.

55. Keeping a watchful eye to prevent future atrocities from happening

Atrocities often result in a change of environment, destruction of buildings and migration of people. They can occur in secretive areas with military regime restricting access. For these reasons, remote sensing applications and imagery are keeping a watchful eye on atrocious acts. GaTHR (Geospatial Technology for Human Rights) are using this approach to help those who are victims. Specifically, satellite remote sensing provides the legal evidence, to help on-the-ground coordination and prevention of future illegal activity.

56. Designing a lift irrigation system to supply water in India

A lift irrigation system can improve water supply for agriculture and other industries. Planning the design of lift irrigation systems require a wide range of data. Satellite stereo image pairs and photogrammetry are particularly useful for

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generating datasets like digital terrain models. The engineers can get the full view on the ground before commencing construction.

57. Measuring the volume difference at a uranium enrichment site using 3d mapping

SAAB's Vricon Rapid 3D Mapping System is really how to make your data come to life. Multiple 3d satellite images can be combined to understand change detection in the third dimension. Using five satellite acquisitions and the 3d mapping system, volume difference at a uranium enrichment site was successfully mapped in Iran.

58. Helping provide clean drinking water with basemaps

Water is life's most basic need. But nearly 1 billion people live without clean drinking water. The first step in solving this problem is identifying areas that are in need of water. High spatial resolution satellite imagery can really differentiate where water shortages exist. This is the starting point to an action plan. Simple remote sensing applications like base maps can positively affect the lives of millions by establishing where and who is in need of essential resources like water.

59. Monitoring active volcanoes using thermal remote sensing

Volcanoes form when hot molten rock from the upper mantle finds its way to the surface. Eruptions are dangerous to humans and the surrounding environment. There are over 600 active volcanoes on Earth. Volcanoes are often inaccessible (unless you are Mario or Luigi) making remote sensing applications like thermal and mid-infrared clear solutions for understanding volcano activity. AVHRR and MODIS are prime candidates for volcano monitoring.

60. Inventorying potential landslides with interferometry

Landslides are often under-represented for hazard research. But every year in the United States, landslides cause loss of life and billions of dollars in damage. The first step in inventorying potential landslides is using stereo and optical images with slope. Slope instability triggers can be a number of things – earthquakes, erosion, poor drainage and more. InSAR can provide early warning signs for landslides because how well it measures ground surface displacements.

61. Catching fish and improving long-term fisheries sustainability

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There are plenty of fish in the sea from a satellites viewpoint. Satellites monitor sea surface temperature and ocean colors because they are indicative of specific fish species. The top-down view of remotely sensed data can be communicated with local fisherman. Fishermen use this information to save time and fuel in real-time. In terms of remote sensing applications in fisheries and marine environment, algal blooms can be mapped which are harmful to aquaculture. This improves overall long-term sustainability.

62. Tracking the great distances of migratory birds and inspecting their prevalence

Birds travel great distances in search of food, climate and breeding sites. Light-weight GPS telemetry is just one of the tools being used to know where birds migrate. As forests become more limited, migration patterns are important for wildlife managers. Remote sensing applications like LiDAR, multispectral and radar can show forest properties like vertical structure and phenology. Habitat suitability models predict the prevalence of bird species using these forest properties.

63. Preventing the spread of diseases in epidemiology

The birth of epidemiology came shortly after Jon Snow mapped the spread of cholera from a contaminated pipe in 1854. Ironically, this was also the birth of Geographic Information Systems. There is a clear connection for epidemiology and geography. Some diseases are best-suited for climate, land use and air. Remote sensing applications in health use these remote sensing data and prediction models to understand epidemiological processes.

64. Recording video footage from satellites

A new, innovative approach that has entered the market is satellite video. Some remote sensing applications include watching airplanes depart/land, examining rush hour traffic and spying on your neighbor. These can all be done from the comfort of your own home, all movie footage courtesy of satellites. The future may be for remote sensing software applications to process videos, instead of still images.

65. Quantifying the damage after an earthquake

The result of an earthquake can be catastrophic and at times difficult to assess. But an earthquake assessment is essential for rescue workers. They need to be done quickly and with accuracy. Object-based

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image classification using change detection (pre- and post-earthquake) is a quick way to get damage assessments. Other remote sensing applications in disaster assessments include casted shadows from buildings and digital surface models.

66. Looking at the Earth as an art masterpiece

Some of the most breathtaking views are from space. Evidence of this is in NASA's 75 page collection of Earth images seen from space. The collection of Earth observation images were taken from the Terra, Landsat, EO-1 and Aqua satellites. In this Earth art masterpiece, you can find some of the most intriguing patterns and geometry of our oceans, atmosphere and land features.

67. Recognizing buildings easily with the bird's eye oblique view

There's some sort of irresistible magnetism people have for the bird's eye oblique view. Pictometry are the specialists of oblique image photography. The logic behind it is that when you view the world at a 45 degree angle, it's much easier to recognize land features (like from an airplane window). This is why Google and Bing maps have added this functionality to their interfaces.

68. Mapping the mysteries of our ocean floors

In this day and age, we have most of the world mapped. The world is at our fingertips with a wide range of open source mapping applications. The next challenge is mapping the ocean floor. ESA's CryoSat-2 and NASA's Jason-1 satellites have pieced together the most complete picture of our ocean floor and subfloor features. The pull of gravity reveals underwater mountains and seafloor topography.

69. Understanding the human rights situation in North Korea

Remote sensing can give an in-depth look at hermit kingdoms like North Korea. Remote sensing enables what some travelers may never get to see in their lifetime. Ostrich farms, breweries, towers – all uniquely North Korean. But satellites also enable to see the darker side of North Korea. For those wanting to escape North Korea, they are sent to prison camps. These camps are clearly seen from the skies.

70. Comparing climatic factors from past to present

Understanding the state of our climate has immeasurable importance. NASA is mapping different climate factors on a

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monthly basis to see how much these variables change. Through this lens, climate variables like carbon monoxide, chlorophyll and aerosol size are being mapped as a function of time. Remote sensing satellites include MODIS, CERES, AMSR-E, TRMM and MOPITT. Never in our history have we understood Earth's climate as we do today. Learn more: NASA's Global Time-Series Climate Maps

71. Monitoring the global sex trade situation in remote areas

The global sex trade is a growing international crime where one's rights are violated through commercial exploitation. Often involuntary, the flow of human trafficking has been tracked using the latest satellite imagery from NASA. The flow of human trafficking often crosses boundaries and done secretively. Remote sensing makes it possible to overcome these barriers and provide evidence for human trafficking globally.

72. Assessing fuel economy of vehicle emissions

Governments have been putting pressure on vehicles to meet emission standards. Satellites can monitor fuel economy and emission standards with minimal interference from the sky. Multispectral remote sensing can measure vehicle emissions such as CO, HC and NO. Ideas have been toyed around with to impose surcharges based on distance driven and improperly maintained equipment. Satellites offer a golden opportunity to control pollution from motor vehicles.

73. Providing early warning signs for famine over large scales

Governments want early warning signs for famine to deliver appropriate food supplies to areas of shortage. Early warning signs for famine have been developed which incorporates vegetation growth and crop yield forecasting. Flooding and drought can be better understood with satellites like SMAP and SMOS. Remote sensing satellites go from moving around orbit into moving our understanding of global famine.

74. Mapping regional economic activity at night

We're giving glowing reviews for night-time remote sensing applications. The total amount of radiance gives insight on regional economies, access to electric power and distribution of income. Higher radiance correlates with Gross Domestic Product and has also been compared with human well-being. Who would've thought you could learn so much by looking at

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Earth at night? Learn more: Mapping economic activity at night

75. Studying geology of the Earth's surface

Geology is one of the rare things that stays constant in our lives. Every landscape, plant and animal we see today are affected by the rocks, material and nutrients. All have an origin from geology. Some of the remote sensing applications in geology include bedrock, lithological and structural mapping. Multispectral spectral reflectance has provided valuable information on rock composition while radar has also been useful in studying surface roughness.

76. Assessing the environmental change and promoting biodiversity in parks

There's no kidding around of the importance of parks. Parks provide a home for a large number of animals and species at risk. They often prohibit development and are used for camping and recreation. Parks can be large in scale making them a difficult resource to manage. Remote sensing data gathered over time can show landscape change. Some remote sensing applications in parks include mapping biodiversity, invasive species and forest fire risk.

77. Measuring albedo for Earth's radiation budget

Albedo measures the percent of reflected sunlight. A darker surface will heat up quickly and absorb sunlight. Brighter surfaces like snow reflect much sunlight back to the atmosphere. Albedo is a key component in the Earth's radiation budget. In order to calculate total albedo, each land cover type is assigned an albedo value. Multiply albedo with the land cover type and sum to measure total albedo.

78. Locating groundwater activity for wells

Earth is surrounded by water in the form of oceans, rivers and lakes. At the ground below your feet is even more water in the form of groundwater. An aquifer stores groundwater. There are thousands of wells that draw water from aquifers. This water is being used in agriculture, drinking water and more. This is why it's important to have good spatial knowledge of groundwater. Groundwater activity can be understood by its rock types, soil, land use and rainfall. Remote sensing groundwater prospect zone maps are used to locate well sites.

79. Observing population growth in urban areas using land use change

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Urban planners want to know population growth and distribution to optimize development and improve the well-being of citizens. Land use change can be modeled to provide an accurate measure for population growth. Not only is it accurate, but land cover provided more detail for population growth distribution within cities and census tracts.

80. Keeping a watchful eye on biodiversity

Biological diversity (biodiversity) is the wide variety of animals and plants in a geographic location. With the spatial and spectral resolutions of sensors improving year by year, remote sensing applications in biodiversity are beginning to play a larger role. It remains in the early development stage but strides are being made using hyperspectral and 3d vegetation structures using LiDAR.

81. Keeping an inventory on cemeteries using UAVs

The Czech Republic implemented a system to map cemeteries using unmanned aerial vehicles UAVs). Over 80,000 graves were captured at 1 cm pixel resolution. Not only was this faster than manually recording each cemetery in the field, but a digital record of the imagery remains. UAVs were a low-cost and highly accurate solution for cemetery mapping. The result was a spatial database and tax dollars saved.

82. Predicting the occurrence of dinosaur tracks for paleontologists

Remote sensing gives the inside track on understanding exactly where dinosaurs once roamed the Earth. Cantwell Foundation lists four primary geospatial factors in the occurrence of fossil sites. These four factors are vegetation coverage, slope, aspect and proximity to landslides and all can be obtained using remote sensing. Forget about doing guess-work and put your best foot forward.

83. Delineating watersheds using DEMs for hydrologists

A digital elevation model determines where and how water flows in a watershed. Hydrologists are interested in the hydrologic budget when they study watersheds. Inputs are precipitation, surface flow and groundwater flow. Outputs are evapotranspiration, infiltration and surface runoff. Remote sensing contributes to watershed delineation by providing accurate elevation data. Digital elevation models are used to accurately represent stream flow paths and the contributing areas with software systems like HEC and Geo-HMC.

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84. Using habitat suitability models to predict the abundance of mosquitoes

Habitat suitability models are making some interesting predictions on the abundance of mosquitoes. Remotely-sensed factors such as greenness, brightness, temperature and especially moisture positively correlate with the over-occurrence of mosquitoes. Knowing the location of high concentrations of mosquitoes can guide risk assessment for disease carrying pathogens and mosquito fogging efforts.

85. Using a least-cost analysis and vegetation to understand wildebeest migration

Tanzania hosts one of the greatest migrations on Earth. More than 2 million wildebeest migrate and give birth on the same month. The purpose of migration is locating food resources. But can we model their movements? Research has shown that variables like vegetation (NDVI) and relief (slope) are drivers for wildebeest movement patterns. However, rainfall may also have an impact on migration patterns as well.

86. Assisting cities manage assets and ensuring safety standards

Companies like CityScan use mobile LiDAR to assist cities manage their assets and ensure safety standards. Each year, cities and municipalities issue thousands of permits for construction. This massive volume of permits makes it difficult for cities to manage activity. Using mobile LiDAR collection and comparing it with municipal data, CityScan ensures construction activity is safe and properly permitted. Road conditions, utilities, billboards and sign inventories are some of the other remote sensing applications in asset management.

87. Calculating the depth of snowpack

Forget about putting on your winter jacket and scarf for measuring snowpack depth. Snowpack is the accumulation of snow over extended periods of time. They feed into rivers as the snow melts. This is why snowpack makes an important source of information for flood control and drinking water. As you can imagine, there is a high level of difficulty measuring the depth of snowpack. NASA has had the most success using LiDAR and a spectrometer to measure albedo and snow depth. Both these variables explain the absorption of sunlight and rate of snowmelt.

88. Planning spine-jarring black diamond ski runs with aspect data

In countries like Canada and Russia, the territory is wide and below freezing for a

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good portion of the year. The mountainous terrain is ideal for ski resorts. But with so much ground to choose from, site selection is more difficult. This is why recreation planners are turning to laser technology for planning ski resort location. Aspect data refers to the horizontal direction a mountain slope faces. The greater the angle, the more black diamond ski runs.

89. Improving efficiency and safety of air traffic control

Air traffic control directs aircrafts from the ground to prevent collision and improve the flow of traffic. Unfortunately, there are excessive dollars and emissions wasted on inefficient routes. The next generation of air traffic moves from ground-based radar to a satellite-based GPS system. The new air traffic control system aims at improving routes, reducing traffic delays and saving money. It also intends to assist planes land faster and help navigate through weather with the use of satellites.

90. Spotting undeclared nuclear power plants automatically

The International Atomic Energy Association plans to verify the absence of undeclared nuclear power plants. A typical nuclear power plant contains at least one circular cooling tower with thermal emissions possibly being released. Nuclear plants are also located near bodies of water and more than often connected with a road or railway. Given this set of criteria, the use of object based classification and multispectral imagery aims at automating the search for undeclared nuclear power plants. Not a bad start – 5 out of 5 were already successfully automatically identified.

91. Narrowing down a search for a missing body

Remote sensing can save time, money and manpower in locating missing people. Crime detectives want to narrow down their search before they go in quest. Remote sensing tools can explore the search area with a fine-tooth comb and pick up anomalies on the ground. This could include anything from a rabbit hole to the crime scene, itself. This is truly time saver if you have a rough idea of the search location.

92. Monitoring oil reserves by looking at floating oil roof tanks

All it takes to monitor oil reserves from the sky is a bit of geometry and some high

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spatial resolution imagery. Oil tanks are usually circular with a floating roof tank to prevent evaporative losses. Satellites can look at how much shadow is being casted in relation to the floating roof. More shadows means less oil reserves. Remote sensing applications like this make use of satellite imagery without having to physically measure each oil tank.

93. Finding ghost cities on the map

If you build it, they will come. Well, not really in the case of China's "ghost cities". Some of the most peculiar satellite imagery shows the construction of apartments, shopping malls and other amenities. But practically nobody lives there. Economists have their eyes on China to push global economic growth. What they've found is that GDP and employment numbers may be deceiving, if resources are improperly being allocated to sectors without demand. Satellites can indicate how real or artificial economic growth is.

94. Spotting swimming pools for late-night dives

Not all satellite imagery is used for good intentions. If you own a swimming pool, it may be a target for a strange craze called 'dipping'. Teenagers have been using aerial and satellite imagery on Google Earth to locate swimming pools. At night, they would take an impromptu dip in any the largest pools they could find. This activity is of course trespassing (which is a crime). In other words, don't try this at home, kids.

95. Reducing traffic jams using change detection

Our increasing populations and urbanization has led to increasing amounts of traffic in urban centers. Traffic jams mean wasted fuel and time. Ground measuring systems provide extremely precise traffic volumes but it's limited to selected roadways. Traffic density is being monitored using change detection. Traffic analysts can compare two satellite images with slight lags. This shows traffic movement over a larger picture.

96. Measuring the size of protests for journalists

How big is the size of the protest? It's something journalists always want to know because it quantifies how strong people's opinions are on a subject matter. Counting every head in a protest can put you to sleep, as it does with sheep. With differing spatial resolution, you can at least see how big the crowd is. But to provide the best estimate, you need area

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and density of protesters – both can be roughly obtained by remote sensing data.

97. Measuring the rise of sea levels

Every year Venice is sinking a little more. Measuring the rise of sea levels is a perfect example of a large-scale application done in a cost-effective manner. There is no need to go on the beach and bring out your measuring stick at sea level all along the coast. In order to understand sea level rise, you need good baseline spatial data. Measuring sea level rise is a function of time with centimeter accuracy measurements using remote sensing data.

98. Creating an automated road network instantly

Urban planners, emergency crews and navigation systems require up-to-date road networks. As new neighborhood sprout up, it's challenging to keep road network databases updated. An approach using multispectral images and object-based classification has automated the tedious process of generating road networks. One of the key challenges has been differentiating parking lots from roads.

99. Picking up on signals from submarines in shallow water

Submarines have the reputation of being excellent spies because they are capable of operating under water. Much research on using earth observation data to track submarines has been kept on the down-low. But new insights indicate some capacity to detect submarines at shallow depths. Satellites might see subtle undersea disturbances caused by submarines using SAR. Another indicator may be vibrations in ocean temperatures using infrared detectors. This means submarines may have no place to hide at all.

100. Exploring, protecting and navigating in the arctic

Things are kind of in flux now for 'who' is claiming 'what' in the Arctic. The US, Russia, Canada and Danish are all staking their territory. But no one can tap the Arctic until all countries come to an agreement. Mineral extraction, natural gas, as well as potential shortcuts for shipping routes – the Arctic may be one of the last great frontiers for human development. Heavy duty tasks like sea ice monitoring, ship tracking and national defense makes satellites a heaven-sent opportunity for maintaining sovereignty in the North.

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CONCLUSION

Satellite information is fundamentally important if we are going to solve some of the major challenges of our time. For issues like climate change, natural resources, disaster management and the environment, remote sensing provides a wealth of information at a global scale. What we get are answers to these problems so we can make informed decisions.

There are endless possibilities of benefits to society from remote sensing. With higher spatial, spectral and temporal resolution, the future of remote sensing is promising. If we are going to take on some of the biggest challenges of Earth in the near future, we need remote sensing to cover that much ground.

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