A REVIEW ON APPLICATION OF REMOTE SENSING IN ENVIRONMENTAL SCIENCE DURING 1999-2022

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Abstract

Environmental science is a field that deals with the study of processes (biological, physical and chemical) on Earth. The use of remote sensing techniques has become an effective tool for mapping large and remote areas, and therefore it has several applications in the field of environmental sciences. Due to the application of this technique, the level of environmental protection and management has increased, and this technique has proved to be useful. Some of the applications of remote sensing technique in environmental science are: Monitoring of forests, Management of natural resources, Protecting water source and course, Air and water quality, Environmental preservation, Detecting physical characteristics, Controlling natural disasters, Weather prediction, Viewing ocean floor, Management of infrastructure, Urban planning, Land mapping and others. In this article, the changing trend of the use of remote sensing technologies in environmental sciences is analyzed over the years. Also, analyzes were carried out regarding publication in scientific journals indexed by Scopus and the field of scientific works.

Key words: *Remote sensing, Environmental science, statistical analysis.*

Introduction. Remote sensing can provide useful information on a number of issues. However, there is no one-size-fits-all solution, as each problem requires unique information. Different tasks may have different data requirements [1].

Natural environment is a universal term for land resources, biological resources, water resources and climatic changes affecting human life and growth. It is directly related to the sustainable development of society and economy [2]. After the industrial revolution, with remarkably growth of the population, the aggregate of human use of natural resources has gradually increased, in particular, the overuse of resources, which leads to environmental degradation, is becoming more and more intense. [3]

For instance, using of fossil fuel and deforestation are actuating global warming and causing fabulous species disappearance [4]but field observation data for various plant functional types are still sparse. This is partly due to the limited availability of commercial SIF measurement systems, the relatively high cost of hyperspectral spectroradiometers, and the difficulties of sensor calibration and maintenance in the field. We developed a filter-based smart near-surface remote sensing system for SIF (4S-SIF. When the pressure on the environment transcend the limit that the ecosystem can stand, the ecosystem gradually declines. Therefore, environmental monitoring has marvelous importance for the protection and use of natural resources reasonable [5]leading to a strong regression of the cover plant. This study was aimed at evaluating the changes in the Taounate forest region landscape between 1975 and 2019 to create awareness in the public about the impact human activities have on the environment and to engage them in its preservation through the integration of residents' knowledge with that of the provincial office in charge of water and forests. The study was conducted in the province of Taounate, which is located in the pre-Rifa and Rifa regions in the north of the Kingdom. The forest estate covers an area of 40,690.96 ha (7%.

The widely used terrestrial monitoring is limited to regions and is only suitable for spot environmental monitoring in a small region. This method is labor intensive, time consuming and resource consuming [6]. Due to the large-scale and dynamic characteristics of the observation, remote sensing sensors are able to quickly obtain a wide range of data on regional and even global levels, so different types of environmental indicators can be gained. Consequently, remote sensing has increasingly become an crucial approach to environmental monitoring, especially on a large or global scale [3], [7]the human activity indexes mainly based on socioeconomic variables have a spatial resolution that is coarser than traditional LUCC datasets, which hinders a deep and comprehensive analysis. In view of these problems, we selected China's Lijiang River Basin as our study area and proposed the use of GPS trajectory data for analyzing the impact of human activity on LUCC from two perspectives: (1.

In this article, an analysis of scientific researches published in the Sciencedirect database was carried out within the scope of the research conducted on environmental sciences through remote sensing technologies [8]we review plant ecophysiological processes affecting optical properties of the forest canopy which can be measured with optical remote sensing by Earth-observation satellites. Spectral reflectance measured by optical remote sensing is utilized to estimate the temporal and spatial variations in the canopy structure and primary productivity. Optical information reflects the physical characteristics of the targeted vegetation; to use this information efficiently, mechanistic understanding of the basic consequences of plant ecophysiological and optical properties is essential over broad scales, from single leaf to canopy and landscape. In theory, canopy spectral reflectance is regulated by leaf optical properties (reflectance and transmittance spectra. More precisely, we conducted a statistical analysis on 4 indicators: the number of scientific works published during the years 1999-2022, the type of scientific development, the name of the published scientific journal, subject area [9], [10]196 samples, including extracted ISW wave crests and corresponding ISW phase speed. We developed an ISW propagation speed (IPS.

Materials and methods: 2.1 Remote Sensing Satellite and Sensor Resources for Environmental Monitoring Environmental monitoring be deeply dependent on remote sensing satellite and sensors which are adept of rapidly gathering spatial and spectral information of large areas on the Earth's surface [11]. Table 1 represents main satellite sensors used for environmental monitoring in the world in last decades.

Table 1: . Major satellite sensors used for environmental monitoring in world.

Satellite	Sensor	Spectral Range (μm)	Spatial Resolution (m)	Revisit Time (day)	Swath Width (km)	Launch Time	Country
EOS-Terra/Aqua	MODIS	0.62–14.38	250/500/1000	0.5	2330	1999/2002	USA
	Aster	0.52–11.65	15/30/90	16	60	1999	Japan
NOAA-TIROS-N NOAA-7–19	AVHRR	0.55–12.5	1100	6	2800	1978.10–2009.2	USA
Landsat (1–8)	MSS	0.5–1.1	80	18	185	1972.7–1984.3	USA
	TM	0.45–2.35	30/60/120	16	185	1982.7–1984.3	USA
	ETM+	0.45–0.90	15/30/60	16d	185*170	1999.4	USA
	OLI	0.433–1.39	15/30/60	16d	170*180	2013.2	USA
	TIRS	10.6–11.2 11.5–12.5	100	16d	170*180	2013.2	USA
IKONOS-2	OSA	0.45–0.9	0.82/3.28	1–3	11.3	1999.9	USA
Quickbird	BGIS	0.45–0.9	0.61/2.44	1–6	16.5	2001.10	USA
GeoEye	GIS	0.45–0.92	0.41/1.65	3	15.2	2008.9	USA
Envisat	ASAR	C band	10/30/150/1000	35	5/100/400	2002.3	Europe
Sentinel-1	SAR	C band	5*20/ 5*5/ 5*5/20*40	12	20/80/250/400	2014.4	Europe
Sentinel-2	MSI	0.4–2.4	10/20/60	10d	290	2016.6 2017.3	Europe
SPOT(1–3)	HRV	0.50–0.89	10/20	26	60	1986.2	France
SPOT 4	HRVIR	0.50–1.75	10/20	26	60	1998.3	France
	VGT	0.45–1.75	1150	26	2250	1998.3	France
SPOT 5	HRG	0.48–1.75	2.5/5/10/20	26	60	2002.5	France
	VGT	0.45–1.75	1150	26	2250	2002.5	France
SPOT 6	NAOMI	0.45–0.89	1.5/6	26	60×60	2012.9	France
SPOT 7	NAOMI	0.45–0.89	1.5/6	26	60	2014.6	France
Rapid Eye	MSI	0.4–0.85	5	1	77	2008.8	Germany
RADARSAT 1	SAR	C band	8–100	1–3	20/50/75/100/ 150/170/300/500	1995.11	Canada
RADARSAT 2	SAR	C band	1–100	1–3	18/20/50/75/100/ 150/170/300/500	2007.12	Canada
ALOS-1	PRISM	0.52–0.77	2.5	2	70	2006.1	Japan
	AVNIR-2	0.42–0.89	10	2	70	2006.1	Japan
	PALSAR	L band	7–100	2	20–350	2006.1	Japan
ALOS-2	PALSAR-2	L band	1–100	14	25/50–70/350/490	2014.5	Japan
HJ-A	CCD	0.43–0.90	30	4	360	2008.9	China
	HSI	0.43–0.52	100	4	50	2008.9	China
HJ-B	CCD	0.43–0.90	30	4	360	2008.9	China
	IRS	0.43–0.52	150/300	4	720	2008.9	China
HJ-C	SAR	S band	5/20	31	40/100	2012.11	China
ZY-1-02C	HRC/PMS	0.50–0.89	2.36/5/10	3–5	54/60	2011.11	China
ZY-3-01/02	PMS/MUX	0.45–0.89	2.1/5.8	3–5	51	2012.1 2016.5	China
Gaofen-1	PMS/WFV	0.45–0.9	2/8/16	2–4	60/800	2013.4	China
Gaofen -2	PMS/MSS	0.45–0.9	1/4	5	45	2014.8	China
Gaofen -3	SAR	C band	1–500	1.5–3	10–650	2016.8	China
Gaofen -4	PMI	0.45–0.9 3.5–4.1	50/400	20 seconds	400	2015.12	China
Gaofen -5	AHSI	0.45–2.5	30	51	60	2018.5	China
	VIMI	0.45–12.5	20/40	51	60		
Gaofen -6	PMS/WFV	0.45–0.9	2/8/16	2–4	60/800	2018.6	China

2.2 Nature Reserves

Nature reserves are special geographical entities designated to protect important ecosystems, save endangered species or protect natural historical heritages [5]leading to a strong regression of the cover plant. This study was aimed at evaluating the changes in the Taounate forest region landscape between 1975 and 2019 to create awareness in the public about the impact human activities have on the environment and to engage them in its preservation through the integration of residents' knowledge with that of the provincial office in charge of water and forests. The study was conducted in the province of Taounate, which is located in the pre-Rifa and Rifa regions in the north of the Kingdom. The forest estate covers an area of 40,690.96 ha (7%. They play a vital role in the sustainable development of ecological balance. Remote sensing for monitoring nature reserves has been implemented mainly from two aspects. The first is to monitor land use/cover change (LUCC) in nature reserves [12]which provides the ability to move the user in the forward and backward direction between any pair of incident points of a panoramic survey using a custom geoportal. The proposed approach takes into account changes in the urban environment (transport networks, capital structures. The international satellite datasets, especially the long time-series of Landsat images, were widely used for LUCC monitoring, either by conducting image classifications based on original satellite images or by directly using available products such as EVI provided by NASA [13].

2.3 Data from the Sciencedirect database

For the purposes of this research an organized review was under-taken. A systematic review is defined as an evidence-based review on multiples questions about a study area or topic, made to identify and critique relevant research and to analyze data from multiple studies.

- "Environmental science", "remote sensing" were added to the platform as search terms.
- The results of the entered keywords were recorded
- The obtained results were statistically analyzed in Microsoft Excel

Results.

3.1. The results of the analysis show that during 1999-2022, the application of remote sensing technologies to environmental sciences has increased dramatically. The number of scientific research publications was 608 in 1999, and 10,429 by 2022. From this sharp increase, it can be clearly said that the application of remote sensing in environmental sciences is becoming more and more useful and this trend can be predicted to increase even more.

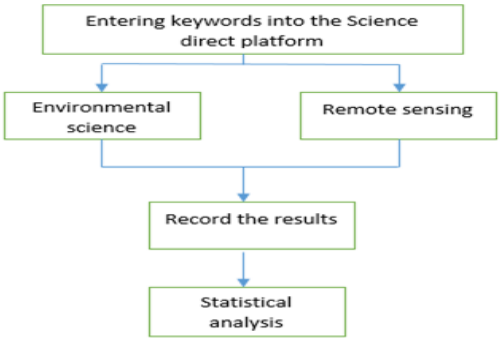

Figure 1. Entering keywords into the Science Direct platform.

3.2 The most frequently published type of research over the years has been research articles. "review articles" took the next place, encyclopedia took the third place. Indeed, field-based work requires a lot of time and resources to complete a research article. in this situation, it is very easy to obtain the necessary information by processing remote sensing, especially satellite images, and if there are open access images.

3.3 The next analysis was conducted on the scientific journals with the most scientific research published and indexed in the Scopus database. the next analysis was conducted on the scientific journals with the most scientific research published and indexed in the Scopus database. The journal Remote sensing of environment has the highest index despite having an impact factor of 13.63. This scientific journal is one of the most authoritative in the field of remote sensing and Geoinformation systems. Science of The Total Environment and Ecological Indicators are on the second and third places, respectively.

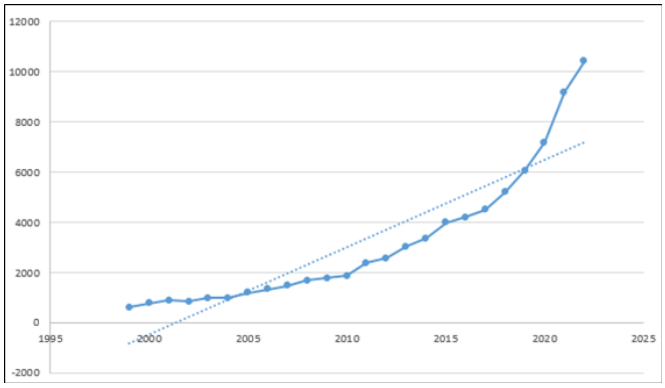

Figure 2: Number of scientific research published using remote sensing technology in environmental sciences during 1999-2022

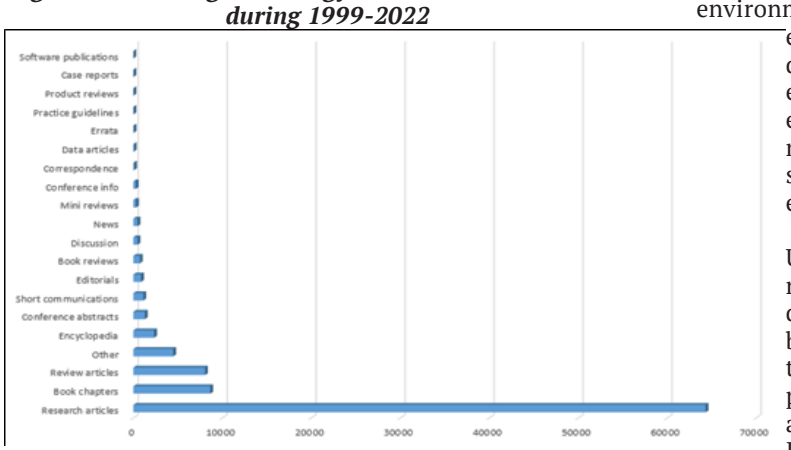

Figure 3: Types of scientific researches published during 1999-2022

3.4 Subject areas have been one of the most interesting indicators for us. because precisely in which departments remote sensing technologies are used means that there is a lot of specific information in this area. This analysis presents a statistical analysis of the areas in which remote sensing is used the most. In this analysis, of course, remote sensing was used in the field of Environmental science. The field of earth and planetary sciences took the next place, and Agricultural and biological sciences took the third place.

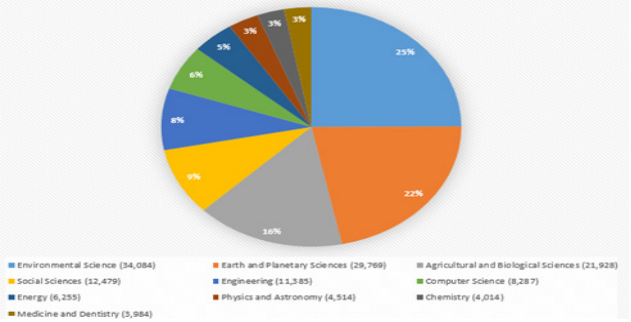

Figure 4: Subject area of scientific works published during 1999-2022.

Conclusion.

Even if there have made successes in improving the environment in the world, it still now expressions severe environmental pressure. The environmental degradation happens regularly because of economically motivated activities. To preserve environmental security, lucid waters and lush mountains, there is necessaries for the world to support the protection and supervision of the environment with remote sensing technology.

If we look at the example of the Republic of Uzbekistan, environmental protection through remote sensing technologies is now among the developing fields. A vivid example of this is the beginning of the growth of scientific articles on this topic in the last decades. There are many problems waiting to be solved in the field of application of technology.

In particular, the lack of experienced specialists has a negative impact on the widespread use of technologies.

Most scientific researchers do not understand the essence of remote sensing technologies because the main reason for this is that they do not know a foreign language (mainly English).

Lack of books on remote sensing in native language. Despite the fact that scientific treatises were published during several projects, they did not sufficiently reveal the essence, because of, errors in translation and/or scientific terms were not widely used.

The open access part of the spatial data can mainly provide a limited database with a small resolution. If our republic has its own satellite, it is possible to obtain information about any area and effectively start environmental monitoring.

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