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User-centered design of a geoinformation system for identifying the visitor's impact in environmentally fragile areas in natural parks

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Abstract:

This research study aims to define the characteristics of a geoinformation system (GIS) designed to minimize the impacts on visitors in natural parks. Our premises are that it is essential to understand the user needs and establish the geoinformation characteristics that meet their needs when designing the system. We are developing this research as a study case that aims to prepare the system requirements documentation that will be the basis for designing a geoinformation system for a Brazilian national park called *Aparados da Serra* (in Portuguese). The system's users are experts in environmental protection that work at that park. The users are not experts in geoinformation systems but can use some of the functionalities of QGIS software and some smartphone application to collect geodetic coordinates and images of chosen places.

According to Brazilian Law #9985 of 2000, national parks are a type of environmental protection area (EPA) classified as a strict nature reserve. Classifying an area as a strict nature reserve aims to preserve natural ecosystems of great ecological relevance and landscape beauty. Brazil has 520 parks and one wildness-protected area of 36,470,098 hectares. Scientific research works, and public land use are allowed in national parks, including recreation, environmental education, and ecotourism. Visitation in Brazilian parks has increased significantly in the last few years. In 2018 the national parks received around 8.7 million people, and in 2019 around 9.8 million. However, poor management of public land use can cause negative impacts on environmental protection. On the order hand, visitation in parks can play an essential role in environmental protection when it is efficiently planned and managed to provide high-quality experiences for the visitors and simultaneously control and reduce the physical, biological, and social impacts. Today, only 15% of the Brazilian national parks are monitored to avoid environmental impacts, even though sporadic and unplanned.

The *Aparados da Serra* Park is a strict nature reserve between Brazil's *Rio Grande do Sul* and *Santa Catarina* states. The park's creation aimed to protect native species, preserve the region's characteristics and protect the beauty of the landscape composed of highlands and canyons. Today the park is the most visited in *Rio Grande do Sul* state, and in 2022 UNESCO recognized it as a world geopark called *Caminhos dos Cânions do Sul* (in Portuguese) Geopark.

A multidisciplinary GIS makes it easier to solve real problems in managing protected areas (Burrough and McDonnell, 1998; Formaggio, 2017). GIS has components that can accomplish many spatial data operations as general-use software. However, the characteristic of a particular discipline may demand specific customizations of a GIS solution that can define the best way to use it. A GIS can be designed and implemented as a system whose primary purpose is to represent and make available geoinformation for some users and be developed as a user-centered design product to achieve high-quality results. We use Requirements Engineering methods and techniques to understand the spatial analysis the users must perform to fulfill their professional responsibilities since a GIS is a particular information system (Sluter et al., 2016). Requirements Engineering provides the necessary resources to understand what the users intend to accomplish, considering their needs and the system's viability.

We established the research method in three phases: requirements elicitation, analysis, and documentation. A focal group interview with the GIS users was the first task of requirement elicitation. We used the guidelines proposed by Sluter et al. (2016) to prepare and conduct the users' interviews. The interview was organized into four topics: (1) the tasks performed by the users to fulfill their job responsibilities; (2) the problem to be solved using the GIS solution; (3) the existing GIS solutions in the park; (4) the geoinformation restrictions for the system. In the requirements analysis phase,

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we answered the questions proposed in Sluter et al. (2016) guideline, which helped to consider the geoinformation characteristics as the system conditions and restrictions. We prepared and composed the requirements document in the third phase of the method. The requirement document contains essential information for the design and implementation of the GIS, including the system conditions and restrictions. To prepare the requirements document, we adapted a framework proposed by Electrical and Electronics Engineers, Inc. (IEEE) together with International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC): o ISO/IEC/IEEE 29148:2018-11 (ISO/IEC and IEEE, 2018).

As a result, we understand that the GIS must allow storing data on tourist trails, soils, vegetation, hydrography, terrain slope, management zoning, the location of the species in piracy danger, the biophysical attributes, and the visitation infrastructure. The requirement document makes designing and implementing a geoinformation solution for those users possible. We also can foresee the visual analysis the users will probably perform, and we can propose solutions for generating thematic maps to be seen on GIS. In the analysis step, we can determine the functional and non-functional requirements. The functional requirements comprise operations the system must perform. The system usability requirements are part of the non-functional requirements. Because it is a GIS solution, we added the geoinformation characteristics necessary for the system to achieve its main objective.

In conclusion, we learn that using requirements elicitation and analysis, complemented with the guidelines proposed by Sluter et al. (2016) as the first step of the GIS design, made it possible to identify the essential components of the GIS to be built. Besides, we can accurately define the system functionalities and usability restrictions. One of the advantages of integrating Requirements Engineering into the design of a geoinformation product is to understand more precisely the problem to be solved, which is a consequence of users' needs. The users' needs are directly related to their professional responsibilities, which must be well-known for eliciting requirements. In Brazil, the number of tourists in national parks grows yearly, and more visitor monitoring must be done to avoid damage in protected areas. A GIS designed according to users' needs can make monitoring visiting impacts on fragile environmental regions more efficient.

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References

Burrough, P.A.; McDonnell, R.A. 1998. *Principles of Geographical Information Systems*. Oxford University Press, New York.

Formaggio, A. R. 2017. *Sensoriamento remoto em agricultura*. São Paulo: Oficina de Textos.

ISO/IEC and IEEE. 2018. ISO/IEC/IEEE 29148 - Systems and software engineering - Life cycle processes - Requirements engineering. IEC Central Office. Geneva, Switzerland.

Sommerville, I. 2011. *Software engineering*. Pearson Education, Inc., publishing as Addison-Wesley, 9th ed. Boston, Massachusetts, USA. ISBN 13: 978-0-13-703515-1.

Sluter, C. R.; van Elzakker, C.P.J.M.; Ivánová, I. 2016. Requirements elicitation for geo-information solutions. *The Cartographic Journal*.