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Towards the 2030 Agenda**

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Edited by

Ewa Głowniak, Agnieszka Wasiłowska, Paulina Leonowicz

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Editors:

Ewa Główniak, Agnieszka Wasiłowska, Paulina Leonowicz

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Faculty of Geology, University of Warsaw,
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Preliminary assessment of ecosystem services provided by geodiversity in the coastal region of the state of São Paulo, Southeastern Brazil

Maria da Glória Motta Garcia¹, José Brilha², Célia Regina de Gouveia Souza³,
Eliane Aparecida Del Lama¹

¹ Centre for Research Support on Geological Heritage and Geotourism (GeoHereditas), Institute of Geosciences, University of São Paulo, Rua do Lago, 562, 05508-080, São Paulo, Brazil; e-mails: mgmgarcia@usp.br; edellama@usp.br

² Earth Sciences Department, University of Minho, Campus de Gualtar, 4710-057, Braga, Portugal; e-mail: jbrilha@dct.uminho.pt

³ Geological Institute-SMA/SP, Av. Miguel Stéfano, 3900. 04301-903, São Paulo, Brazil. Post-Graduation Programme, Geography Department, University of São Paulo, Brazil; e-mail: celia@sp.gov.br

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Abiotic ecosystem services are defined as the functions provided by geodiversity elements, either directly or indirectly, for the benefit of the society and future generations. These services are grouped according to five functions: regulation, provision, support, cultural, and knowledge (Gray 2013). The coastal region of the state of São Paulo, Brazil, is a traditional tourism destination known by landscapes that are the result of geological processes acting mainly since Neoproterozoic. It also comprises important protected areas, including two UNESCO's Biosphere Reserves related to the Atlantic Forest and it is also home to important traditional communities and stone-and-lime masonry buildings. All these natural systems play an important role in the provision of goods and services to the population. But being the most populated and industrialised state of Brazil, São Paulo's coast is the focus of extreme property speculation and a tourism industry that lacks environmental concerns, putting in danger both quantity and quality of these services. As a contribution to an abiotic ecosystem approach, in this work we carry out a preliminary inventory of the contribution of geodiversity for the ecosystem services in the region, both to guide future territorial planning and to promote a smart use of geodiversity resources. We also point out the main threats that affect geodiversity, which is essential to guide future propositions.

The region has been the focus of geoconservation works since 2011. These works include systematic inventories and evaluation of geological sites, as well as several initiatives to both disseminate this knowledge and to raise awareness of geoheritage to the society (Garcia *et al.*

2017). The preliminary inventory of how geodiversity contributes for the ecosystem services was carried out according to the following steps: (1) Identification of ecosystems in the region; (2) Identification of geodiversity elements occurring in each of the ecosystems; (3) Selection of the main ecosystem services provided by geodiversity, based on the list defined by Gray (2013); and (4) Recognition of the main threats that affect geodiversity elements.

Both terrestrial and aquatic ecosystems occur in the area and are related to the Serra do Mar mountain range and to coastal and marine environments. Geodiversity elements include the geological materials (rocks, sediments and soils), structures and landscapes, as well as geological processes that are part of these ecosystems. A synthesis of this survey is shown in Table 1. The main threats to geodiversity are extreme real estate speculation, constructions that modify natural coastal dynamics, unplanned exploitation of sand and grit, deforestation, mass tourism, unplanned human occupation, pollution, coastal erosion and other hazards.

The qualitative evaluation presented in this work has identified 29 ecosystem services distributed by the five functions that overview the importance of geodiversity in the coastal region of the state of São Paulo. The distinct ecosystems in the area are affected in different degrees by anthropic and natural threats that have been affecting both quality and quantity of these services. This reinforces the necessity of a broad strategy that involves nature conservation as a whole. The survey may also direct future management plans, including payment for environmental services.

Table 1. Goods and services provided by geodiversity in the coastal region of the state of São Paulo, Brazil.

REGULATION	SUPPORT	PROVISION	CULTURAL	KNOWLEDGE
Global climate regulation and carbon storage by marine sediments and paleolagoons	Habitat provision for both animal and vegetal species	Food supply by habitats for consumable sea species	Recreation and tourism in coastal islands, rocky shores, beaches, trails, waterfalls, <i>etc.</i>	Scientific research on several branches of geosciences
Local climate regulation by the Serra do Mar mountain range	Soil formation controlled mainly by the underlying rocks and sediments	Fuel and gas provision on Santos Basin	Cultural heritage values reflected in legends	Educational values as field resources for geosciences students
Oceanic circulation promoted by marine landforms	Places for anchorage by coves and bays	Water supply by several main river basins with sources in the Serra do Mar and in the Atlantic Plateau	Sense of place and spiritual values specially for traditional communities	Research centres on coastal and marine topics
Variety of soil types controls diversity of habitats	Foundations for human constructions, such as fortresses and colonial buildings	Rocks, saprolite and sands as ornamental and construction materials	Health and well being promoted by scenic beauties	Dissemination of geosciences by interpretive panels, didactic kits, courses and guided trails
Natural hazard regulation by erosion control	Participation on water cycling (ocean, rivers, mangroves, <i>etc.</i>)	Energy supply by hydro-electric plants	Artistic inspiration for paintings, music, sculptures, and general handcraft	
Water flow and flood regulation by a number of water catchments	Water pathways for transportation by rivers		Promotion of voluntary work on nature conservation	
	Shelters for ancient settlements		Protected areas controlled by the occurrence of the Serra do Mar, estuaries, lagoons, and islands	

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