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RESEARCH NOTE

Environment, tourism and satellite technology: Exploring fruitful interlinkages

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The development of aerospace technology has created a fruitful intersection between sustainability and the environment, satellite technologies, and tourism as economic fields and research areas. Satellites have developed new capacities transcending their simple communications function, providing new tools and data of great utility in tourism, particularly sustainable tourism, or having environmental implications because of the geographical nature of the information provided. The new space technology has proved to be very useful in identifying and monitoring the situation and evolution of certain spaces. Earth observation data can be used to help define high priority areas for tourism and conservation. One of the pressing questions of our times is related with changes to our habitat and their long-term impact on our environment. A new era in knowledge production is clearly observable since 2000.

Satellite imagery has emerged as a vital tool for monitoring the status of environmental parameters (Buchanan, Nelson, Mayaux, Hartley, & Donald, 2009; Horning, Robinson, Sterling, Turner, & Spector, 2010; Pettorelli et al., 2014). With recent advances in sensors and earth observation techniques, we are entering the high-resolution observation era (EOS-4). Multiple on-orbit satellites are currently capturing multi-spatial, multi-temporal RS data from multi-sensors.

The literature is rich in papers linking tourism, satellites and the environment, but in a scattered way and mainly in non-tourism journals. The main objective of this study is to summarise, analyse and show, from among all the scientific literature carried out to date, the research carried out related with satellite technology, tourism and the environment. This study has been carried out with a mixed methods review (Kim, Bai, Kim, & Chon, 2018). From a methodological point of view, we use a systematic approach to cover all so-called "satellite" technologies. In November 2018, the database of the Web of Science (WoS) core collection was used as the only information source. The results of the paper selection stage brought together 170 journals and 261 papers.

Fig. 1 shows the growth in number of publications subject to analysis. An important increase in interest in satellite technology in the scientific literature can be seen with a considerable increase in interest from 2016 on (Table 1).

By areas of research (Fig. 2), the journals directly related with "environmental science" are those which have paid most attention to satellite technology with tourism implications since 1994, the date when the first publication appeared. Publications related directly with "Hospitality, Leisure, Sport & Tourism" or "Hospitality, Leisure, Sport & Tourism; Economics" only represent 2.29% of

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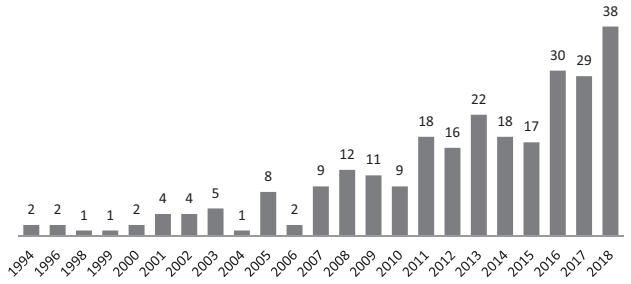

Fig. 1. Growth in publications by number of papers/year.

Table 1
Publication name; number of papers published (N°P); proportion of papers out of the total sample (%P), citations of the papers registered in the WoS core collection (WCC) and percentage of citations out of the total sample (%WCC).

Publication name	N°P	% P	WCC	% WCC
International Journal of Remote Sensing	11	4,21	151	5,63
Journal of Coastal Research	10	3,83	146	5,44
Annals of Tourism Research	1	0,38	125	4,66
Applied Geography	6	2,30	106	3,95
Environmental Earth Sciences	5	1,92	102	3,80
Remote Sensing of Environment	3	1,15	101	3,76
Journal of Environmental Economics and Management	2	0,77	95	3,54
Ocean & Coastal Management	7	2,68	90	3,35
Biological Conservation	2	0,77	89	3,32
Mountain Research and Development	2	0,77	75	2,80

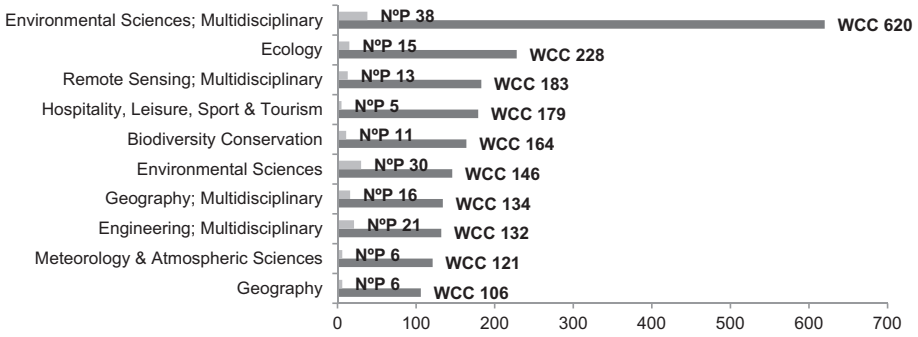

Fig. 2. Impact of the number of citations in WoS (1994–2018) by area of research (WCC) and number of papers published (N°P): top 10 with more than 100 citations.The paper published in 2007 by Annals of Tourism Research (Shoval & Isaacson, 2007) is the most cited work (125 citations) among the whole historic series and knowledge areas analysed.

the sample. They are:

- Annals of Tourism Research,
- Tourism Management,
- Journal of Sustainable Tourism,
- Asia Pacific Journal of Tourism Research
- Handbook of Tourism Economics: Analysis, New Applications and Case Studies.

The selected sample was analysed using VOSviewer_1.6.10 (Van Eck & Waltman, 2010), the main objective was to determine the main lines of research and the relationship between them. The words in the papers were used to establish relationships and build a structural concept of the domain (Koseoglu, Rahimi, Okumus, & Liu, 2016). This semantic map can help researchers to understand its cognitive structure (Börner, Chen, & Boyack, 2003). Six clusters were identified (see Fig. 3 and Table 2).

Characterisation of clusters enables the most important areas of interest to researchers combining environment, tourism and uses of satellites to be identified. The identified groupings are:

1) Sustainable development

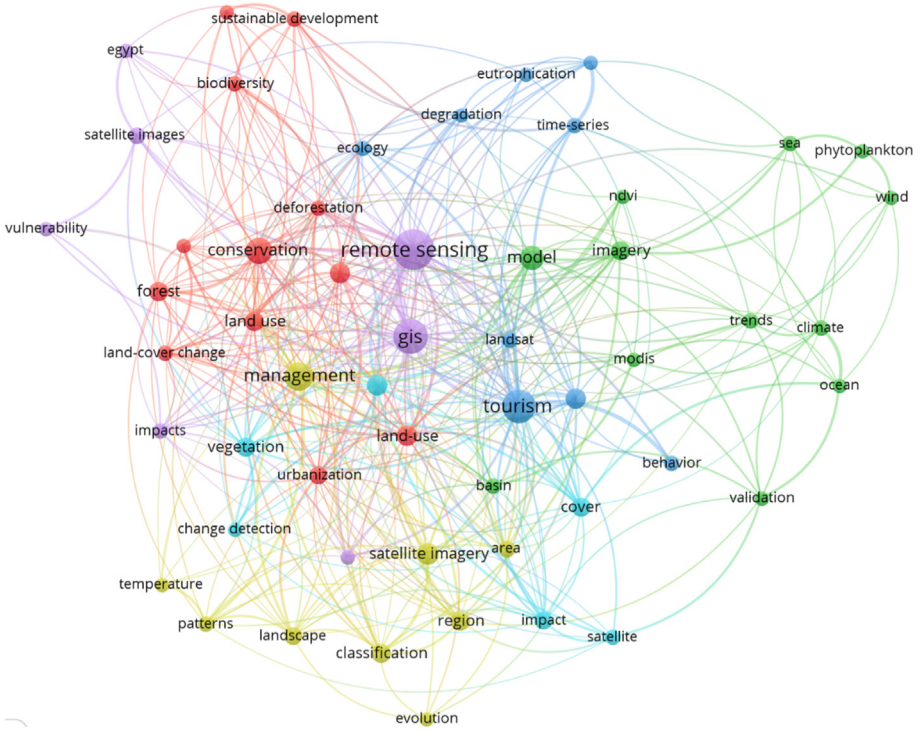

Fig. 3. Environment, Tourism and Satellite knowledge structure and clusters.

Table 2
List of clusters identified in the sample.

No.	Cluster name	Representative keywords for clusters
1. Red	Sustainable development	biodiversity; China; conservation; deforestation; forest; land use; land-use; land-cover change; monitoring; protected areas; sustainable development; urbanization
2. Green	Marine environmental studies	basin; climate; imagery; model; modis; NDVI; ocean; phytoplankton; sea; trends; validation; winds
3. Blue	Human interventions	behaviour; climate-change; degradation; ecology; eutrophication; landsat; satellite data; time-series; tourism
4. Yellow	Landscape and land configuration	area; classification; evolution; landscape; management; patterns, region; satellite imagery; temperature
5. Purple	Tracking tourism impacts	Egypt; GIS; impacts; land-use change; remote sensing; satellite images; vulnerability
6. Turquoise	Land cover and vegetation changes	change detection; cover; dynamics; impact; satellite; vegetation

This includes various studies of tourism and sustainable development, related with biodiversity and environmental conservation as well as phenomena acting against them causing environmental degradation effects (such as deforestation) or changes in land use and increasing urbanization. Growing interest in this line of research can be observed among researchers and universities in China, in many cases related with financing with public funds (e.g., the National Natural Science Foundation of China).

2) Marine environmental studies

The satellite as a data source for analysis of marine changes and study of beaches and their implications for tourism covers a group of research papers including studies of jellyfish, phytoplankton[1] and impact on coral reefs, among other aspects. Research on the normalised difference vegetation index[2] (NDVI), widely used by public entities such as the American National Oceanic and Atmospheric Administration, is included in this section.

[1] Aquatic autotrophic plankton with photosynthetic capacity which live scattered in water

[2] Index used to estimate the amount, quality and development of vegetation based on measurement by remote sensors, commonly installed from a space platform, of the intensity of radiation of the electromagnetic spectrum which vegetation emits or reflects according to its active photosynthetic radiation

3) Human interventions

Research studies devoted to study the impact and effects on natural resources subjected to intensive exploitation, and climate change. Includes analysis of the impact of eutrophication[3] and other human activities in natural spaces.

4) Landscape and land configuration

This includes territorial changes basically due to changes in temperature and precipitation, which may affect tourism, as well as regional impact studies. For example: temporal changes for coastline and coastal area in Turkey and Greece.

5) Tracking tourism impacts

This group includes examples such as a study of flash floods in the Nile Delta, or the evolution of the Red Sea zone, characterised by its sensitive, fragile, unique natural resources and habitats, where major changes in the tourism industry have taken place in the last few decades.

6) Land cover and vegetation changes

Studies focused on detection and implications of changes in vegetation connected to a territory, e.g., land cover changes in Pisa, Italy, or Cambodia.

We have offered an overall of the link between the environment, tourism and satellite technology, avoiding a fragmentary focus. We see that journals in the technological and ICT spheres reflect these technical changes more quickly, including their impact in the field of tourism, because of their cross-cutting nature, whereas tourism journals take longer to pick up on such aspects. Research in related disciplines enables the richness of the tourism phenomenon to be expressed (Tribe, 2018). There is a delay in literature reviews and bibliographical studies of tourism, where only contributions from the literature in that sector are recognised. When the aim is to detect trends, observe development and/or trace future lines, journals other than tourism publications should be included in the research; otherwise, aspects relevant to the sector can easily be overlooked. We advocate more holistic, integral methods.

The new trends and implications open up new avenues of research, especially in the area of “Hospitality, Leisure, Sport and Tourism”, studying the intersections of different fields of research with interdisciplinary contributions. Satellite technology may find new applications in tourism areas related with intelligent vehicle transport; maritime navigation; urban development and planning; rural areas; mapping/planning/administration of land use, infrastructures, natural and forest resources; or endless cases in environmental research where geolocation of information on the environment is important. In addition, satellite information can be of great use in a rapid emergency response in tourist areas. Satellites will be essential for monitoring natural disasters such as earthquakes and floods, and movements in urban areas.

The needs of environmental protection, management of biodiversity, ecotourism, deforestation, geolocation of tourists or protected species, tracking of migrations or habitat changes allowed by satellite technology may favour sustainable tourism. Therefore, our results are already of great value to scholars and practitioners, by identifying very specific areas where tourism has an effect or is affected by the environment where it takes place. Satellite study can help us detect and characterise this interaction, not always environment-friendly, between tourism and the geographical place where it occurs. Effects like eutrophication or land-cover change can not only be aggravated by poorly managed tourism, but can also have an effect on the future of tourism in those places: This is a two-way interaction.

As we have seen, this fertile combination has not yet been reflected in tourism journals. As we have shown in the analysis section, only five papers have taken an interest in this field of research despite its clear economic and environmental implications.

Our study has several limitations precisely due to its abundant bibliography, and its interdisciplinary nature, seeking to incorporate knowledge related with tourism which arises in other fields of research, beyond tourism journals, in order not to overlook any important aspect related with the technology under study. This fact has enabled us to detect some deficiencies of a purely *tourism-centric* approach.

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[3] Excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.

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