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**SOLAR ATLAS IMPLEMENTATION AND MULTICRITERIA
CONTEXT OF PV PLANT PLANNING IN CORSICA ISLAND (FRANCE)**

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ABSTRACT: Wind and solar potentials make Corsica so attractive that the construction of a reasoned planning for on grid plants is essential all the more so as variability of renewable energy production makes integration of this kind of energy delicate and a 100 MW threshold has been calculated in order to ensure the grid stability.

MultiCriteria Decision Aiding (MCDA) approaches, that allow best compromise based recommendations between alternatives, considering constraints, criteria and actors, are adapted to projects planning. The object of this study first part is to present a MCDA methodology and to show the first steps of application that are constraints and criteria sets constructions. Photovoltaic energy production is one of the most important criterion. The large number of projects that must be studied and their geographic dispatching impose the construction of a solar irradiance map that the poor Corsica's meteorological network does not allow to create, justifying satellite data used. A second part of this study shows the first step of a solar irradiance map construction, consisting in checking the satellite data validity, comparing them with terrestrial meteorological data. In agreement with the literature survey, these irradiation maps represent the first successful stage of the whole MCDA approach.

Keywords: PV planning, multicriteria approach, solar atlas.

1 INTRODUCTION

Corsica's wind and solar potentials make this region one of the more attractive in France for renewable energy. The 100 MW threshold of renewable energy systems connected to the grid imposes a reasoned planning for grid PV plants, as well as rulers and decision makers have to select the more relevant photovoltaic plants projects among numerous ones. Multi-criteria decision aiding methodologies are very useful within the selection framework.

The energetic criterion is one of the dominant criterion for photovoltaic plants projects selection. The poor Corsica's meteorological network and the geographic dispatching of the different projects that will be evaluate justifies the necessary creation of a solar energy potential atlas of Corsica from satellite data.

The object of MCDA is to build recommendations based on compromises and satisfactory action, more than optimal, satisfying constraints and meeting at best the criteria defined by the actors of the decision process.

Figure 1 presents the ten principal steps of participative decisional process [6], which will be applied for our study.

The first part of this item presents definitions of specific terms used in a multicriteria study and the first steps that are actions definition, constraints and criteria lists construction.

2.1 Potential actions

An action is *“the decision or the decision aiding object [...] An action is called potential when it can be implemented or is worthwhile for a decision aiding.”* [10]. In this work, multicriteria tools are going to be used to evaluate potential actions that are photovoltaic plants projects on cultivated areas, for which the Haute-Corse chamber of farming solicited our laboratories for a scientific help to give an opinion.

2.2 Constraints on photovoltaic plants

In decision theories, constraints are defined as *“acceptability or eligibility conditions that actions have to satisfy imperatively to candidate for the decision or/and the multicriteria study.”* [6] Constraints that projects have to satisfy are established and presented in Table 1.

2 MULTICRITERIA DECISION AIDING APPROACH

Multicriteria Decision Aiding (MCDA) is a 40 year old field of modern operational research define as *“experts' activity formulating recommendation for decision makers, improving coherence between decision process evolution, objectives and concerning people's values system.”*. Contrary to classical operational research based on the postulate that *“all situation needing a decision has at least one decision objectively proven as optimal [...]”* [9],

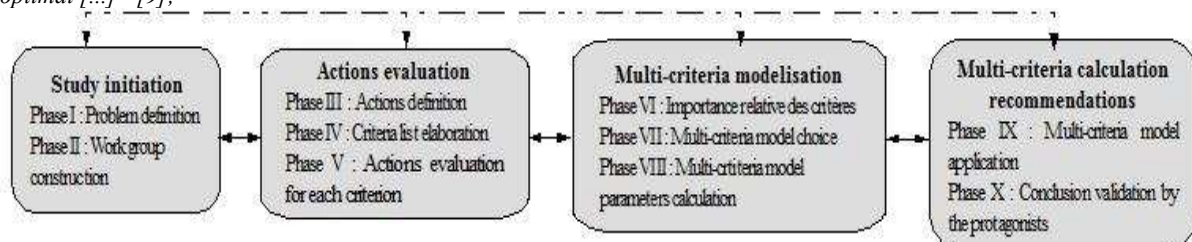


Figure 1: General structure of the multicriteria decision aiding process

Table I: Constraints defined between University of Corsica and Agriculture chamber of Northern Corsica

Constraints	Definitions
C ₁	Plants dismantling guarantee: plants dismantling must be guaranteed in the exploitation contracts
C ₂	Respect constraints linked to ecological classifications: Concerned areas must not be classified Natura2000 or Wetland
C ₃	Constraints linked to area's topography Areas' slopes must not exceed 10%

2.3 Criteria for photovoltaic plants evaluation

A criterion is “*a tool create to evaluate and compare potential actions from a point of view.*” [6] Criteria are associated to preferences scales which are ordered items groups permitting actions evaluation. Table 2 presents the pertinent criteria built for this specific study and listed by the Haute-Corse chamber of farming in cooperation with SPE and LISA laboratories.

ELECTRE outranking models [3] are the multicriteria methods that have been selected within our study framework [6]. This approach is based on comparison between an action to another, determining the actions advantages and drawbacks from each criterion point of view. Discrimination (indifference, preference) thresholds and even veto threshold at each criterion will be introduced in order to obtain the selected actions subset.

Table II: Criteria for plants projects evaluation

Point of view	Criteria title	Criteria creation principe	Scale terms	Preference way
Energetic	Net production	Energy production evaluation	Wh annual	Maximize
Geo-economic	Ratio of rent area innocupated by the installation	Ratio between free area of productive land and the total rent area	%	Maximize
Ecological	Ecological potentiel degradation	weighted sum	Points	Maximize
Visual Impact	Pertinence of visuel impact presentation in the files	weighted sum	Points	Maximize
Visual Impact	Observers-plants minimum distance	Mesures from cartography	km	Maximize
Territorial use	Use conflicts risks	weighted sum	Points	Maximize
Financial effect	Influence on the communal budget	Professional, property duties evaluation	€/an/inhab	Maximize
Financial effect	Financial incomes for local industries	weighted sum	Points	Maximize

3 SOLAR RESOURCE MAPPING

The aim of the second part of this study deals with the evaluation of net production from an irradiance potential cartography of Corsica, in order to evaluate this criterion for each plant.

A spacial correlogram demonstrated that there is no correlation, from a solar point of view, between two 10 km apart sites in Corsica [5]. Thus, considering the poor Corsica's meteorological network, using meteorological data from terrestrial stations is not enough to built a solar potential map, justifying the use of satellite data.

Our solar potential map will be built using solar radiation from Meteosat7 retrievals. Solar radiation is hourly and issued from Ajonc products [7]. It has 96x64 pixels over Corsica (41-44°N ; 8-10°E) with 2.5x2.5 km resolution. A data processing has been built, removing sunrise and sunset corresponding data which can't be accurately treat by the models because of their irradiance diffused nature [8].

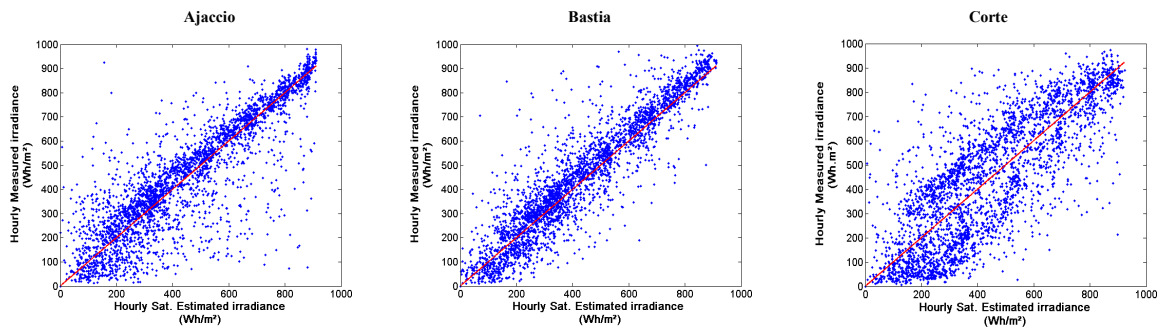


Figure 2: Meteosat7 data of hourly horizontal irradiance compared to ground measures

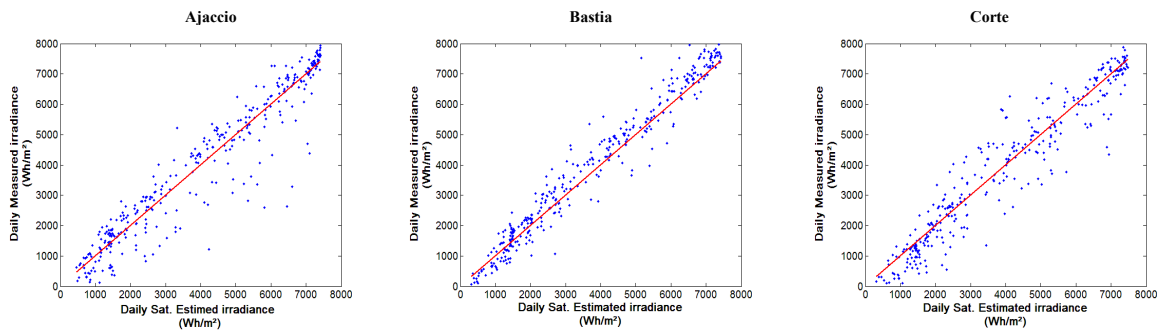


Figure 3: Meteosat7 data of daily horizontal irradiance compared to ground measures

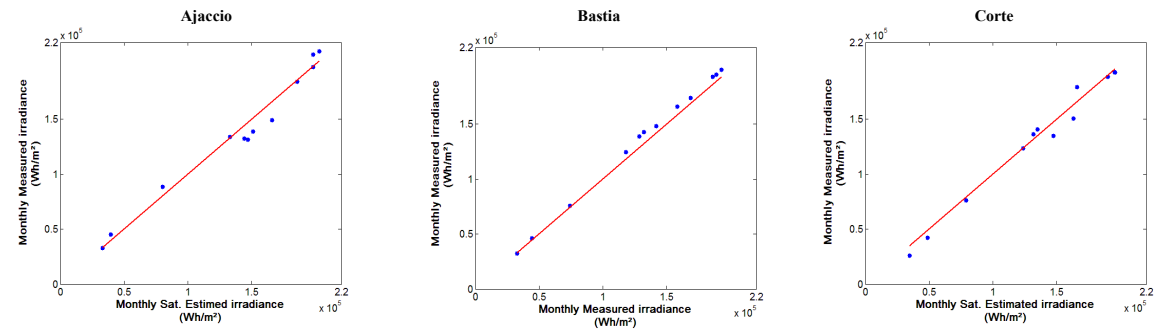


Figure 4: Meteosat7 data of monthly horizontal irradiance compared to ground measures

3.1 Satellite data validity

Figures 2 to 4 show hourly, daily and monthly horizontal irradiance evaluated by Meteosat7 and measured in Ajaccio (41°55'00 N ; 8°47'30"E, Alt: 5m), Bastia (42°32'54"N ; 09°28'54"E, Alt: 10m) and Corte (42°17'54"N ; 9°10'24"E, Alt: 362m) from 04.01.2004 to 03.31.2005

Table 3 shows the statistical coefficients that have been calculated to compare Meteosat data to terrestrial meteorological ones in order to ensure the satellite data validity. Relative Mean Bias error (RMBE), Relative Root Mean Square Error (RRMSE) and Correlation Coefficients (Cc) for the three meteorological stations (Bastia, Ajaccio and Corte) are listed. Cc are very closed to 1, meaning that our satellite data are comparable to terrestrial ones. Our daily RRMSE are between 12.7% and 18%, these results are situated in the upper part of the interval formed by RRMSE found in the literature. (Table 4)

Table II: Cc, RMBE, RRMSE (% of the mean) for our data

	Ajaccio	Bastia	Corte
Hourly C.c	0.93	0.96	0.89
Daily C.c	0.94	0.98	0.95
Monthly C.c	0.99	0.99	0.99
Daily RMBE (%)	0.3	4.92	-0.61
Daily RRMSE (%)	19.4	13.3	19.6
Monthly RMBE (%)	-1.4	4.3	-1.63
Monthly RRMSE (%)	6.9	4.93	5.77

Table III: RMBE and RRMSE (% of the mean) from literature

References	Models	Stations	RMBE (%)	RRMSE (%)
Beyer <i>et al</i> [1]	Heliosat		5	23
Dagestad [2]	Heliosat-II	Europe	5	30
Moradi <i>et al</i> [4]	Heliosat-II	Iran	1.8	11.7
Rigollier <i>et al</i> [8]	Heliosat-II	Europe	5	10(jul)- 20(Jan)

4 CONCLUSIONS AND PROSPECTS

The important number of proposed photovoltaic projects in Corsica imposes to rulers and decision makers the use of specific decision aiding tools in order to select the most pertinent ones. This paper presents constraints and criteria that have been defined for the study by the protagonists in this aim. Thus first steps of participative decision process which are actions, constraints and criteria definitions, have been done. Other stages such as criteria weight determination, projects evaluations from each criterion point of view, appropriated multicriteria methodology selection and application have to be passed before the final recommendations. Outranking models of the ELECTRE family [3] will be applied.

Photovoltaic energy production is one of the dominant criterion. It needs the knowledge of solar potential for each project, suggesting the creation of a solar potential map of Corsica. The second part of this paper shows a validity study of satellite data through statistical coefficients calculation in order to estimate the pertinence of satellite based mapping. The statistical coefficients which are obtained are closed to the literatures.

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