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Editorial

Earth Observation, Remote Sensing, and Geoscientific Ground Investigations for Archaeological and Heritage Research

Deodato Tapete

Italian Space Agency (ASI), Via del Politecnico snc, 00133 Rome, Italy; deodato.tapete@asi.it

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Abstract: Building upon the positive outcomes and evidence of dissemination across the community of the first Special Issue *"Remote Sensing and Geosciences for Archaeology"*, the second edition of this Special Series of *Geosciences* dedicated to *"Earth Observation, Remote Sensing and Geoscientific Ground Investigations for Archaeological and Heritage Research"* collects a varied body of original scientific research contributions showcasing the technological, methodological, and interpretational advances that have been achieved in this field of archaeological and cultural heritage sciences over the last years. The fourteen papers, published after rigorous peer review, allowed the guest editor to make considerations on the capabilities, limitations, challenges, and perspectives of Earth observation (EO), remote sensing (RS), and geoscientific ground investigations with regard to: (1) archaeological prospection with high resolution satellite SAR and optical imagery; (2) high resolution documentation of archaeological features with drones; (3) archaeological mapping with LiDAR towards automation; (4) digital fieldwork using old and modern data; (5) field and archaeometric investigations to corroborate archaeological hypotheses; (6) new frontiers in archaeological research from space in contemporary Africa; and (7) education and capacity building in EO and RS for cultural heritage.

Keywords: Earth Observation; remote sensing; optical; SAR; drone; airborne LiDAR; GIS; OBIA; neutron diffraction; archaeological prospection; pattern recognition; archaeometry; geological mapping

1. Introduction

The first Special Issue on *"Remote Sensing and Geosciences for Archaeology"* that I was invited to lead as guest editor by the journal *Geosciences* in 2017, collected 21 high-quality peer-reviewed papers (plus the editorial) outlining the state-of-the-art of research in the fields of archaeological remote sensing and geosciences. The contributions published in that Special Issue provide a wide portfolio of methodologies, data, and techniques proving that remote sensing and geosciences for archaeology are currently vibrant research and practice domains, with expertise spread across the globe, and teams fully exploiting the capability of remote sensing to investigate sites and landscapes in different geographic, social, and environmental contexts [1].

After one year of publication, the metrics of the Special Issue summarized in Table 1 can be considered promising to assess the dissemination degree of these papers across the specialist community. We also need to account for the fact that the Special Issue was the first in *Geosciences* which was dedicated to remote sensing and archaeology, and the journal itself was not as much known to the specialist readership as it is nowadays. In particular, it is worth mentioning that two of the published papers, i.e., Traviglia & Torsello [2] and Agapiou et al. [3], have repeatedly been listed among the dynamic ranking of the 10 most-cited papers of *Geosciences* in the last 24 months.

Table 1. Article metrics of the papers published in the first edition of the Special Issue as of 01/04/2019 (source: *Geosciences*).

Authors	Views	Downloads	Citations
Agapiou et al. [8]	3278	1904	5
Agapiou et al. [3]	1708	970	8
Chyla [9]	1429	827	1
Comer et al. [5]	1570	1102	3
Corso et al. [12]	1753	1215	2
Danti et al. [10]	1943	1740	7
Drap et al. [13]	1571	1565	2
Gade et al. [6]	1751	1210	4
Garcia-Garcia et al. [14]	1282	995	1
Guidi et al. [15]	1719	976	3
Kalayci et al. [16]	1218	968	2
Křivánek [17]	1420	1174	2
Malinverni et al. [18]	1445	1345	1
Parcak et al. [11]	1486	1374	3
Poux et al. [19]	2306	2249	7
Rayne et al. [7]	1750	1500	5
Rutishauser et al. [4]	1784	1345	2
Sonnemann et al. [20]	1582	1046	2
Tapete [1]	1256	2313	3
Traviglia & Torsello [2]	1680	1311	9
Verhoeven [21]	1573	1399	6

Building upon the positive outcome achieved in 2017 and in order to continue this Special Series, in March 2018 I launched the call for papers for a second edition of the Special Issue with the title "*Earth Observation, Remote Sensing and Geoscientific Ground Investigations for Archaeological and Heritage Research*".

Comparing the titles of the two editions of this Special Series, it clearly emerges that, in this second Special Issue, I intentionally:

(1) broadened the spectrum of the topics to include Earth Observation (EO), to acknowledge that satellite imagery is nowadays regarded by the archaeological and heritage communities as a resource of spatial and temporal information (see the majority of the papers published in the first edition of the Special Issue: [3–11]);

(2) cited "heritage" alongside "archaeology" to be more inclusive of the various disciplines and domains of geoscientific research focusing on cultural subjects;

(3) included geoscientific ground investigations, in the hope of receiving submissions highlighting not only new methods for ground-based surveying, archaeological prospection, and diagnostic investigation, but also validation of signals, parameters, features, and marks extracted from EO and remote sensing (RS) analyses with ground-truth data collected in the field.

The topics that I envisioned to cover for the submissions to this second edition included:

- archaeological prospection
- digital archaeological fieldwork
- condition assessment of heritage assets
- GIS analysis of spatial settlement patterns in modern landscapes
- assessment of natural or human-induced threats to conservation
- education and capacity building in EO and RS for archaeology

2. Facts and Figures of the Special Issue

A total of 21 submissions were received for consideration of publication in the Special Issue from April 2018 to January 2019. After rigorous editorial checks and the peer review process involving external and independent experts in the field, the acceptance rate was 67%. The published Special Issue therefore contains a collection of 14 research articles.

Figure 1a shows the countries where the study areas of the papers published in the Special Issue are located, while Figure 1b the spatial distribution of these study areas, distinguished between cultural landscapes and individual heritage sites. By comparison with Figure 1b published in [1], it is apparent that in this second edition the study areas are more widespread across the globe, while in the first edition the majority was concentrated in Europe and in the Middle East. The latter region, alongside Peru and Germany, is still of research interest. However, this time the archaeology of the Indian subcontinent and African continent gathered specific attention of the research community. It is also worth mentioning that one of the contributions [22] provides an overview of space law and space sciences for archaeological and heritage research in contemporary Africa. Thus, the African continent has been marked in grey in Figure 1a to signify the wider geographic focus of this paper.

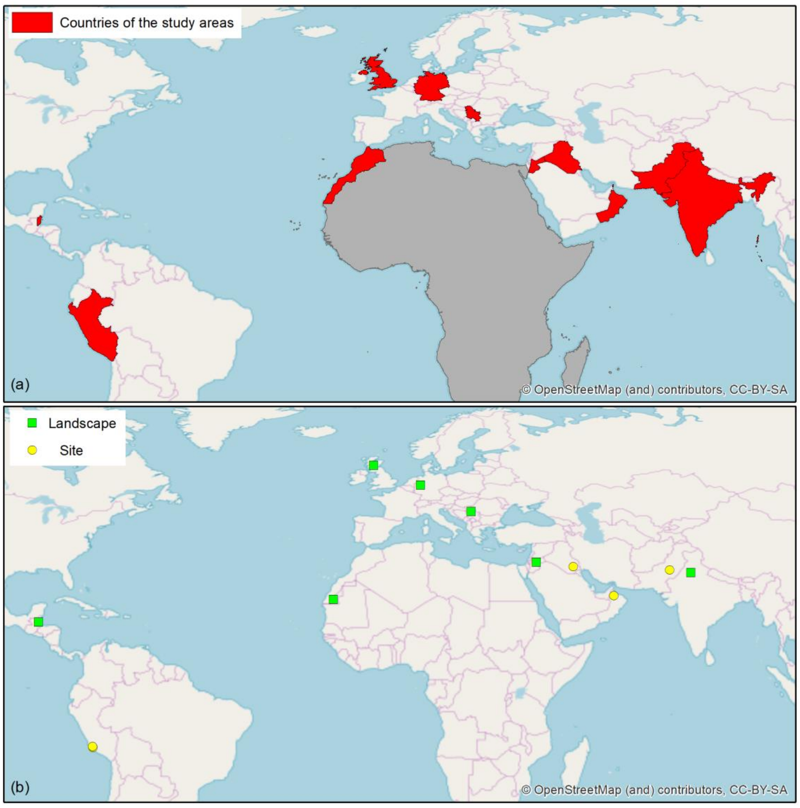

Figure 1. (**a**) Countries where the study areas of the papers published in the Special Issue are located; (**b**) geographic distribution of the study areas distinguished by typology ("landscape" in case of regional archaeological mapping and wide-area archaeological prospection; "site" in case of site-focused studies and investigations in single location). The African continent is marked in grey because one of the published papers [22] provides an overview of space law and space sciences for archaeological and heritage research in contemporary Africa.

This geographic distribution could not be predicted, was not intentional, and indeed, was the random result of the call for papers and following peer review. However, some considerations can be made.

The remote location and vastness of the study areas covered by the majority of the published papers once again prove the impact that EO and RS can generate in facilitating archaeological research, by making investigations more cost-effective and less risky for the operators.

Furthermore, it can be rightly said that with EO and RS there is no frontier for archaeological and heritage research. On the contrary, unexplored regions and areas with limited literature are ideal geographic locations for exercises of archaeological mapping and site discovery studies.

Finally, the predominance of landscape studies compared to site investigations (7 vs. 5; Figure 1b) highlights a growing interest in using EO and RS for regional and wide-area mapping. This trend has been recently observed and commented by several authors in the literature (e.g., [23,24]).

3. Overview of the Published Papers

As manuscripts were submitted and processed for peer review, it progressively became clear that this Special Issue was shaping not only along the topics that I had delineated in the call for papers (see Section 1), but also following other unexpected topics, including automation in archaeological prospection, methodological reflections on the use of old and new remote sensing data for digital fieldwork, and legal aspects of archaeological research. A summary of the published papers is reported in the following sections.

3.1. Archaeological Prospection with High Resolution Satellite SAR and Optical Imagery

The two papers published by Wiig et al. [25] and Zanni & De Rosa [26] respectively seem to contrast the controversial statements (sometimes written in the literature or claimed at conferences) that archaeologists are not familiar with satellite Synthetic Aperture Radar (SAR) imagery as a source of information for archaeological prospection due to difficulties with access, processing and interpretation of these data, and that high-resolution (HR) satellite optical imagery (i.e., 5–30 m) is of marginal usefulness in archaeology (see also [23,27]).

Wiig et al. [25] add a novel contribution to the still open discussion whether satellite SAR sensors operating at short wavelength (i.e., in C- and X-band, 5 to 3 cm wavelength) can penetrate through the subsurface in arid regions. The authors compared the observations made at the site of 'Uqdat al-Bakrah (Safah), Oman, with HR TanDEM-X bistatic and RADARSAT-2 images that were acquired at different incidence angles at scene center (from 27° to 53°) and polarization, and then processed to achieve pixel spacing of 0.87–1.14 m and 2.1–2.95 m, respectively. In particular, the authors' attention was concentrated on a subsurface paleo-channel that was not visible on the ground surface, but was first identified through Ground Penetrating Radar (GPR) survey and later verified by test excavations at a depth of 0.6–0.7 m. Although it is still unclear whether the microwaves are penetrating to the specific depth at which this paleo-channel was found, the findings are significant as this paper is one of the very few studies where features found in satellite SAR images were verified in the field.

Zanni & De Rosa [26] tested different combinations of the spectral information collected in the 13 bands of the Multispectral Instrument (MSI) onboard the satellite Sentinel-2A of the Copernicus programme, to investigate the capabilities of these satellite data for detection of buried features belonging to Roman roads. The experimental trials were run in the Srem District in Serbia, part of the original Roman itinerary between Aquileia (Italy) and Singidunum (Belgrade). Sentinel-2A images acquired in the summer season in 2016 were first carefully selected from the available catalogue and then processed to extract the Normalized Difference Vegetation Index (NDVI), Normalized Archaeological Index (NAI), the combination of Red and NIR (RN) and Crop Coefficient 3 (CC3). The visual assessment of the obtained maps and the comparison with the same processing outputs of a matching WorldView2 image led to the identification of 60 crop-marks in the portion of territory stretching from Sremska Mitrovica to Zemun. Of these, during the in-situ validation surveys, 13 were found to correspond to already known archaeological sites and stretches of the Roman road, whereas 47 crop-marks remained unmatched, thus highlighting the benefits and limitations of Sentinel-2 and WorldView2 observations.

3.2. High Resolution Documentation of Archaeological Features with Drones

In the current practice of archaeological remote sensing where small Unmanned Aerial Vehicles (UAV)/Remotely Piloted Aircraft System (RPAS) are increasingly used by archaeologists as data acquisition platforms and (semi-)autonomous measurement instrumentation, the paper published by Pavelka et al. [28] demonstrates the agility of this RS solution in arid environments and the opportunity that it can offer for fascinating discoveries while documenting cultural landscapes. The authors exploited very high resolution (VHR) satellite data and super resolution data from the drone to improve the digital documentation of the "Pista" geoglyph in Palpa, Peru, and refine the knowledge and interpretation of this geoglyph that had been researched several times by the archaeologists, but still poses some open questions. Through the description of the methodological workflow of data capture, processing and post-processing, the authors present the final vector map that they generated, achieving more detailed delineation of surviving archaeological features than older outputs based on satellite or old aerial data. The surveys also offered the opportunity to discover unknown geoglyphs (a bird, a guinea pig, and other small drawings), thus adding new information in an area of well-known geoglyphs. While dating these new geoglyphs remains a challenging task, the digital record of these newly found geoglyphs allowed the authors to observe similarity in the iconography compared with other well-known geoglyphs.

3.3. Archaeological Mapping with LiDAR towards Automation

There is no doubt about the great value of airborne LiDAR (Light Detection and Ranging) for archaeological mapping [29], as well as the high degree of appreciation that this technology finds across the archaeological community.

The contribution by Moyes & Montgomery [30] adds a further proof of the usefulness of this technology to explore Maya lowlands and other tropical regions, where dense vegetation usually prevents archaeologists from conducting extensive surveys or, at least, makes this type of archaeological survey less cost-effective. In particular, the authors describe a method for locating potential cave openings using local relief models that require only a working knowledge of relief visualization techniques. This method was exploited in Chiquibul Forest Reserve, a heavily forested area in western Belize, where caves were utilized by the ancient Maya people as ritual spaces. Almost all attempts to find caves using LiDAR data focused on locating sinkholes that lead to underground cave systems, but caves in Chiquibul can be entered in some cases by sinkholes, in others via vertical cliff faces or by dropping into small shafts. Therefore, the authors aimed to locate and investigate not only sinkholes but other types of cave entrances using point cloud modeling. Validation was undertaken through an opportunistic survey to verify selected caves identified on the LiDAR, and a systematic pedestrian survey that was completed over two six-week field seasons in the summers of 2017 and 2018 using two to three crews of three people each. The opportunistic survey led to 86% success rate with only three false positives, verifying 26 cave openings, and proved LiDAR to be expedient in meeting the project goals of locating and investigating unknown cave sites.

Regional and national LiDAR collections are increasingly made available by territorial administrations under open data policies for land management and scientific research purposes. Although these data are generally acquired in the context of flood or other hazard management, it is envisaged that their continuous release to the public will only further increase the impact of airborne LiDAR on archaeological research and heritage management [31]. While these initiatives are welcome as they provide an extraordinary source of spatial data, there is lively discussion about the impact that automation can bring to improve the operator's capabilities to handle huge quantities of LiDAR data for archaeological mapping of large regions. However, it cannot be neglected that the development of automation methods and approaches in archaeological prospection is still in its infancy.

Towards this direction, Meyer et al. [32] exploited the LiDAR datasets acquired between 2008 and 2010, and later in 2016, and made available to archaeologists in North Rhine-Westphalia, Germany, by the provincial government according to the Open Geodata principle, to assess the potential for automated classifications using Object-Based Image Analysis (OBIA). Three types of field monuments were considered: Ridge and Furrow areas (of early medieval fields), Burial Mounds (Bronze and Iron Ages), and Motte-and-Bailey castles. The latter two are not classified as binary, but in multiple classes, depending on their degree of erosion. After a detailed description of the methodology and processing workflow, the authors focus their results discussion around the challenge of discriminating between true and false positives in situations where the terrain becomes complex and a more anthropogenic influence is present. On the other side, the detection rate of field monuments with OBIA is ~90%, although this technique is vulnerable to distortions and frequently can be implemented in commercial software that may limit the accessibility to archaeologists due to fund constraints.

3.4. Digital Fieldwork and Reflections on Challenges of Archaeological Mapping with Old and Modern Data

One of the main objectives of this Special Issue was to capture the state-of-the-art of the methods of digital fieldwork in remote and inaccessible areas. The picture coming out from the collection of the papers described in this section is that archaeologists, from different countries, are making efforts to develop rigorous and robust methodologies for archaeological mapping which are at the same time systematic, accurate, reliable, and cost-effective. Digital fieldwork is undertaken as a desk-based task in the perspective of precisely planning ground-truth and validation surveys, to optimize resources and prioritize in-situ inspections in areas of higher archaeological potential.

In this regard, Nsanziyera et al. [33] present a predictive model based on GIS and remote sensing data to locate areas with high potential to be archaeological sites. The authors apply a multi-criteria decision making method—analytic hierarchy process (AHP)—that integrates archaeological data and environmental factors, geospatial analysis, and predictive modeling, to identify possible tumuli locations in Awsard (total study area of 980 km^2), southern Morocco. The results consist of a prediction map with a gain of 92.8%, in a scale where 1 means a high predictive model and 0 no a predictive model. Interestingly, 56.87% of all sites were found to be located in only 4.04% of the total study area. This method proves effective to prioritize areas for archaeological expeditions.

Smith & Chambrade [34] showcase the results of the systematic analysis of the arid "Black Desert" of north-eastern Jordan, which they conducted in the framework of the archaeological project Western Harra Survey (WHS), using the full VHR Google Earth coverage released in 2017, with further GeoEye and CNES/Airbus satellite imagery becoming available, as well as DigitalGlobe products appearing in Bing Maps. The high spatial resolution of such datasets enabled a more clear definition of structural differences between the types of prehistoric structures (e.g., enclosures, "wheels", "pendants", "kites", and meandering walls). The major benefit of this satellite digital fieldwork was the precise planning of ground surveys, with advanced knowledge of which sites were vehicle-accessible and how to efficiently visit a stratified sample of different site types. The fieldwork-derived data were then fed back into the satellite imagery survey, helping the authors to interpret what can be seen in remote sensing more accurately for future investigations.

However, the advent of new EO and RS data, visualization platforms, and processing technologies does not mean that archaeologists and heritage scientists disregard historical mapping resources. On the contrary, the community is working on bringing these old fashioned resources back to light, standardizing the methodology for their use and interpretation, and combining the information extracted with modern data, to achieve a diachronic and dynamic reconstruction of the cultural landscape evolution in time.

Petrie et al. [35] and Garcia et al. [36] are two interlinked papers that need to be read in conjunction, because they were conceived and published in the framework of TwoRains, WaMStrIn and Marginscapes projects. Petrie et al. [35] advocates the value and importance of the Survey of India 1" to 1-mile map series, an historical mapping resource which was under-utilized and, with this paper, gains the attention it deserves since it is a precious reservoir of spatial information of topographic features and elevated mounds visible at the time of the surveys, but which were either damaged or destroyed by the expansion of irrigation agriculture, and urbanism, and are no longer visible. The authors present a method for accurately georeferencing these maps and review the symbology that was used to represent elevated mound features that have the potential to be archaeological sites. Certainly, this method will be very useful to support further studies by other scholars willing to use this mapping resource alongside modern RS data, as it is well demonstrated by the accompanying Garcia et al. paper [36]. Within the latter paper, the authors investigate the historical inundation that hit the city of Dera Ghazi Kkan, in Punjab, Pakistan, in 1909. Historic news reports, books, and maps are used to undertake a regressive analysis to reconstruct the historical dynamics between the urban settlement and the river morphodynamics in the Indus alluvial plain. Declassified CORONA images, multispectral Landsat time series, and microtopographic data derived from ALOS Global Digital Surface Model "ALOS World 3D-30 m (AW3D30)" using the Multi-Scale Relief Model (MSRM), are combined to examine: (1) how historical hydrological dynamics are reflected in RS data; (2) the implications of river morphodynamics in the interpretation of settlement patterning; and (3) the documented socio-political responses to the geomorphological change of the local environment.

If old mapping data preserve an otherwise vanishing memory, they have to be handled carefully, especially if they have been collected by different operators and according to different study purposes. In this context, the feature paper by Banaszek et al. [37] will be, in the author's opinion, a reference piece of research, since it provides a practical discussion of the challenges that archaeologists need to deal with for creating systematic datasets of national-scale archaeological mapping, where the standards to which these datasets were created are explicit, and against which the reliability of the knowledge of the material remains of the past can be assessed. With the focus on Scotland, the authors start by acknowledging that the National Record of the Historic Environment (NRHE) is an inventory of what has been recorded over the years and it reflects the interests and recording policies of those who created it, with bias in content as a result. The lack of scalability in traditional approaches to large area mapping which rely heavily on human resources and field visits, is definitely a constraint to deal with. The authors use the Isle of Arran as an outdoor laboratory for scoping their approach to rapid large area mapping and test how airborne laser scanning derivatives and orthophotographs, supplemented by field observations, can help to increase the records of the known monuments. This exercise demonstrated the strengths and weaknesses of remotely sensed data acquired for general purpose, the variability of desk-based interpretation between individuals, and the necessity for targeted field observations in areas with poor data coverage and where background noise obscures the visibility of archaeological features in the visualizations derived from the airborne laser scanning surveys.

3.5. Field and Archaeometric Investigations to Corroborate Archaeological Hypotheses

In a multidisciplinary perspective, geoscientific ground investigations and laboratory analyses remain essential to achieve an insightful knowledge of the near surface in archaeological and heritage sites, as well as of objects and findings, that EO and RS alone could not be able to document or investigate. While most of the analytical techniques and research methodologies in geo-archaeology and archaeometry are well-established and standardized, there are always opportunities to employ advanced approaches and collect elements to support or modify existing archaeological hypotheses.

Festa et al. ref. [38] is an archaeometric paper presenting the results of non-destructive analyses carried out on 36 Sumerian pottery fragments found in the settlement of Abu Tbeirah (3rd millennium BC), southern Iraq. The analysis aimed to characterize the crystallographic composition of the ceramic material, to shed light on the ancient technology and manufacturing techniques. Combining non-invasive neutron diffraction (ND) with chemometrics such as Principal Component Analysis (PCA) and Cluster Analysis (CA), the authors observed a general uniformity of the raw materials and could suggest a local origin of the clay used for Sumerian vases, by comparison with modern clay collected from the canal near the excavated site. The secondary minerals found and their marker-temperature formation are compatible with two different ranges of firing temperature that never exceeded 1000 °C. In the absence of kiln traces in the archaeological site of Abu Tbeirah, it appears reasonable to hypothesize that the analyzed pottery was produced with pit-firing techniques and not kiln firing.

Because kilns have been documented in the Mesopotamian archaeological record for earlier periods, the finding of this research would suggest the coeval presence of different firing methodologies that has been neglected by archaeologists so far.

Delle Rose et al. [39] attempt to find stratigraphic evidence corroborating (or confuting) the hypothesis that the ceremonial center of Cahuachi, Rio Grande de Nazca, in southern Peru, was first severely damaged, then completely buried by catastrophic river floods as a result of two Mega El Niño events, which occurred around 600 Common Era (CE) and 1000 CE, respectively. The occurrence of such catastrophic events would be proved by the presence of a conglomerate layer in the stratigraphy. Therefore, during the 2012 archaeological excavation works at Cahuachi, the geological substratum close to the Piramide Sur was temporarily exposed and stratigraphic, grain-size distribution, and petrographic investigations were carried out. No fundamental discontinuity was found in the studied stratigraphic interval which instead, due to the lithological features, matches with common regional successions (i.e., Changuillo or Changuillo–Canete Formations) of the pampa of Nazca rather than the deposits related to El Niño–Southern Oscillation (ENSO) events.

3.6. New Frontiers in Archaeological Research from Space in Contemporary Africa

As recalled in Figure 1a, the last paper published in the Special Issue [22] provides an overview of space law and space sciences for archaeological and heritage research in contemporary Africa, which could become a new frontier for activities of discovery and preservation in this continent. This paper also reminds the reader that there are far more diverse categories of heritage and archaeological features than those commonly studied with EO and RS. Indeed Oduntan [22] articulates a series of insightful reflections on the legal aspects of EO and RS, trying to answer questions about the impact that these aspects of space law and space sciences have in relation to: (a) international boundaries disputes and demarcation activities; (b) management and preservation of the African heritage; (c) disaster and conservation management. In particular, the paper tests the hypothesis that it is crucial for the development of the African continent that states should sustain and increase investment in the following areas: archaeological prospection, condition assessment of heritage assets; Geographic Information System (GIS) analysis of spatial settlement patterns in modern landscapes, and assessment of natural or human-induced threats to conservation. Through a critical, comparative, and socio-legal methodology, the author focuses on the space active African states and the emergent patterns in African domestic space-related policies and space-dedicated legislation. The connection with the EO and RS practice of archaeological and heritage research lies in the area of the reconstruction of African territories from space, the demarcation of boundaries, and geodetic ground investigations, not only to resolve disputes but also to preserve state boundaries and ancient African "relict boundaries". The latter term refers to antecedent boundaries which were abandoned for political purposes but are still evident in the cultural landscape and, as such, manifest themselves in space by, among other features, direct border remains such as border stones, mounds, ancient walls, border roads, clearings, customs houses, and watch-towers. The latter are among the less known African heritage and treasures that EO and RS can help to unveil, document, and preserve within national and international legal frameworks and space policies.

3.7. Education and Capacity Building in EO and RS for Cultural Heritage

All the papers summarized above were published by expert scientists and researchers who are extremely familiar with and competent in EO, RS, geoscientific ground investigations, and laboratory analytical techniques. The knowledge transfer and the capacity building to heritage stakeholders and early beginners are still challenging tasks, and require a specialist educational preparation that is not obvious. Showcasing the ability of a technology to support a specific operational task (e.g., condition assessment of heritage sites) does not mean that the potential users of that technology will be able to use it themselves or, after training, will recognize the value of that technology and will search for it in their daily duties. In the current context where more work is definitely required to reach the users and stakeholders and generate real impact on archaeological and heritage practice, the paper by Matusch et al. [40] is proof that some initiatives are ongoing. The authors present the e-learning module Space2Place that they developed in the framework of the project "Space4Geography" carried out between 2013 and 2017, with the aim to empower UNESCO site stakeholders to incorporate EO into their working routines. This e-learning module is contextualized in the current situation of knowledge gaps by the user, limited technical and financial facilities, or the lack of ready-to-use data, despite the abundance of satellite data and user-oriented services made available by EO programs such as the European Commission Copernicus. Space2Place is therefore a capacity building initiative to enable heritage stakeholders obtain a substantial introduction into EO and overcome the knowledge barriers that may exist. One of the key features of this paper is the discussion of the results collected after an expert survey that the authors ran with the participation of 11 experts coming from various institutions. The survey provides insights into the main barriers and expected benefits that stakeholders perceive in the use of EO to address specific threats to conservation of cultural heritage (e.g., climate change, natural hazards, intentional destruction, and warfare). Of all the interesting elements emerging from this direct feedback, two are worthy of mention. First, not all EO data are appropriate for each task, thus stakeholders need to be able to choose themselves the appropriate EO sensor(s) with regard to their specific needs, the study time, and the size and location of the site to observe. This approach will make the stakeholders aware and become critical users of these technologies. Second, there is a clear demand for up-to-date information with high cost-efficiency, that can be used in support of daily and routine tasks such as detection of impacts, evaluation of interventions, and early detection of critical changes in heritage sites. However, accessibility in terms of finance, infrastructure, and human resources remains a constraint.

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