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The Geoportals of Renewable Energy Sources in Latin America

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Abstract*---*Geographic information systems are tools used in the organization and planning of the territory; they show physical-spatial information on different topics very opportune for decision making. In Latin America, several countries are using it for the purposes of inventories of the different renewable energy sources, fundamentally in order to know where they are located, these are a potential for local development and improve the energy sustainability of the territories. For the development of the research, a bibliography search was carried out, to know the countries of the region that are developing geoportals that contribute to local development, use of natural resources and mainly energy resources, as a result it was obtained that most of the Countries are working on inventories that help decision-making in national and territorial development programs, mainly natural and energy resources.
Keywords*---*geoportals, America Latin, local development, natural and resources, renewable energy sources.

Introduction

The field of geographic information systems (GIS) began in the 1960s, while computers and the first concepts of quantitative and computational geography were emerging. The first works of the SIG included important investigations of the academic community (Perez et al., 2017). Later, the National Center for Geographic Information and Analysis, led by Michael Goodchild, formalized research on key geographic information science topics, such as spatial analysis and analysis. These efforts fueled a quantitative revolution in the world of geographic science and laid the foundation for GIS. Roger Tomlinson's pioneering work to initiate, plan, and develop Canada's Geographic Information System resulted in the world's first computerized GIS, in 1963. Meanwhile, at North Western University, in 1964, Howard Fisher was creating one of the first mapping software programs, known as SYMAP. In 1965, the Harvard Laboratory for Computer Graphics was established. In 1969, Harvard Laboratory Fellow Jack Dangermond and his wife Laura founded the Environmental Systems Research Institute (Olaya, 2016). As computers became more powerful, in 1981 Esri improved its software tools, working on projects that solved real-world problems; led the company to innovate and develop robust GIS tools and approaches that could be widely used (De, 2010; Maguire, & Longley 2005).

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These systems offer people the ability to create their own digital map layers to help solve real-world problems. The integration with information in real time through the Internet of Things (IOT), these will become a relevant platform to almost all human activity, the interactive system of the planet. As the world faces challenges, such as the expansion of conflict or war, deforestation and pollution, GIS will play an increasingly significant role in how these problems are understood and addressed, as well as providing the means to communicate solutions using common language maps. The objective is to identify the geoportals that exist in Latin America on renewable energy sources (Tait, 2005; Kulawiak et al., 2019).

Materials and Methods

For the development of the research, the bibliographic review was used, in addition to the qualitative analysis, being able to obtain existing information related to the use of geospatial infrastructures for the development of the countries of the Latin American region (Moet et al., 2007; Tanaka, 2000).

Analysis and Discussion of the Results

Since 2010, the use of GIS implementations in administrations and state and private institutions increased due to its strength and the advantages that technology offers; but the number of geoportals that have data on renewable energy sources (FRE) is minimal, in some there is data only from one or two types of sources during this investigation, information was found on solar radiation, use soil, biomass, rivers, among others. In Argentina the National Geographic Institute (IGN), the system provides a service of the defense ministry, based on the implementation of standards by the geoserver software that has information related to the FRE, such as hydrography and oceanography on rivers, lakes, wetlands, reservoirs, islands, the water stream (intermittent or perennial) among others (Piñón et al., 2018). There is also Geoportal (CONAE), this geoportal administered by the National Commission for Space Activities (CONAE) of the Ministry of Science, Technology and Productive Innovation. This platform offers geographic data about soil moisture (estimated by homogeneous zones. Its percentage scale represents the volumetric content of water in the soil as an average up to 50 cm deep, the production of different products such as wheat, corn, soybeans, Sea Surface, this helps to obtain information on specific areas with biomass potential (Fukuda, 2020).

The Integrated Environmental Information System (IEIS) makes information generated within the national state available to citizens, with contributions from other institutions, academia, civil society and the private sector. It depends on the Ministry of the Environment and Sustainable Development of the country. The information presented in the IEIS is grouped into 15 thematic axes on a national scale and disaggregated at regional or jurisdictional scales in those cases in which the available information allows such opening. According to this research, the axes related to renewable sources are water, soil, forests, and productive activities. There is an energy portal, this platform available to the public the information generated in the scope of the state that depends on the secretariat of energy of the presidency. The information presented is grouped into 3 thematic axes (hydrocarbons, energy, and socioeconomic information). The renewable folder groups data on, wind energy (wind speed), geothermal energy (area of geothermal interest for electricity generation), solar energy (insolation and irradiation) of the entire Argentine territory and bioenergy, it is a complete geoportal with detailed data on the FREs and their geospatial location secretariat of energy (Heinrich & Teoh, 2004; McKenzie et al., 2012).

In Brazil, the INDE was conceived as the purpose of cataloging, integrating and harmonizing geospatial data produced and managed through various government institutions so that they can be easily located, explored in their characteristics and can be accessed by any user who has internet. This geoportal has several viewers, but those selected, which are related to the investigation, are: areas with biomass potential and the climate of Brazil. In Chile, the Geomin geoportal depends on the national geology and mining service, it offers information on all the data related to geology and mining, such as the temperature of the groundwater of the aquifers of high hydrogeological importance, the aquifers of high hydrogeological importance of the regions of rivers and lakes, among others (Sachs & Warner, 2001; Bankole et al., 2015; Pérez et al., 2016).

The San Ignacio del Huinay Foundation and the Pontifical Catholic University of Valparaíso launched the Observational GeoPortal (Geoos). It is a platform for free and timely access to georeferenced information from monitoring stations with satellite information and in real time. GEOOs have the necessary tools for the deployment of georeferenced information, allowing the visualization and rapid comparison between the different climatic variables and the terrestrial and aquatic ecosystems. In Colombia, a geoportal of the Mining-Energy Planning Unit

(UPME) was found. The geoportal (UPME) has four sections: Geoservices, Map Gallery, General Viewer and Thematic Viewers. The Geoservices section offers ten (10) WMS links with the following topics: Mineral Production and its history; Hydropotential Atlas; Solar Radiation Atlas; Potential Wind Energy of Colombia; Atlas of the Energy Potential of Residual Biomass, National Transmission System, etc., in addition to the Wind Energy Viewer made up of the Category, energy potential and monthly wind energy measured at 50 meters above the surface. The display shows a bar to scroll through the months of the year. The values in the legend are expressed in watts (W) per.

The Atlas Biomass viewer is a set of maps that show the amount of residual biomass produced in Colombia and its corresponding energy potential for eight agricultural crops, three livestock species and the urban organic solid waste from the marketplaces of 12 cities and the pruning of green areas in 10 cities, and their corresponding potential. The Atlas compiles and consolidates information on the cultivated area, the livestock population, and the volume of urban organic solid waste. This viewer has information on permanent crops; crops (Panela, coffee, banana, rice, and corn), the potential (animal, vegetable and bovine); poultry and solid urban waste. It is a well-organized viewer with very clear and detailed data in addition to GISPERS. It is the geographic information system of the PERS (Sustainable Rural Energization Plans). This geoportal offers data on solar radiation, solar brightness, and insolation kWh/m² among others. Only in sustainable rural areas that make up the PERS plan in Colombia.

In Costa Rica, the National Territorial Information System (NTIS) is a complement to the SIRI (Real Estate Registry Information System), these two entities depend on the Costa Rican national registry. It is a public institution, governing and responsible for registration and geospatial activity. The SNIT allows the exchange of territorial information between all those institutions that require it. The SNIT is conceived as the platform for the administration of the territory, in a way that allows a correct planning, use and control of the same. The system is open, it allows access to data in the content, in a simple and transparent way, and it operates on the WEB platform in such a way that it guarantees universal access to spatial data. It is constituted in the cartographic and geoportal viewer that currently covers basic aspects of the publication at the level of visualization and consultation of some of the fundamental data at the national level (Lobo-Hernández). The geoportal has data on the areas with water resources in Costa Rica.

The geoportal of the Military Geographical Institute (IGM) of Ecuador is made up of eight (8) viewers, each of which has specific data related respectively to the subject of the viewer. This geoportal is the most complex and complete that exists in the country. In the geoinformation viewer at the national level, in the climate and hydrology folder, information on temperature, water deficit, hydrographic division, land use, etc. is grouped together. By zone at the national level (Flores, 2020). In the official geographic data viewer of the geoportal you will find data such as the ecological system (bioclimate), flooding and land use, etc. In the viewer Environmental Geographical Atlas of Ecuador, chapter 3 has 6 folders that are the following: water, soil, forestry, scenic beauties, energy, oil and mining. Each folder groups geospatial data on the topics respectively. The energy folder itself is made up of six (6) points that are: non-renewable power plants, renewable power plants, and homes with electricity, cooking fuel (fossils), cooking fuel (electricity), and state megaprojects. In it you will find data on the levels of solar radiation at the national level and the bioclimate level, At the University of Azuay (UDA) there is a geospatial portal that presents data on the populated centers and the cantons of this province and the entire country (Pontón et al., 2017).

The Ministry of Agriculture and Livestock (MAG), presents its geoportal of the Ministry of Agriculture (geohistoric) is a platform that has precise information on the types of soils that exist in Ecuador, this develops four topics: land cover and use, geopedology, agricultural industries and services, marketing, annual crop estimates, permanent crop estimates, etc. The first groups data on the areas, agricultural, forest, anthropic, conserved and protected, and unproductive lands, the second has precise data, the type of soil (taxonomy, slope, texture) and agricultural aptitude (crops, forest, urban area, pastures, etc (Cuellar et al., 2006). The National Polytechnic School (EPN), through its geophysical institute, has statistical data on volcanic stations, and on earthquakes; in addition, the Technical University of Manabí (UTM), is building the geographic information system for Sustainable development (SIGDS), with information that will contribute to the local development of the province of Manabí aimed at the efficient use of natural resources and achieve sustainable development, this shows information related to the potential of renewable sources of energy, on environment and risk.

The Spatial Data Infrastructure (IDE) of the University of Cuenca and the province of Tungurahua, present reliable and timely cartographic information on water resources, conservation areas, climate, natural risks, soils and geology. The objective of this material is to contribute to the management and planning of the Tungurahua province (Schwarzenbach et al., 2016). The geoportal of the Ministry of Energy and Non-renewable Natural Resources does not have data on renewable energy sources, but it can consult information related to the hydrographic map of Ecuador. This allows identifying or viewing areas with hydrographic potential, in addition to that presented by the Geological and Energy Research Institute (INIGEMM), this requires identification before accessing the site. In

Honduras there is the UNAH geoportal, where it is derived from the study of territories at risk II, which is a contribution to the debate on the future of the extraction of minerals, hydrocarbons and the generation of electricity, it points out the possible risks in the neighboring territories with these activities, based on cartography to identify conflicts related to the territory. The main objective of this Geoportal is the visualization and dissemination of maps and geographic information related to the mining cadastre and renewable energy, for the identification and spatial location of tax and conflict issues in its territory. It also presents the sites where there is biomass in great quantity as can be seen in figure 15, the blue dots show the areas with potential in biomass (Odoh et al., 2021).

CONABIO is in Mexico, it is a geographic information portal where you can consult, view and download thematic cartography of different scales generated and compiled by it, has as the development of access mechanisms to the collections of geographic data through services of specialized information, such as: graphic view of the information by general topics, detailed information on the cartography available through metadata searches, downloading of information in a compatible format. The cartographic information is administered by the Sub-directorate of Geographic Information Systems, it is consulted through a general classification of topics, under the following headings: SNIB, biodiversity, topography, hydrology, edaphology, geology, climatology, vegetation and land use, political division, population, infrastructure, regionalization, satellite products, risk, etc.

It also has the geoportal of the National Institute of Statistics, Geography and Informatics (INEGI), which is an autonomous public body responsible for regulating and coordinating the National System of Statistical and Geographical Information, as well as for capturing and disseminating information on Mexico regarding the territory, the resources, the population and the economy, which makes it possible to publicize the characteristics of the country for decision-making. It offers data on the mean annual temperature and total annual precipitation, as well as the types of climates according to the Koeppen classification, modified to adapt it to the conditions of the Mexican territory. The presence of phenomena such as heatwave, interstitial drought, frost and prevailing winds, water deficit, mean annual real evapotranspiration, and water balance by basin are also considered. It includes the same frames of reference that were mentioned for the topographic chart. Likewise, it presents the lines of the same temperature and precipitation - isotherms and isohyets - and the location and average measurements of the existing meteorological stations in the country. In addition, it provides information on the annual average temperature and precipitation records from all meteorological stations. The only drawback is that the platform does not present encrypted temperature values.

The Geographic Information System for Geographical Energies for Renewable Energies (SIGER) is developed in the country by the old Electrical Research Institute (IIE), it is a system composed of maps in raster and vector formats and data in tabular form, the Which contain information on renewable energies and those geographical elements that influence the determination of sites for the use of this resource, is designed to contain information on the entire national territory. The spatial resolution of the maps is 100 meters and in the case of the political division it reaches the municipal level (Guedea, 2016). The Dominican Republic has a geoportal that facilitates the environmental review process and project planning with respect to environmental considerations, from the country's ministry of environment and natural resources. This application is web-based and collects the databases on the environment and the web services of the Geographic Information System (GIS), dynamically providing an immediate classification of the environmental assessment indicators for a defined area of interest. By the user, it offers information on the climatic aspect (wind potential), water resources, and natural hazards, among others.

In Uruguay, there is a MVOTMA platform of the Ministry of the Environment, managed through the National Environmental Observatory (OAN), which provides inputs for institutional decision-making and at the same time brings that information to the people. Through this tool you can display and consult information about the country's biomass, ecosystem, rivers, etc. In addition to the portal DINAMIGE, from the National Directorate of Mining and Geology service. (DINAMIGE), is a geoportal that provides information on the water resource, and what is related to the hydrogeology of the country.

Conclusion

Most Latin American countries have geoportals related to energy that facilitate access to geographical and environmental information on the territories, including the one dedicated especially to renewable energy sources, the environment, and natural risks in the province of Manabí. (Ecuador), with the aim of helping the energy sustainability of the territory. Countries such as Colombia, Argentina, Ecuador, Mexico, Chile, Costa Rica, among others, are using this geographic information technology for decision-making purposes; in addition to other platforms such as GEOSUR (the geospatial network of Latin America and the Caribbean) and CEPAL, which provide

geospatial information on the different countries of South America, as well as geospatial web applications developed by the Central American Network of Geographical Information Systems Technicians of the CICA (REDSIG-CICA) which is limited to the Central American level.

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