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# POSTER PAPERS

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# GIS-based Multi-Criteria Analysis and if… then… rules for ranking industrial zones

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**Abstract.** The approach proposed in this article allows, from a study of geographic, environmental and socio-economic criteria, to cooperate If Then rules, Analytic Hierarchic Process (AHP) and geographic information system (GIS) for spatial choosing of the right site for installing industrial projects. The result obtained by IAHP (Intelligent Analytic Hierarchic Process) for ranking industrial zones in Algeria is refined by a viewing GIS-IZ (Geographic Information System for Industrial Zones). The IAHP unit ranks industrial zones using AHP after reduction of judgment criteria by If… then… rules and GIS-IZ module to the visualization of these zones on the map. The system was designed for the evaluation of a new methodology of multi-criteria analysis guided by data mining. Only the Spatial Decision Making Support System (SDMSS) is presented here.

**Keywords:** GIS, MCDA, MCDA-GIS integration, Industrial zones, AHP, if…Then rules.

## 1 Introduction

The project under investigation is to rank the industrial zones of western Algerian programmed by the state to satisfy the expectations of investors**,** for the economic balance of regions and population stabilization with respect to the environment. Policy makers should act early based on deep analysis of the environmental, socioeconomic and other criteria (factors, constraints) to carefully carry out their selection to end without risks. Anarchical zoning to solve such problems can cause epidemiological change and deterioration in the health of citizens. The linear model of Simon (intelligence, design, and choice) and its extensions are insufficient to respond to the complexity of these problems [1]. Decision making in this project is complex because of the inherent trade-offs between sociopolitical, environmental, ecological, and economic criteria. Each zone is a spatial action since action to take is spatial if it is defined by its geographical location, shape and spatial relations [2]. Most judgment criteria have a geographical character. The specifics of this kind of problems is in favor of integration between GIS and MCDA. The researchers focused on this approach since 1999 trying to answer questions like: What MCDA methods to integrate with what GIS? In what field the approach is used? What integration mode is adopted... hundreds of articles have been published to answer this questions, the earlier works are that of Diamond and Wright (1988), Janssen and Reitveld (1990),Carver (1991), Langevin et al (1991 [3]. The conceptual idea on which is based MCDA-GIS integration work is to use the functions of GIS to prepare inputs necessary for the MCDA methods and GIS presentation potentialities to visualize the results of the analysis on the map [4]. Geographic information systems (GIS) are used to model, store, manage, view, analyze, and represent objects or collections of spatial objects [5]. Analytic Hierarchy process (AHP) is used because it is successfully applied in the fields of industrial location[6], it is a user-friendly method and have mathematical properties and it is understandable by the decision maker. AHP allows ranking [7]. A knowledge base especially for the problem is constituted with a set of decision rules [8]. The objective is to reduce the number of objective technical criteria. In this paper, Pairwise comparison matrices are built on the basis of a performance table made for the same case study but using an outranking method [9]. IAHP unit is developed for ranking, the best zones are obtained while visualization is performed by GIS-IZ unit on map before and after ranking. Before the aggregation by AHP, if ... then… rules are used to reduce the number of criteria. Reduction of criteria improves results and reduces the complexity. When adopting GIS-MCDA approach in this case, a mixed integration mode is proposed. We encountered many problems such as the choice of the appropriate MCDA method, the subjectivity and hesitance of decision makers. To solve the second problem we will engage data mining. The rest of this article is presented as follows. Section 2 is devoted to present briefly

GIS-MCDA integration and if…then… rules , Section 3 is devoted to the Proposed Spatial Decision Making Approach, a case study is illustrated in section 4 and we end with a conclusion and perspectives.

## 2 Integration between GIS,MCDA and If…Then… rules

All data are processed and aggregated in one hand by MCDA using appropriate decision rules and by GIS for spatial analysis and mapping in the other hand.[4] Has proposed three integration mode (a: Indirect Integration, b: Built Integration, c: Complete integration). In this paper a mixed integration is proposed: Mapping geographic criteria is made independently (indirect integration) while visualizing function is integrated directly with the MCDA Module. (Fig. 1).

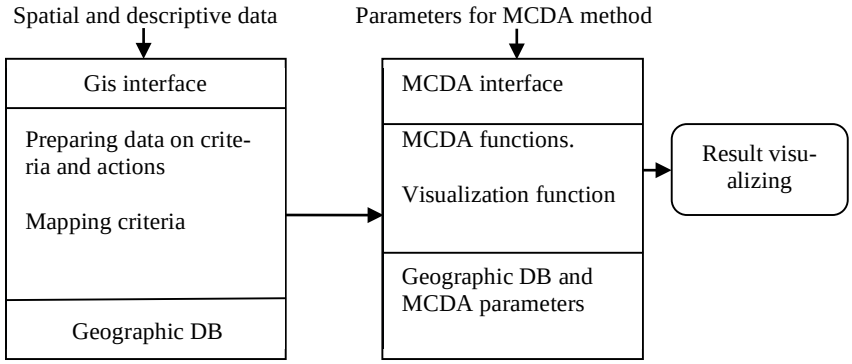



**Fig. 1.** GIS-MCDA proposed mode integration.

The rules base serve as a filter that perform a pretreatment of information and consequently reduce the number of criteria to be processed by MCDA [10] (Fig. 2)

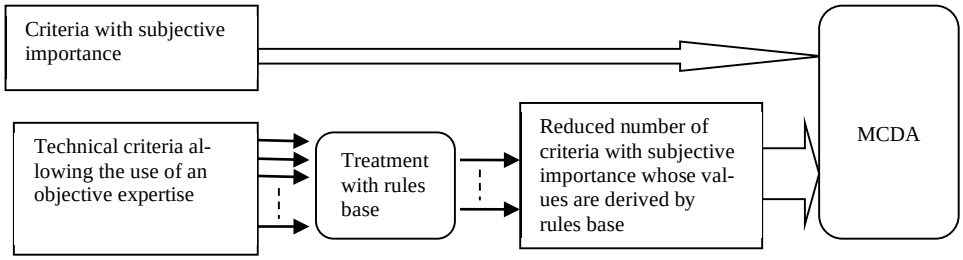
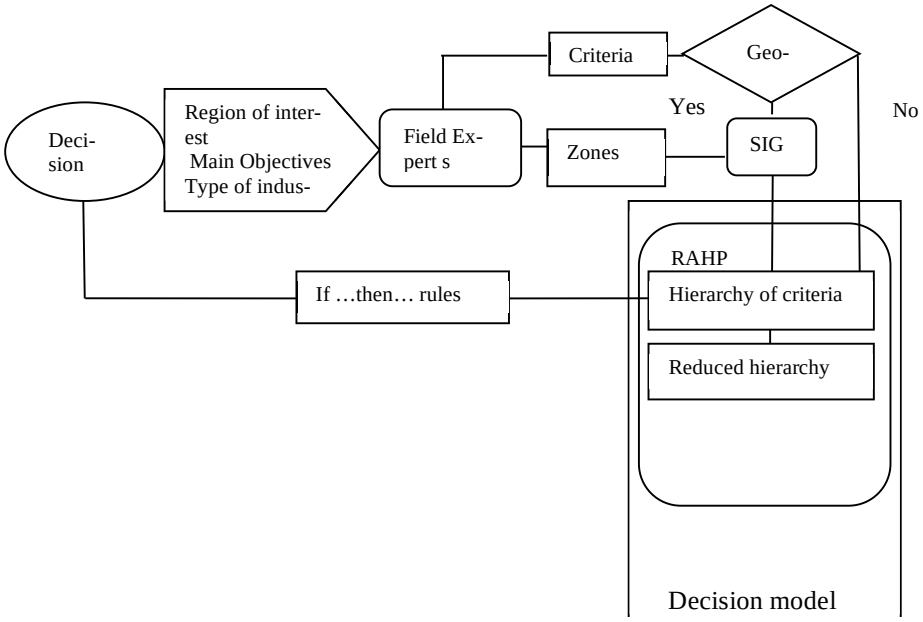



**Fig. 2.** Combining multi-criteria analysis and rules base inspired from [10]

## 3 Proposed Spatial Decision Making Approach

The proposed approach consists of two phases: Screening and Evaluation, as depicted in (Fig. 3)



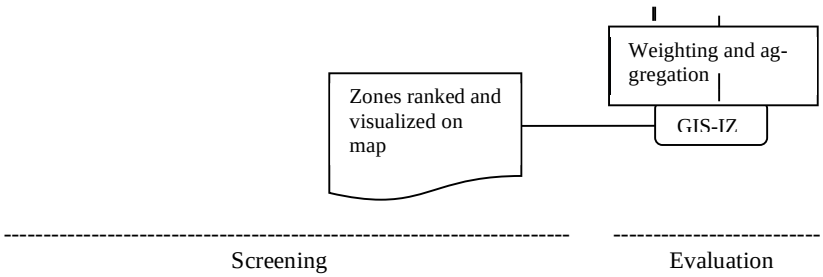



**Fig.3.** Framework of proposed approach

## 4 Case Study

### 4.1 Set of actions

Of the 39 industrial zones created through the entire national territory by ANIREF (Agence Nationale d'Intermédiation et de REgulation Fonciére) [11] our study has focused on the industrial zones of western Algerian. Each zone is an action (A1: Maghnia, A2: Sidi Bel Abbes, A3: Ras Elma, A4: Sidi Ahmed, A5: Horchaia.)

### 4.2 The criteria

The initial criteria used in this study were classified into four categories: natural risks, socio-economic, environmental impact and climate characteristics. According to these categories, 11 criteria are defined. Fig.4 shows the hierarchy of judgment criteria.

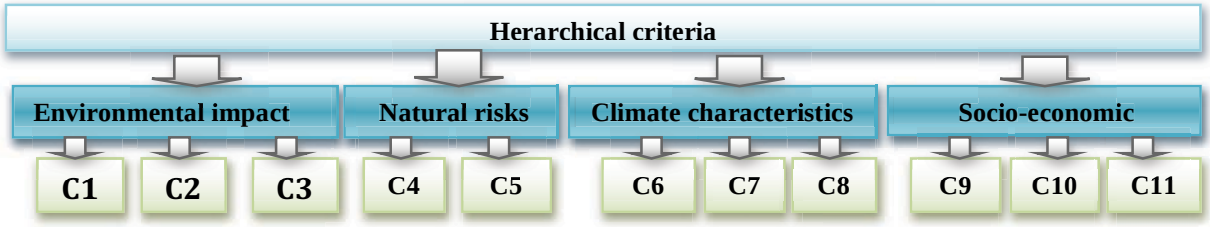



**Fig. 4**: Hierarchy of judgment criteria.

(C1): Risk groundwater pollution. (C2): fauna and flora problem. (C3): Noise citizens.(C4): Seismicity. (C5): Flood. (C6): Temperature. (C7): Rainfall.(C8): bioclimatic Floor.(C9): Cost management (C10): equipment and development potentiality (C11): Transport Infrastructure

Certain criteria are geographic as shown in (Fig. 5). The decision maker refers to the thematic maps of these criteria and to geographical positions of actions on these criteria maps to give the pair wise comparison matrices with help of a performance table [9]

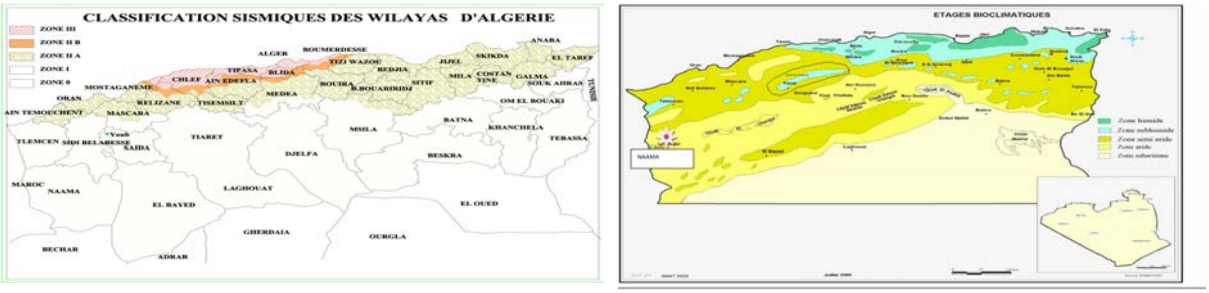



**Fig. 5.** Seismic classification and Bioclimatic Floors of Algeria [11]

## 4.3 Rules base

Rule base must be developed with the help of expert since the deductions must be based on the field expert. (Fig.6) show the set of criteria after pretreatment by rules .Example of rules used in this case is given below:

If ((15 < C6< 20) and (50<C7<200) and (C8 =semi arid)) then (climate = favorable)

If (C4 = strong and C5 = strong) then (natural risk = strong)

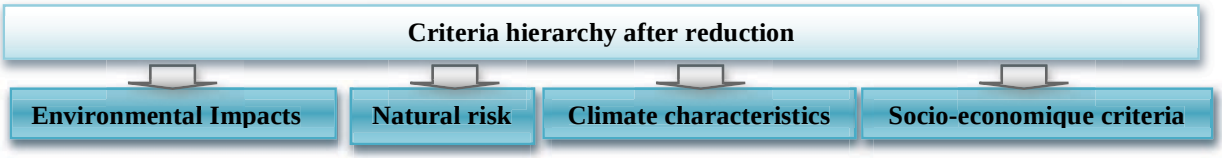



**Fig. 6.** Criteria hierarchy after reduction by if…then…rules

## 4.4 Results

After pair wise comparison and aggregation by both AHP and IAHP ranks are given in table 1 and table 2 below:

Table1: Zone ranks using IAHP

| Action | Weight | Rank |
|---|---|---|
| SBA | 24.55% | 1 |
| Hourchia | 18.62% | 4 |
| Koléa | 20.00% | 3 |
| Ras Elma | 23.47% | 2 |
| Maghnia | 7% | 5 |

Table2: Zone Ranks using AHP

| Action | Weight | Rank |
|---|---|---|
| SBA | 20.27% | 2 |
| Hourchia | 16.98% | 4 |
| Koléa | 17.04% | 3 |
| Ras Elma | 23.8% | 1 |
| Maghnia | 7% | 5 |

## 5. Conclusion and perspectives

By comparing the two results we note that changes are not significant between IAHP and AHP. In terms of complexity we save to build eleven (5X5) matrices with aggregation of each one.

This study allowed us to determine the usefulness of the approach for many sectors where the decision is important and dangerous, and intersects with the geography and even history. It is a contribution to make out the approach from the academic side to the field. The rank of an industrial area so obtained is an index that can: Criticize the choice of this zone, Alert the planners and builders of the area and assign the area to adequate investment projects. Our perspectives are to extend the study on all industrial zones at the national level. To remedy the disadvantage of MCDA methods in modeling the preferences of decision makers with subjectivities and hesitance we will engage data mining.

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