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Remote Sensing Application in Monitoring and Management of Soil and Water Pollution

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SUMMARY

Pollution, encompassing various contaminants introduced into the environment, adversely impacts human and ecological health, with far-reaching consequences for social and economic systems. Among the types of pollution, soil pollution is often caused by industrial activities, agricultural chemicals, and improper waste disposal, while water pollution stems from industrial discharges, untreated sewage, and runoff containing contaminants. Remote sensing, involving passive and active methods, employs sensors on satellites or aircraft to monitor and manage soil and water pollution. In water resource applications, it aids in tasks such as snow and glacier mapping, water quality monitoring, and flood forecasting. For soil pollution, remote sensing assists in identifying pollution sources, monitoring land use changes, detecting contaminated areas, assessing water quality, and tracking changes in soil moisture, utilizing sensors like Landsat, SPOT, and high-resolution imagery. The technology proves invaluable in understanding and mitigating the impact of pollution on the environment.

INTRODUCTION

Pollution is the introduction of contaminants into the natural environment that cause adverse change. Pollution can take the form of any substance (solid, liquid, or gas) or energy (such as radioactivity, heat, sound, or light). Pollution has widespread consequences on human and environmental health, having systematic impact on social and economic systems.

Types of pollution

Soil pollution

Soil contamination, **soil pollution**, or **land pollution** as a part of land degradation is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste. The most common chemicals involved are petroleum hydrocarbons, polynuclear aromatic hydrocarbons (such as naphthalene and pesticides, lead and other heavy metals.

Water pollution

Water pollution, caused by the discharge of industrial wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated sewage and chemical contaminants, such as chlorine, from treated sewage; and releases of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides, as well as human feces from open defecation).

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object, in contrast to in situ or on-site observation.

Two types of methods:

1. Passive remote sensing
2. Active remote sensing.

Active remote sensing instruments operate with their own source of emission or light, while passive onesrely on the reflected one.

Passive Remote Sensors used are Geo Eye, World View, Quick bird, Digital Globe and Astrium/ Black Bridge, Pleiades and SPOT.

Active Remote Sensors used are LIDAR, RADARSAT-1 and RADARSAT-2, Airbus defense and space Terra-SAR-X-RADAR satellite.

Remote sensing is a valuable tool for monitoring and managing soil and water pollution. It involves the use of various sensors, typically mounted on satellites or aircraft, to collect data from a distance. This data can be used to detect and analyze changes in the environment, including pollution levels.

Water pollution monitoring

Water quality is affected by materials delivered to a water body from either point or nonpoint sources

Point sources can be traced to a single source, such as a pipe or ditch

Nonpoint sources are diffuse and associated with the landscape and its response to water movement, land use and management or human and natural activities on the watershed.

Major factors affecting water quality in water bodies across the landscape are suspended sediments, algae, chemicals, dissolved organic matter, pathogens and oils.

Remote sensing for water resource

The overall application of RS and GIS in water resources sector can be broadly categorized as below,

- Snow and glacier mapping and monitoring
- Irrigation water management
- Flood disaster monitoring, forecasting and management
- Water quality monitoring
- Watershed management
- Environmental impact assessment

Water quality

Substance (suspended sediments, algae, dissolved organic matter, oils, aquatic vascular plants and thermal releases) in surface water can significantly change the **backscattering** characteristics of surface water. Remote sensing technique depends on the ability to measure these changes in the **spectral signature backscattered** from water and relate these measured changes by empirical or analytical models to a water quality parameter

Snow and glacier studies

The snow cover can be detected and monitored from a variety of remote sensing platforms. Glacier lakes are easily identifiable on **Multi –Spectral Satellite** data of medium resolution (24-30m)to fine resolution (6m). Cloud and snow bound areas appear similar in standard FCC images, which is resolved through **SWIR band** responses in which snow cover areas have low reflectance.

Major sensors used for snow cover mapping

- NOAA-AVHRR
- MODIS-Aqua/Terra
- ResourceSat 1-AWiFS, LISSIII
- LANDSAT-ETM
- ASTER
- SPOT

Remote Sensing for Floods

Land use

- IRS, SPOT, LANDSAT and IKONOSSoil type

Meteorological satellite: GOES and POES, SAR, NOAA, AHVRR)

- Soil type DEM (ERS, SPOT)

Soil Pollution Monitoring

While mapping the soil using RS, the stereo data is highly useful in identification of different landforms, which have got close relationship with soils associated with them.The stereo data from PAN cameras aboard SPOT/ IRS-1C/ Cartosat-1 enable the delineation ofphysiographic units and soil maps derived there from in a better way.

Salinity and water logged area mapping and monitoring.

Due to improper management of soil and water resources in the command areas, the problems of salinity and water logging are reported to be on the increase.

Information on the nature, extent, spatial distribution and temporal behavior of areas under water logging and salinity is essential for proper management if irrigated lands.

Sensors used are:

- Landsat –MSS, TM
- IRS-LISS-I/II/III
- ResourceSat-I
- SPOT
- Very high resolution imagery (QuickBird, IKNOS, CARTOSAT-1 and 2)

Identification of Pollution Sources: Remote sensing can help identify potential pollution sources such as industrial facilities, mining operations, or agricultural areas that may contribute to soil and water contamination. High-resolution satellite imagery and aerial photography can provide a bird's- eye view of the landscape, making it easier to pinpoint these sources.

Monitoring Land Use Changes: Remote sensing can track changes in land use over time. For example, it can detect the expansion of urban areas, deforestation, or changes in agricultural practices.These changes can have a significant impact on soil and water quality, and monitoring them can help identify potential pollution risks.

Detection of Contaminated Areas: Remote sensing techniques, including hyperspectral and multispectral imaging, can be used to identify areas with abnormal vegetation or soil conditions that may indicate pollution. For instance, changes in vegetation health or soil reflectance can suggest the presence of contaminants.

Monitoring Water Quality: Remote sensing can be used to assess water quality in rivers, lakes, and other water bodies. Sensors on satellites can detect parameters such as water turbidity, temperature, and color, which can indicate the presence of pollutants. Additionally, remote sensing can help identify algal blooms and other waterborne contaminants.

Tracking Changes in Soil Moisture: Changes in soil moisture levels can be indicative of pollution. Remote sensing technology, including radar and microwave sensors, can measure soil moisture content across large areas. Sudden decreases in soil moisture may indicate contamination or excessivewater extraction.

CONCLUSION

Remote sensing plays a crucial role in monitoring and managing soil and water pollution by providing valuable data for identifying pollution sources, tracking changes in the environment, assessing water and soil quality and supporting informed decision-making by regulatory agencies and environmental organizations.

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