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Research Article

HYBRIDIZATION APPARATUS FOR A NEW CHEMICAL COMPOSITION OF THE DREDGING SLUDGE: CASE OF THE BOUHANIFIA DAM

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ABSTRACT

To overcome the deficit in natural resources and meet the ever-increasing demand in the field of construction, waste recovery channels represent significant interests in a sustainable development perspective.

The valorization of the dredged silt at the Bouhanifia dam, located in the north-west of Algeria, for its use in the brick-making technology is the way we have followed. In the context of decision support in order to have an adequate chemical analysis of a clay used in the manufacture of red brick, the use of the Electre III multi-criteria method, developed in hybridization with the Genetic Algorithm, is recommended, which makes it possible to establish a ranking of the different parameters, within a set of potential actions constituting a range of possible solutions for the choice of the best chemical composition of the mud from the dredging of the Bouhanifia dam.

Keywords: Sludge; Brick; Genetic; Hybridization; Electre III.

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1. INTRODUCTION

Today in the world, the reduction of natural resources and the preservation of the environment are the main concerns of those in charge. On the one hand, the environmental problem is posed by the release into the natural environment of many products considered as waste without worrying about the possibilities of their possible exploitation. On the other hand, there is a real deficit in natural resources for the production of building materials such as bricks, cement, concrete, ceramics etc. In a waste recovery approach in the red brick design and the circular economy and taking into account the random activity of dam dredging operations that generates a diversity of samples taken, we prefer to introduce an optimization tool, a hybridization system (Genetics + Decision Support).

2. TO RESEARCH

In this article we introduce the concept of decision support; we use the definition proposed by [1,2]. Decision support is defined as "the activity of the one (man of study) who, based on models that are clearly defined but not necessarily completely formalized, seeks to obtain elements of answers to the questions posed by a speaker. Decision-maker in a decision-making process". This method helps the decision maker to construct a relevant representation of the situation. Indeed, the use of multicriteria methods of decision support, Electre III, allows establishing a classification among actions likely to bring a solution to a given problem and this, being based on several criteria [3].

How can the Genetic Algorithm and the Electre III method of decision support be useful in our study? And how to proceed to have the best chemical composition of the clay designed for the design of the red brick?

2.1 The Principle of Genetic Algorithm

Genetic algorithms have the distinction of being inspired by the evolution of species in their natural setting. The genetic algorithm will replicate the evolution model in order to find solutions for a given problem [4].

The genetic principle is illustrated in Figure1.

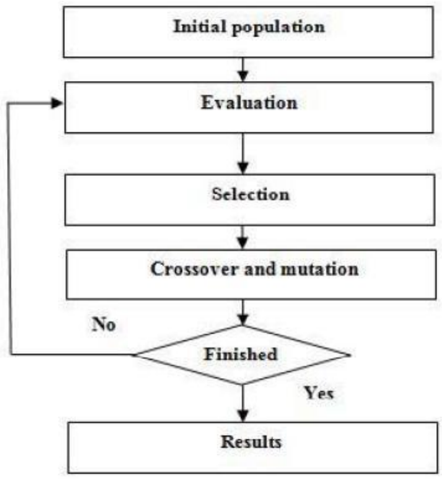

Fig.1. Genetic principle

The proposed model is shown in Figure 2,

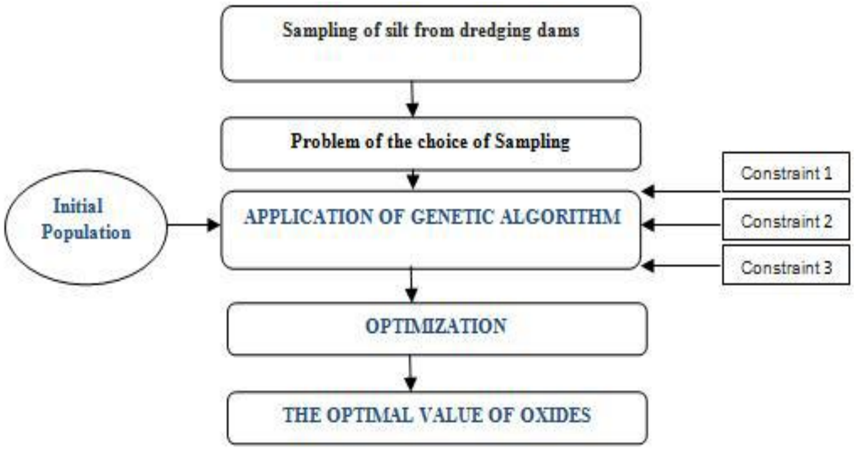

Fig.2. The Proposed Model

During these different generations, each element is evaluated using a mathematical function "Fitness". To optimize the choice of the chemical composition; at first, we used two different linear fitness F1 and F2 [4]. In a second step, we referred to the Lagrange or Newton F'1 and F'2 interpolation with a nonlinear characterization.

2.2 Decision Aid (Electre III)

HA Simon (1977), one of the pioneers of organizational decision-making, proposed a non-sequential cognitive vision of the decision process materialized by a decision-making scheme sufficiently general to be recognized as a true canonical model of the decision where the information and design phases play a major role [2].

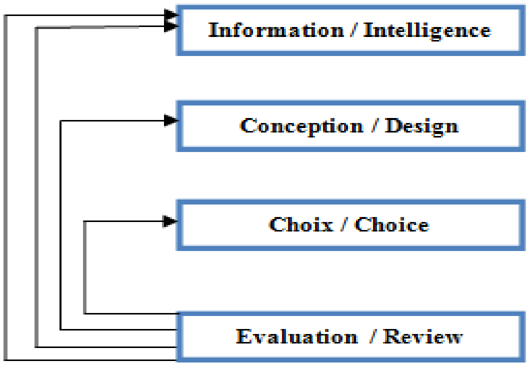

Fig.3. Model of the decision process [2,5]

In their book dedicated to multicriteria analysis, [1] make it clear that "in a multicriteria decision support process, the main objective is not to find a solution, but to build or create a tool considered useful. In the eyes of an actor involved in the decision-making process"[6].

Among the many existing multicriteria methods, electre III [7] proves to be one of the most commonly used, especially in the case of environmental issues: drinking water supply in rural areas [8], storm sanitation in urban areas [9,10], water resources management [11], waste management [12,13] and urban planning [14].

ELECTRE III is a multicriteria method based on a ranking procedure (P.γ) of the alternatives, from (the) best (s) to the least good (s) [6].

The starting point for most outranking methods is a decision matrix describing the performance of the alternatives to be evaluated with respect to identified criteria. The output of an analysis is an outranking relation on the set of alternatives. An alternative *a* is said to outrank another alternative *b* if, taking account of all available information regarding the problem and the decision maker's preferences, there is a strong enough argument to support a conclusion that *a* is at least as good as *b* and no strong argument against [15].

2.3 Recommended Parameter Thresholds

A criterion is a tool allowing the comparison of two actions from at some point of view [6]. In our study the criterion is defined by the oxide of the chemical composition of clay.

Each criterion j in ELECTRE III can be accompanied by three thresholds (indifference, preference and veto, respectively qj, pj and vj), making it possible to define zones of preference between two actions.

Indifference threshold q_j: Value below which the decision maker is indifferent between two management alternatives for criterion i.

Préférence threshold p_j: Value against which the decision maker strongly prefers a management alternative for criterion i.

Veto threshold Vj: Value that blocks the overclass relationship between alternatives for criterion i [15].

The values of the thresholds chosen in this study are presented in Table 1.

The weight, indifference, preference and veto values given for each criterion are set by experts; the weights are inspired by a synthesized reading of the various tested chemical analyzes. The sum of the different weights given equal to 1 [4]. The value of the weight given for each oxide reflects its importance in the chemical characterization of the clay.

For the indifference thresholds, the extreme values are the value of the preference threshold and the value 1. For the preference thresholds, the minimum value is the indifference threshold and the maximum value is the veto threshold. The veto threshold is limited downwards by the maximum threshold of indifference and upwards by the maximum threshold of preference.

Table1. Values of indifference thresholds (q), preference (p) and veto (v)

Oxides	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O+Na_2O	TiO_2	Fire loss
Weight w	0.45	0.2	0.1	0.11	0.01	0.002	0.03	0.01	0.088
Preference Threshold (p)	9	8	4	5	0.5	0.1	0.75	0.5	0.1
Indifference Threshold (q)	1	1	0.5	0.5	0.1	0.1	0.1	0.1	0.1
Veto Threshold (v)	9	8	6	7	3	1	5	4	2

2.4 Genetic and Electre III Hybridization

For each stage of the genetic method (Fi, selection, crossing, mutation and evaluation) one obtains a set of individuals, that these form between them a matrix of solutions whose lines are the individuals relating to the actions and the columns are the chemical components related to the criteria.

This matrix in the Electre III method is called the performance matrix. By using the subjective parameters of each criterion (p, q, v) and launching the Algorithm Electre III, we obtain as an output result an ideal and perfect storage of individuals according to "The best Solution".

The study flowchart is shown in Figure 3,

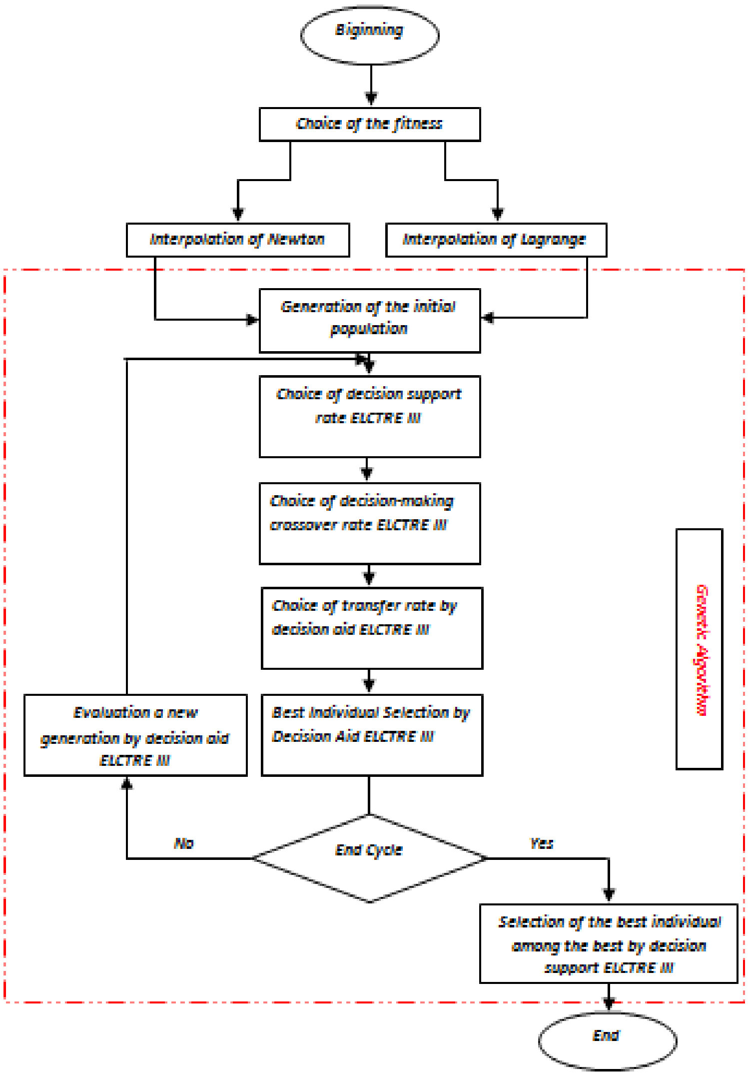

Fig.4. Software Flowchart

3. RESULTS AND INTERPRETATIONS

Following the path of Genetic Algorithm in hybridization with the decision aid (Electre III), for the choice of the best chemical composition of a clay (Bouhanifia vase), designed for the manufacture of red brick, we notice that there is no difference between the use of the two methods Lagrange and Newton see figures 5 and 6, but that they are complementary for a better interpretation. These figures show that the curves obtained in each case are very similar. The values of the optimal chemical compositions obtained are also very similar.

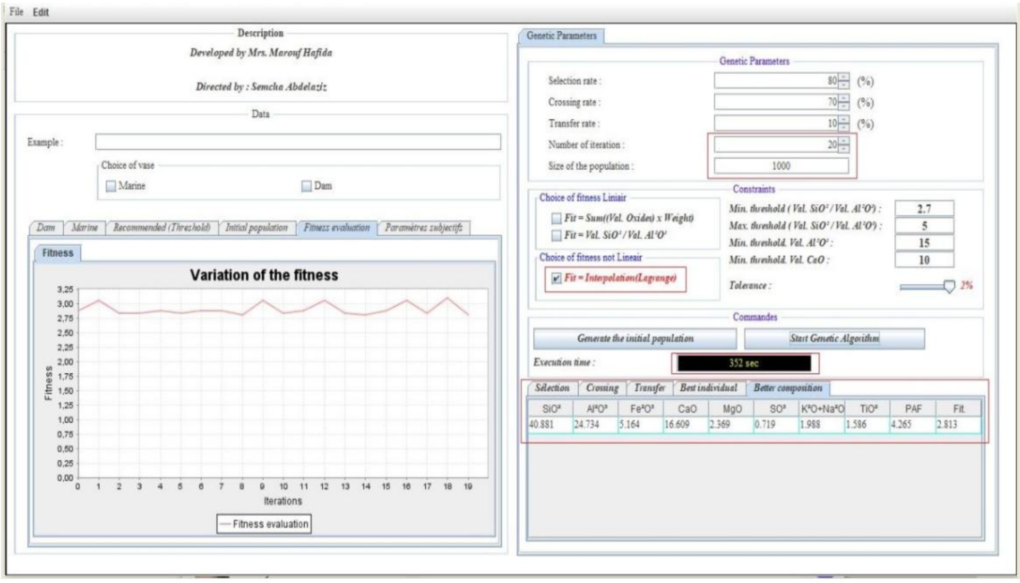

Fig.5. Nickname Lagrange Algorithm for the best individual

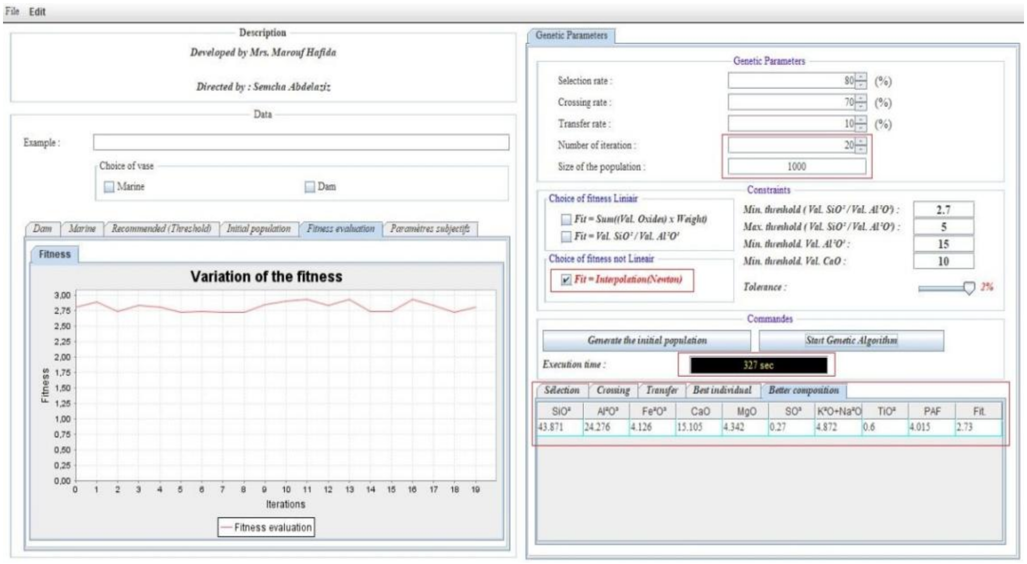

Fig.6. Nickname Newton Algorithm for the best individual

4. CONCLUSION

The search for the best composition for the making of our material requires the analysis of different compositions. The genetic algorithm has given appreciable results in the choice of the best composition but remains random because it is related to the initial choices of the fitness. Hybridization of the Genetic Algorithm with Electre III decision support makes it possible to select individuals more appropriately for a better approach.

The application of the Electre III multi-criteria method is complex and does not in itself give the desired sensitivity to decision-making, its hybridization with the Genetic Algorithm allowed a better approach to the choice of the best desired chemical composition.

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