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The Role of Geomatics in Management of Urban Solid Waste. The Case of Constantine Wilaya, Algeria

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Abstract		

Waste management has become a concern for Africans major cities, especially those from Algeria. These municipalities face rapid expansion in terms of population and urbanization, as well as changing consumption patterns resulting in an increase in waste volumes. This situation have contributed to generate significant nuisances for the inhabitants and harmful consequences on the health of populations, on the environment and on natural resources. Constantine is one of the cities or Wilayas (the local administrative term) that suffer from this problem for several reasons due to the lack of technical landfills. The lack of funds and the absence of coordination between the different actors in this field have made waste management difficult, whereas every day the garbage overwhelms the streets and homesand that they constitute a daily scourge dangerous to health, for which a solution should be found. Therefore, it is necessary to use appropriate techniques that can help converging to effective solutions, such as the use of GIS technology coupled by the Multi Criteria Analysis method (AHP) to locate appropriate geographical sites for the location of technical landfills, and the creation of database to raise public awareness of the dangers of waste and involve them in their management.

Key words: Environment, Waste Management, - Technical Landfill Center, GIS.

INTRODCUTION

Nowadays, the environment is one of the most important topics of modern times(Duan 2019). Theessential question, that many researchers and economists have in mind is regarding the relationship between man and his nature and how this relationship can be continue, especially with the appearance of signs of great dangers to which the Earth and its inhabitants could face in the near future (Ackerman 1963, Mullin 1999).

It is important to know that the city concept as a built organism must breathe, nourish itself and develop in order to satisfy the five needs of the human being. At the same time, it should have a good digestive system to eliminate leftovers from daily activities (Pradhan 2004). In recent years, the issue of waste has become alarming especially in developed countries. The effects of this situation are visible to all, it generates significant nuisances for the inhabitants and hasharmful consequences on the health of populations, on the environment and on natural resources. Actually, the increase of waste production is in a straight line with the population growth and with the improved level of income per capita or the level of economic activity. In all cases, this large production of waste constitutes a threat for the quality ofthe living environment, and their impacts on human health are important(Marshall,and Khosrow 2013).

In Algeria, which is considered as a leader of African emerging country, has made a lot of progress in this area, but remains far from the development mechanisms experienced by the management sector waste in developed countries. In addition the idea of adopting successful concepts in certain countries and trying to adapt themto the local context of Algeria has also not led to much development in the sector and has not been able to correct the different problems from which Algerian cities suffer (Chisholm et al. 2021). Indeed, waste management remain problematic for all communities. In the township of Constantine, which is considered as the capital of eastern Algeria and the commercial center of its region, the production of waste continues to increase significantly following the growth population, economic development and rapid urbanization with the creation of new towns inside, this environmental issue affects the local population need to be pointed out.

PROBLEM STATMENT

The management of urban solid waste remains a great challenge for Algerianmunicipalities. The questions concerning the management of municipal solid waste are among the most complex questions that must be answered by environmental managers because of their effects on human health and sustainable development.

The National Waste Agency (AND) has set the main guidelines for waste management urban solids; and in relation to these national guidelines, each city in Algeria tries to implement implements an urban solid waste management system that varies according to the degree of organization. Constantine has known very fast urbanization due to a strong growth of the urban population (figure 1), almost one million of habitants (ONS, 2018). This situation was done with limited means such as the absence of functional structures for the collection and disposal of household waste, and the lack of Technical Landfill Centers (CET). This circumstances results households throw garbage into inappropriate places, in the streets, along watercourses. Thus, we are witnessing more and more creations of wild and uncontrolled landfills (figure 2).



Figure 1. The fast urbanization of Constantine.



Figure 2. The environment issues at Constantine Township.

Today, Geomatics is recognized as one of the most promising disciplines for automate the planning process and management of urban solid waste, allowing to capture, store, display, manipulate and analyze different data in a way synchronized. Indeed, the Geographic Information System (GIS) tool has made it possible to model various applications in waste management such as the choice of location for transfer centers and landfill sites. Thereby; the key question this study will answer is: What is the role of Geomatics in the management of urban solid waste?

RESEARCH OBJECTIVES

The main objective of this study is to highlight the role of Geomatics in the management urban solid waste in the town of Constantine. Four (04) specific objectives are fixed: 1) Understand how the current municipal solid waste management system works in the township of Constantine. 2) Identify the main actors in the management of urban solid waste. 3) Define the usefulness of a GIS, as well as indicators (factors) of spatial analysis with a Multi-criteria analysis to select landfill sites CET technique (A CET aptitude card); and 4) Establishment of a special waste management website which contributes effectively to raise awareness among the population and all partners about better waste management.

PRESENTATION OF THE STUDY AREA

The Wilaya of Constantine (Figure 03) is part of North East Algeria, it is limited to the North and to the South respectively by Latitudes 36°75'N and 36°5'N, as for the East and West by the Longitudes 7°E and 6°25'E. The wilaya of Constantine has an area of 2297.2 km². And also is limited by: a) The Wilaya of Skikda in the North; b) The Wilaya of Oum-El Bouaghi in the South; c) The Wilaya of Mila in the West; and d) The Wilaya of Guelma in the East. The township was divided during the last administrative division into six (06) chief towns of daïras composed of a total of twelve (12) municipalities.



Figure 3. The administrative location of the Wilaya of Constantine.

Regarding to waste collection, each day around 700 tons are collected which represent in oneyear more than 350,000 tons of waste are collected through the wilaya of Constantine (Table 1). The most important quantity is collected at the level of the commune (County) of ElKhroub with 98,000 tons due to the existence of two new towns at the level of this commune.



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These wastesare transferred all to two (02) Technical Landfill Center (CET): Boughareb and Doghra (figure 4).



Figure 4. The technical landfill of the Wilaya of Constantine: a) Boughareb and b) Doghra.

METHODS AND MATERIALS

The methodology should be adopted according to the following documents: 1) The Guide: Design of technical landfill centers for household waste, established by the Ministry of Territorial Planning and the Environment (MTPE, 2005), and 2) The environmental impact study of the concerned technical landfill center inConstantine, made by the design office: center for study and project management (CEGEP, 2020), several site inspection and interview with experts in the fieldon thecriteria to be taken into account when choosing the site for setting up a CET.We have summarized the Multi Criteria Analysis methodology used to select theCET site in Figure 5.



Figure 5. The adopted methodology.

Several criteria were taken in consideration such as: the elevation, the slope, the exposition, the hydrographic network, the hill reservoir, the existing geology, road and railway network and the rainfall. These criteria's were selected due to their importance in relation with subject of this research. The selected criteria map are as shown in the following figures6 and 7.



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Figure 6. The selected criteria's:a) the elevation, b) the slope, c) the exposition, d) the hydrographic network, e) the hill reservoir, f) the existing geology.



Figure 7. The selected criteria's:a) the road , b) railway network and c) the rainfall map.

RESULTS AND DISCUSSION

The Analytical Hierarchy Process (AHP)Weight Results

AHP is a mathematical method of multi-criteria analysis aimed at resolvingdecision support problems. The AHP is a quantitative method for classifyingdecision-making alternatives by developing a numerical score to rank each decisionbased on how well each alternative meets the decision maker's criteria.

AHP is a decision-making approach developed by Saaty in 1980. The process helps tosolving complex multi-criteria problems in a number of areas application. The three basic steps for considering AHP decision problems are: 1) Construction of a structural hierarchy; 2) Establishment of comparative judgments; 3) Summary of priorities. For our case study; we used the Excel spreadsheet to make the matrixcriteria and determine the weights of the criteria (Layers) of the Analysis Multi Criteria (Figure 8).



Figure 8. Matrix of comparison between criteria and the weights of the Multi Criteria Analysis.

Multi Criteria Analysis

After preparing the layers (criteria) and determining the weights of each criterion with theExcel spreadsheet; it is necessary to use the Raster Calculator orArcGIS desktop Weighted Overlay (Figure 09).



Initial Aptitude Map of Cet

We used the Raster calculator function of ArcGIS for the initial aptitude card of the CET (figure 10a). In addition, according to the C.E.T Design Guide: areas considered as absolutelyinappropriate are areas with a distance of less than: 200m from urban areas, 5km for an airport and 200m from natural and cultural heritage.For more security we have taken the buffer zone 500m instead of 200m (figure 10b).



Figure 10. a) Initial aptitude card of a CET, b): Map of areas excluded from the Multi Criteria Analysis.

Final Aptitude Card of a CET

Finally, once all the stages of the Multi Criteria Analysis have been completed, the final result which ispresented in figure 11 confirmed the good choice of the site of CET Boughareb, which has already beenapproved by a design office specializing in the field, and which gives the model a sort ofcredibility and reliability.



Figure 11. Final aptitude card of a CET.

CONCLUSION

Today, and thanks to its history, site, natural and cultural capacities, infrastructures,Constantine saw economic development, great population growth moreof one million inhabitants and rapid urbanization, which causes aphenomenal increase in the production of solid wastewhich reached 700 tons per day, contributing to the appearance of major problems of theirmanagements.

Through the analysis that we made in our study which isbased on a constituent inquiry approach, it appear that Geomatics as a multidisciplinary discipline brings all the sciences andtechnologies that make it possible to model, represent and analyze the territory, which has allowed usenabled a final suitability map to be drawn up showing the areas suitable for the installation of CETs. This map confirmed the correct location of the CET Boughareb on the onehand, and on the otherapart from the CET Doghra refused by the inhabitants found himself in the red zone which is not suitable forset up a technical landfill.

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