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Modern Approaches and Applications
Towards the 2030 Agenda**

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Panoramic 360° images and 3D models as tools to promote cultural and geological heritage: the example of Bertioiga, central coast of São Paulo State, Brazil

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Keywords: geospatial technologies, geoheritage, built heritage, Bertioiga, Brazil

Goal: This work presents a case study aimed in geological sites protection and dissemination of geoscientific knowledge – some of the pillars in which geoconservation is based upon (Brilha 2016; Weber *et al.* 2017) – through the use of geospatial technologies (Cayla 2014; Martin 2014).

Methods: Several geological points illustrate the importance of Bertioiga municipality in such a project. The municipality comprises one of the largest coastal plains of the region, in which there are registered most of the depositional systems observed along the Brazilian coast (Souza 2015), with the escarpments of Serra do Mar at the background. It possesses a large number of protected areas (72% of its territory) and the oldest colonial fortification of the country. These facts, and the use of a geo-technological approach, allow the development of interpretive resources useful for educational purposes.

Previous surveys of geological sites and historical fortifications enabled the selection of three geological sites suitable for the aims of the project (Mucivuna *et al.* 2016; Mucivuna *et al.* 2017): (1)

Bertioiga channel and São João Fort; (2) Meanders of the Itapanhaú River; and (3) Marine terraces of Itaguaré Beach. Image acquisition was carried out with a DJI Phantom 4 Pro Unmanned Aerial Vehicle (UAV) according to the interpretation products. Hence, 360° aerial images served as input for panoramic montages for each site, and oblique photos taken from different heights were used in the construction of 3D models for points 1 and 3 through Structure from Motion algorithms. Additionally, aerial footage was produced during the field trip. Obtained data was treated in specialized image processing software, *i.e.* Agisoft Photoscan Pro, Autopano Giga, Panotour Pro and Adobe Photoshop.

Results: The developed resources fit in both educational and tourism projects. Consequently, the resources may be used in interpretive activities by teachers at various school grades, as well as by tourism offices. The main contents and interpretive elements to be used are shown in Table 1. These geoscientific themes can be added to the topics already explored by school trips and touristic routes.

Table 1. Interests and interpretive contents of the selected sites in Bertioiga. Main geological interests based on the GEOSIT Platform, of the Geological Survey of Brazil (Rocha *et al.* 2016)

	Bertioiga Channel and São João Fort	Meanders of the Itapanhaú River	Marine terraces at Itaguaré Beach
Main geological interests	Geomorphological; Sedimentary	Geomorphological	Palaeoenvironmental; Sedimentary; Palaeontological
Potential interpretive contents	Building material used in the fort and historical aspects of military fortifications	Formation of the Bertioiga Coastal Plain; Alluvial landforms	Ichnofossils; Marine terraces, Sea-level variation, Coastal dynamics; Alluvial landforms
Other interests	Historical and geographical aspects related to the fort	Urban occupation at legally restricted areas	Ecological aspects related to the protected area

The products are available online in the form of an interactive platform starting from 360° images to simulate a virtual tour. These images are endowed with 'hotspots', hyperlinks calling attention to the locations for which the 3D models were created. Every interactive product is presented with graphical elements and texts with geological interpretation, as well as hyperlinks pointing to additional web-pages for supplementary information. Talks are being conducted with the fort management to include an interactive application in the premises, which consists of a 3D model of the building with geoscientific interpretation for the use of visitors. The description presented in each product has respected elements used in interpretation principles (Tilden 1957). For this reason, textual information makes use of an accessible language with few technical or specific terms from Geosciences, as well as provocative sentences that evoke interaction between people's personal knowledge and physical environment.

Final remarks: Some advantages of using a non-personal media, based on data produced by UAV's to promote geosciences include the facilitated visualization of features or processes not easily accessed in the field. It also allows easy content access, as many times the person wants. As these products will be included in the website, enabling easy access, it will include possibilities for persons with disabilities, elders and infants. Furthermore, some environmental education activities are already carried out in the region. These could be improved

if the interpretive products could be included in the existing activities, thus collaborating for an integrated view of both biotic and abiotic aspects.

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