Proceedings

Lifecycle of Geospatial Data in a High-Voltage Electrical Infrastructure Project: Geodesign Framework in the Electrical Network of Spain (REE) †

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Abstract: This paper presents the advances in the design and implementation of a geodesign framework and workflow for the development of HVEI projects, which is supported by corporate methodologies and by the execution of automatic models guaranteeing the traceability of the development of each project, in the different stages of its lifecycle. The ultimate goal is to minimize environmental, social and local impacts, while, at the same time, providing the system's actors with support tools that facilitate planning and decision-making. Our framework integrates the principles of geodesign and harmonizes the corporate procedures in the project phases. It also takes into consideration the conditions alerted by other actors, through a design process guided by feedback-iteration-consensus mechanisms. In this way there is a participatory, transparent, visible and improved framework for the development of new electricity infrastructures. The geodesign framework that we present addresses the problem of managing geospatial information for the development of new HVEI projects with two fundamental approaches: (1) including all the geospatial information representative of each constraint or territorial restriction and, (2) defining procedures throughout the phases of each project to ensure that all projects are developed homogeneously in terms of scope, precision and depth of analysis.

Keywords: electrical infrastructure; geodesign; HVEI; Project lifecycle; geospatial data

1. Introduction

The design and implementation of new High-Voltage Electrical Infrastructures (HVEI) in the territory are influenced by multiple constraints from the administrative, legal, environmental, tourism, landscape or private perspectives. Although not all the interested parties have the same point of view of the project, all the conditioning factors must be studied together so that the decisions that are adopted are the most appropriate.

Society is more informed and is increasingly demanding responsibility for companies in the development of their activities. Companies know that in order to be sustainable, they must maintain a balance between the technical-economic sphere and the social and regulatory spheres. To achieve this they must gain efficiency, control activities and provide transparency in the development of activities. Especially in those related to the environment and actions that change the environment of citizens. When talking about efficiency we are talking indirectly about reducing resources, reducing costs and reducing deadlines.

In a world as complex as the energy sector and specifically the electric energy transport sector, that is, high-voltage transport, a balance must be found between the technical field and the social and regulatory environments. This balance, which must be based on the quality of service and respect for current legislation, the environment and private property, must be achieved under two fundamental premises: an internal premise for companies that has to do with efficiency and activity control, and an external premise that has to do with transparency.

It is necessary to be efficient and socially committed, but it is also necessary to be able to demonstrate it, so the procedures to be implemented in companies must satisfy both needs.

Geospatial information analysis has become a tool that makes it possible to work in the technical field by calculating how a new installation will affect the territory and, on the other hand, it serves as a communication and transparency tool thanks to the visual power of the current systems (virtual globes). Working in the technical field means the ability to consider, in the same work environment, all the territorial constraints or restrictions as well as the project design of the future installation.

In the HVEI project lifecycle, a large volume of geodata is generated and analyzed at multiple scales, from the smallest to the largest. Each scale corresponds to a type of information and is associated to a phase of the project, and, in the transition of the scales, it is changed the technical team developing each phase. Geodesign provides the design frameworks and technologies that enable professionals can share the data and find designs according to the characteristics of each territory.

The work environment in which these ideas are shared is the corporate GIS. We are currently investing in efficiency and control of activities in the geospatial field, considering that a special effort is made to be able to communicate the projects in an appropriate way to the actors involved.

This paper proposes a framework that allows: to homogenize the development of projects from the technical area, to control the degree of progress of their activities, to increase the efficiency of the work teams and to be always prepared to explain the projects from any point of view, be it technical or not.

It is an evolution of the workflow published a year ago in the Sustainability magazine by the same authors [1]. In this article, a first approach was made to the creation of a framework that contributed to increase homogeneity in the projects, and it was proposed an automated analysis that allowed to have better information for decision making and greater efficiency in the processes related to Geospatial Information. (GI). This new work expands the framework to manage, with the same approach, the projects of electrical Substations as connection nodes between high voltage lines.

2. Methodological Approach: The GeoRED Framework for HVEI

Thanks to the maturity level of the Information Society [2], society and companies have numerous digital data sources from many regions of the planet, including geospatial data usually in SDI (Spatial Data Infrastructures). The concept of Digital Earth [3] is becoming reality and there is GI available, both official and voluntary (for example Open Street Maps, OSM) that allow to support the analysis and decision making, specifically in the design and geodesign processes.

Since the GI flows produced in the phases of the project of a new electrical installation have already been established in the framework and workflow of geodesign, they are currently being implemented as a set of procedures to follow in each new project. To facilitate the management and storage of all this GI, the corporate GIS (GeoRED) of the company is being used. GeoRED was designed to meet the needs of stakeholder collaboration. It is supported by the GI that facilitates the collaboration and understanding of geographical reality through the use of maps, visual tools and geoprocessing, creating a virtual meeting room accessible from the offices of the actors, enabling the execution of several iterative design cycles until participants reach a consensus [4]. GeoRED has the ability to represent the requirements of different stakeholders in a single environment. Thus, the virtual meeting room provides an alternative methodological approach to investigate how to involve different actors, from technicians to local actors, in an open and participatory process. This participation facilitates transparency and visibility in the different decisions and responsibilities. However, the design of this platform does not follow any geodesign framework, there is no homogeneous procedures for each phase of the projects, and the applied procedures depend on the criteria of the responsible technical staff.

A new electrical installation will be part of the physical elements in the territory (such as landforms, communication routes, constructions, etc.) and how the territory behaves in terms of its social, cultural or economic activities. Considering this, GI is incorporated in each project phase to represent the conditioning factors of involved groups and actors, and it is also necessary to use GI with increasingly precise scales in the corresponding studies.

The proposal presented here is based on the application of different models, with homogeneous procedures, in each of the phases described that will also provide a traceability system for the evolution of the HVEI project.

The proposed models, within each phase, are dependent on the previous ones according to the GI flow, in a way analogous to the Steinitz's geodesign framework [5]. If there is no data, or they are insufficient to apply any model, their acquisition becomes a priority activity. Or, if the processes cannot be modeled, specific works will be carried out on some aspect of the HVEI project dynamics.

Each HVEI project is divided into 5 main phases, among which the results of each phase feed the following one: planning, study of alternatives, engineering project, permit obtaining and construction. Figure 1 details the methodological approach of the geodesign framework for the HVEI of each phase and how they are sequenced among them.

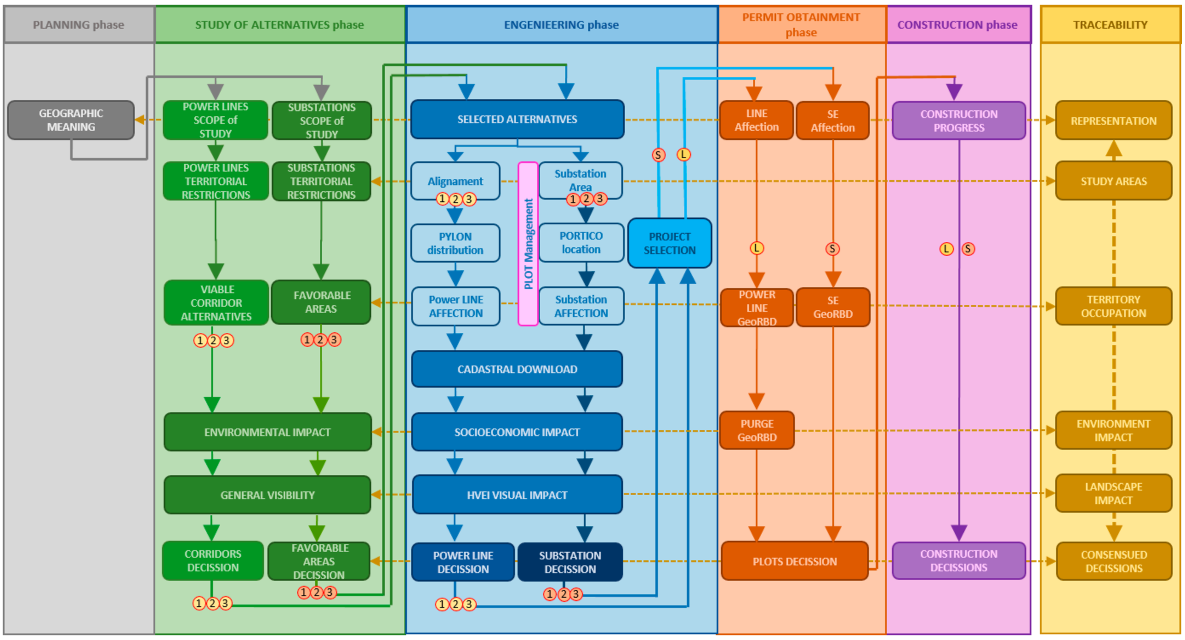

Figure 1. Methodological approach of the geodesign framework for the HVEI considering the projects of lines and of substations.

Considering the linear task flow, each of the phases can be understood as different projects and each of them associated with its discipline. Thus, it will be necessary to carry out a planning project to detect future energy needs; a project to study alternatives, obtaining as a result at least three viable alternatives from the environmental point of view; an engineering project for each of the environmental alternatives, finally selecting one; a project to obtain permits for the parcels affected for the finalist project and, finally, a construction project.

The planning phase the project is represented cartographically as an approximation. In the phase of study of alternatives, the territory is analyzed using official GI sources that already consider, at the territorial organization level, the territorial constraints that imply the search of the corridors with less impact. In the engineering phase, its own GI is generated by classical topography, photogrammetry or LiDAR flights, thus, within the lowest impact corridor, the GI that describes it acquires a really high level of richness. In the permit obtaining phase, two GI sources are combined, the official Cadastral one [6] and the one resulting from the engineering phase. Finally, in the construction phase, the GI goes through the field work to redefine the design project.

The analyses of each phase are sequential and the results of one phase are part of the next one. In each phase, a set of models that lead to a final decision are sequenced. This sequence of models of each phase is related to those of other phases, so for each project, and by all the GI describing each phase, there is traceability of all the states which the project has gone through.

The main difference of this methodological approach compared to the previous author's work is the contribution in the flows related to the substation projects.

The decisions of lines and substations must be coordinated so that each line alternative has a substation as source or destination. Although these are different electrical installations, and with different territorial conditions, they are not independent.

Even considering that substations have a smaller impact on the territory, due to their size, they greatly condition the area in which they will be built since substations constitute the connection nodes of some lines with others. Thus, the location of a substation will generate a direct impact, as it is an electrical installation, and an indirect impact due to the confluence of the lines. For this reason, in addition to the civil works necessary to build a substation, the confluence of lines can make the land useless for other uses, for which a patrimonial management of acquisition of the lands affected by the substation must be made.

3. Conclusions

The implementation of the geodesign workflow for HVEI in REE, makes the lifecycle of the geospatial data subject to corporate criteria. These make necessary to use specific data for each of the phases. Such data must always have the same structure (in terms of format, precision, descriptive attributes, etc.) and the models must always perform the same established procedures. This guarantees access to data when necessary during the processes as stipulated by the corporate definitions. In this way it will be easier to achieve quality indicators in the results, since the workflow of GI is managed through standardized procedures according to a corporate criterion.

This framework is being implemented and developed using the AGILE—SCRUM methodology [7], which favors the continuous improvement and consolidation of the methodology.

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