GEODECISION 2019
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Geodecision for Sustainable Communities

TOOL FOR THE PLANNING OF RURAL ELECTRIFICATION TAKING INTO ACCOUNT CRITERIA OF THE TERRITORIAL ORDERING

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Introducción

"It is currently estimated that 840 million people, 11% of the world's population, have little or no access to electricity and more than 80% of those suffering from energy poverty live in rural areas" (World Bank Energy, 2019).

Las Tunas Electric company survey

UNE
EMPRESA ELÉCTRICA LAS TUNAS

Las Tunas, 2 de febrero de 2015
"Año 57 de la Revolución"

RESUMEN LEVANTAMIENTO DE VIVIENDAS OSCURAS AISLADAS.

Municipios	Consejos Populares con viviendas oscuras aisladas	Circunscripciones con viviendas oscuras aisladas	Cantidad de viviendas oscuras aisladas
Manatí	7	13	61
Puerto Padre	4	4	17
Menéndez	6	15	28
Tunas	5	11	162
Majibacoa	8	18	111
Jobabo	5	5	71
Colombia	4	9	81
Amancio	7	26	126
Provincia	**46**	**101**	**655**

Nota: este es el resultado del levantamiento realizado por los Gobiernos municipales junto con las entidades encargadas en cada territorio (IPF, Gestores sociales, Eléctrica, etc.)

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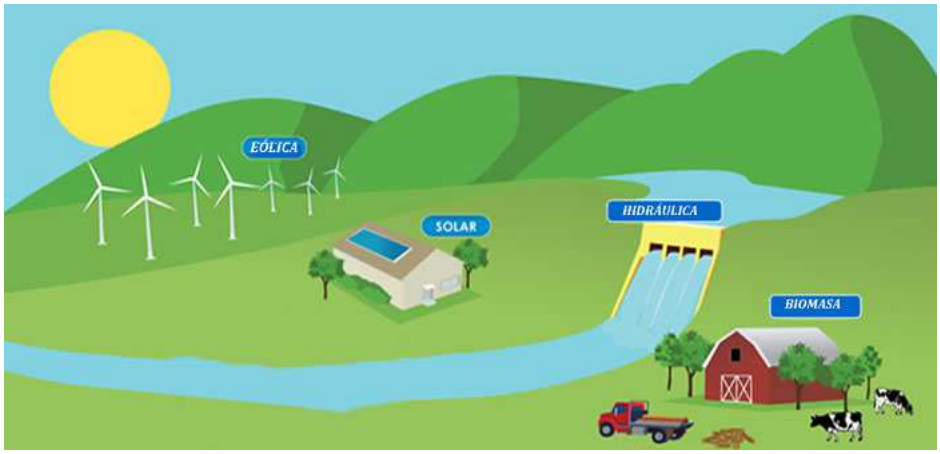
Introduction



Geographical dispersion of the Renewable Energy Sources (RES)

Introduction

The Cuban Society for the Promotion of Renewable Sources of Energy and Environmental Respect (Cubasolar) is a Non-Governmental Organization (NGO), which aims to contribute to the development of activities aimed at knowledge and rational use of renewable sources of energy, in solving the economic and social problems of the country.

Problematic situation

The main problems that Cubasolar is facing in the decision-making process associated with the electrification of rural houses using RES in Las Tunas province are:

- Lack of knowledge of the renewable potential in the region under study.
- Shortage of updated information about the location and size of the communities to be electrified.
- Little availability of geographic data of the region under study.

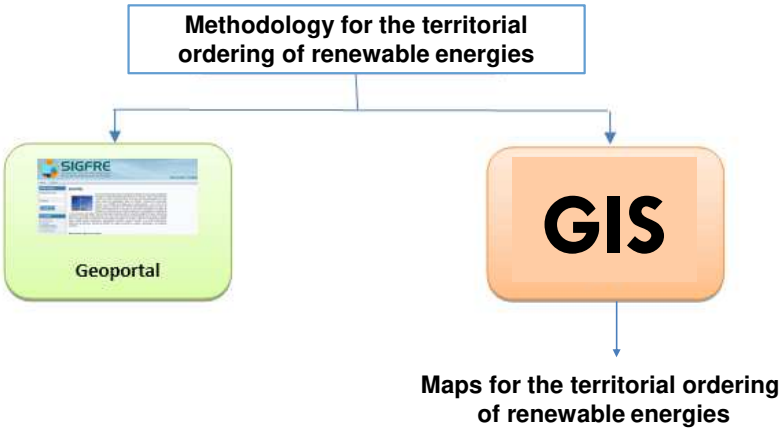
Problematic situation

GIS-based models (Ellman, 2015; Kemausuor et al., 2014; Mentis et al., 2017; Pinedo Pascua, 2010) for the planning of rural electrification with RES are characterized by **techno-economic assessments** and for **not considering criteria and concepts of land management**, so as to avoid conflicts in land use or preservation of resources and the environment; key aspects to ensure the use of available resources and limit development in sensitive areas.

Objective

Develop a tool based on GIS that would allow planning of rural electrification taking into account criteria of the territorial ordering of the renewable sources.

Background in Cuba



Rodríguez, M. (2011). The management and planning of renewable energy sources in the Island of Cuba from a territorial perspective. Case study in the municipality of Guamá from a Geoportal. PhD thesis, University Pablo de Olavide, Spain.

Materials and methods

According to (Khan et al., 2014), when developing a tool in a GIS environment, the following steps must be taken:

1. **Identify the criteria,** to make thematic maps associated with the criteria, which will influence the process.
2. **Identify the appropriate software support,** which is capable of handling the identified criteria.
3. **Build the software support** in the GIS environment.
4. **Analysis.**

Criteria to be used for the analysis of rural areas without electricity

- **Analysis criteria**: those that enhance the selection or adaptation of the site and have positive connotation.
- **Exclusion criteria**: those that restrict the alternatives and have negative connotation.

Analysis criteria

- Distance to the main roads.
- Distance to the electrical network.
- Renewable sources of energy available.

Parameters to recommend the use of RES

Based on the researches analyzed (Madruga, 2008; Rodríguez, 2011; Shiota Akio, 2002), the following parameters were adopted to recommend the use of energy sources in the electrification of houses:

- Recommend connecting to the electricity grid if the house is less than 6 km from it.
- If the distance to the electricity network is less than 5 km and in the area are available some of the renewable sources of water, biomass, wind and solar in that order, recommend the use of the systems connected to the electricity grid (SCG) associated with those RES.

Parameters to recommend the use of RES

- If the house is more than 6 km from the electricity grid, the autonomous systems (AS) associated with the water, biomass, wind and solar RES will be recommended in that order, if the resource is available in the area of the house. In the case of the solar resource, it is known that its potential is adequate throughout the province.

Exclusion criteria

Variables	Protection Perimeters (m)
Protected areas	1000
Electrical networks	50
Roads	150
Railway lines	100
Rivers, dams, reservoirs and canals	300
Forest	0
Coast Line	40
Low areas	40

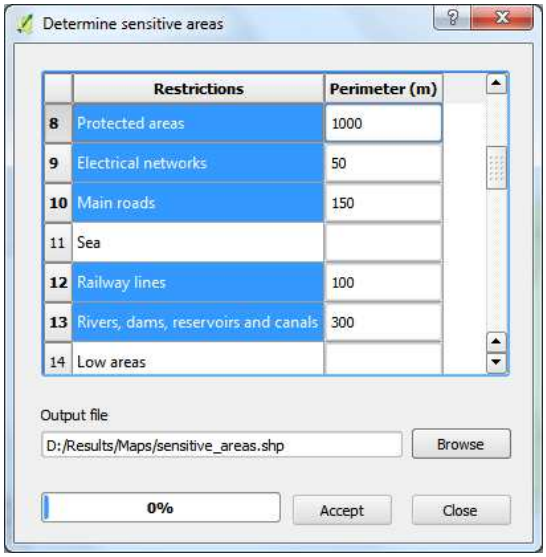
Description of the tool

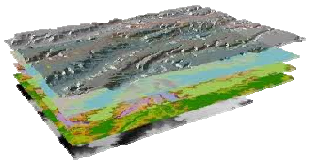
Description of the tool

The tool developed is based on a plugin for QGIS named ExamZonas, which is compatible with the versions 2.x. This implements the functionalities:

- **Determine sensitive areas.**
- Calculate distances to the electrical network and the main roads.
- Longitude of low voltage lines.
- **Analyze rural houses.**
- Update community data.

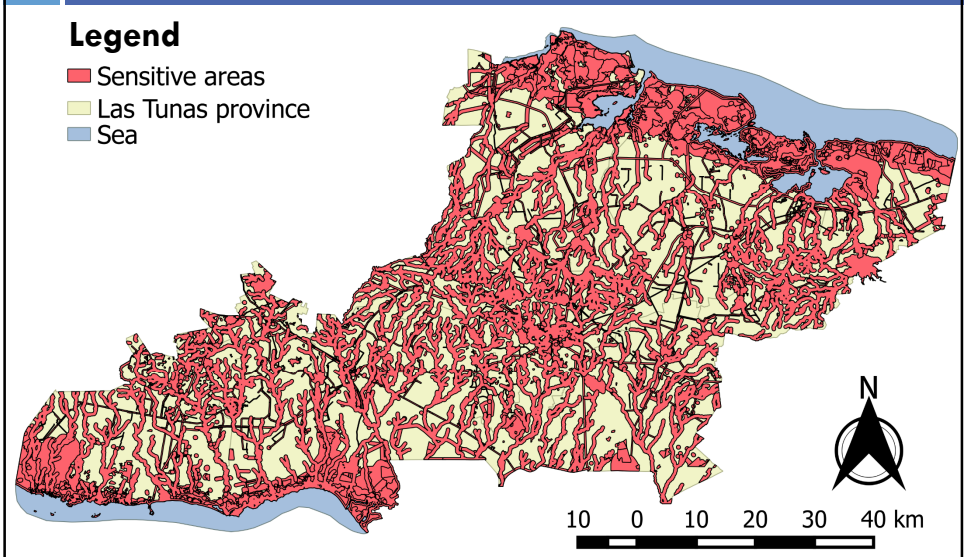
Determine sensitive areas



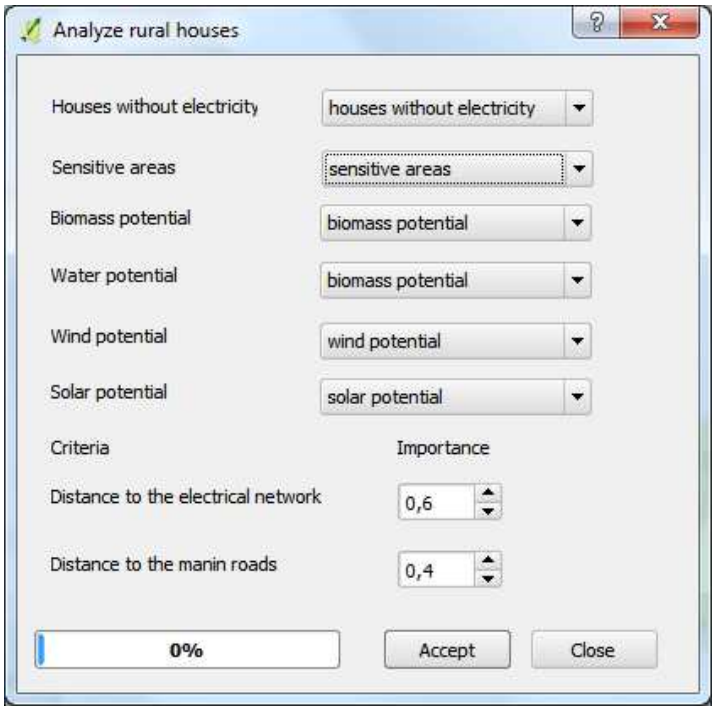


Layers

Map of the sensitive areas



Analyze rural houses



Attributes added in the analysis

- Type of Area: "limited" or "not limited", in case it coincides with a sensitive area or not.
- Source of Energy (SE): that is recommended to be implemented in the house.
- Degree of Isolation: calculated based on the distance to the electricity grid and the main roads.

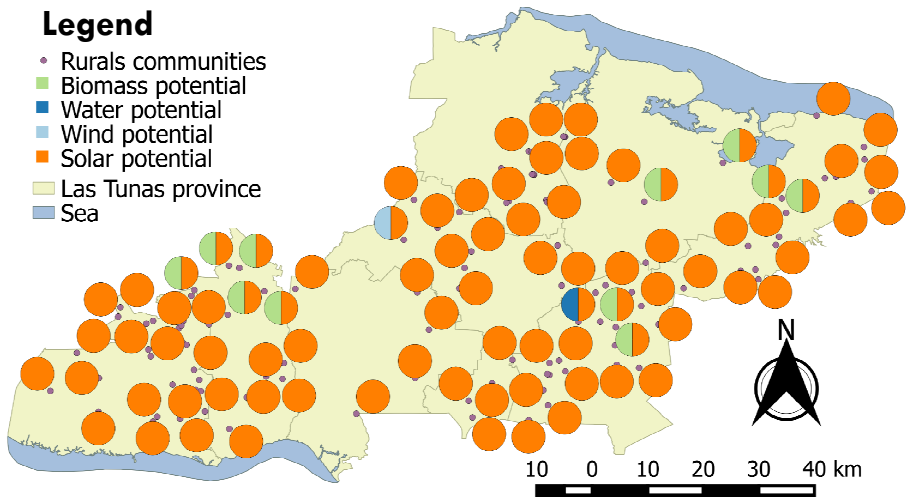
$$GA = I_{d_s} * \left(\frac{d_s}{max(d_s)}\right) + I_{d_c} * \left(\frac{d_c}{max(d_c)}\right)$$

d_s: distance of the house to the electrical network

d_c: distance to the main roads

I: importance

Renewable potentials in rural communities



Results and Discussion

Taking into account the values of the attribute, "SE recommended":

- There are 567 houses that are less than 6 km from the electricity grid and where it was recommended to connect them to this. Of these 513, have the potential to implement photovoltaic systems connected to the electricity grid.
- They are only 21 houses located more than 6 km from the electrical network, and where the use of the Autonomous Photovoltaic Systems (SFA) was recommended.

Conclusions

- The study of research associated with the planning of rural electrification with RES made it possible to determine that GIS are a powerful tool for manipulating, processing, analyzing large amounts of spatial data and supporting decision-making in the spatial deployment of these systems.

Conclusions

- The ExamZonas plugin is capable of recommending the energy source to be used to electrify each house in the study area, for this it establishes a priority among the available RES. In addition, it facilitates the identification of the areas farthest from the electrical network and the main roads.

Conclusions

- The tools provided by QGIS, together with the functionalities added with the ExamZonas plugin, as well as the maps corresponding to the criteria and renewable potentials, contribute to decision-making in the planning of rural electrification projects in Las Tunas province.

Acknowledgement

With the support of the HIBRI2 Project, "Integrated control system for energy supply through hybrid systems in isolated communities in Cuba. Phase II", financed by Spanish International Cooperation and Development Agency (AECID) through its call for innovation projects 2018. (2018 / ACDE / 000600).

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