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Impact of natural climate change and historical land use on vegetation cover and geomorphological process dynamics in the Serra dos Órgãos mountain range in Rio de Janeiro State, Brazil

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The Serra dos Órgãos mountain range in the hinterland of Rio de Janeiro contains extensive remnants of the Atlantic Forest (Mata Atlântica) biome, which once covered about 1.5 million km^2 from Northeast to South Brazil and further inland to Paraguay and Argentina. As a result of historical deforestation and recent land use intensification processes today only 5 to 8% of the original Atlantic Forest remains. Despite the dramatic habitat loss and a high degree of forest fragmentation, the remnants are among the Earth's most diverse habitats in terms of species richness. Furthermore, they are characterized by a high level of endemism. Therefore, the biome is considered a "hotspot of biodiversity".

In the last years many efforts have been taken to investigate the Mata Atlântica biome in different spatial and time scales and from different scientific perspectives. We are working in the Atlantic Forest of Rio de Janeiro since 2004 and focus in our research particularly on Quaternary landscape evolution and landscape history. By means of landscape and soil archives we reconstruct changes in the landscape system, which are mainly the result of Quaternary climate variability, young tectonic uplift and human impact. The findings throw light on paleoecological conditions in the Late Quaternary and the impact of pre-colonial and colonial land use practices on these landscapes. In this context, a main focus is set on climate and human-driven changes of the vegetation cover and its consequences for the geomorphological process dynamics, in particular erosion and sedimentation processes.

Research methods include geomorphological field studies, interpretation of satellite images, physical and chemical sediment and soil analyses as well as relative and absolute dating (Feo/Fed ratio and 14C dating). For the Late Quaternary landscape evolution, the findings are compared with results from paleoclimatic and paloecological investigations in Southeast and South Brazil using other dating techniques, such as pollen analysis. The impact of early civilizations on deforestation, forest fragmentation and geomorphological process dynamics is estimated on the basis of archaeological and anthropological findings. Furthermore, historical sources, such as written documents, maps, paintings and photographs, were collected and analysed to get a more detailed picture of the younger landscape history.

As a result we present a landscape genetic model for the Late Quaternary in the Serra dos Órgãos mountain range and the Guanabara Basin. Based on a functional analysis of the natural process dynamics we reconstruct the human impact on the vegetation cover and related erosion and sedimentation processes in different time periods. According to this, the polycyclic climate fluctuations in the Pleistocene emerge as periods of stability and instability in the landscape system. During dry and cool periods of the Ice Ages forests drew back and erosion processes increased, causing higher erosion and deposition rates on slopes and stronger incision of river beds, accompanied by a deposition of gravels. The colluvial soils presently found in the mountain region were mainly deposited during the last instability period in the Late Pleistocene (Wisconsin) and Early Holocene. With the return of rainforests from their retreats under wetter climate conditions in the mid Holocene, slopes were stabilized under a dense vegetation cover.

In the Late Holocene erosion conditions changed again with human deforestation and land use, which led to high erosion rates in the mountainous landscape. Concerning the human impact on rainforests and geomorphological process dynamics we give an overview of the pre-historical (Sambaqui, Tupi) and historical (colonial exploitation cycles) landscape transformation and degradation processes for different landscape units within the Serra dos Órgãos and its floodplains. The results not only give a detailed picture of historical land use patterns and landscape degradation processes, but also contribute to the understanding of recent changes in the landscape system. Thus, landscape genetic and historical analysis is essential for assessing the present landscape status with respect to degradation, stability, resilience and land use potentials, and moreover it is a reference for the development of future scenarios.