



**CONTRIBUTION OF GIS IN SELECTING THE FAVORABLE
SITE FOR THE LOCATION OF THE STATION PURIFYING
WASTEWATER OF AZROU CITY
(MIDDLE ATLAS, MOROCCO)**

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ABSTRACT

Domestic wastewaters from the Azrou city are released into the environment without any treatment. Indeed, an initial rejection is close to neighborhoods Boumeloul, Hay Tabadlit and Hay Arz, a second in the middle of neighborhoods Tit H'sain and Kachla and a third discharge upstream of the source Ain Aghbal. These waters are contaminated and polluted directly reused in irrigation plots with high agricultural activities downstream of the city. They constitute a negative impact on the environment and can cause disease in both consumers in farm workers. Solving this problem requires the establishment of a wastewater treatment plant wastewater to their safe reuse in agriculture.

The main objective of this work is the choice of suitable sites for the establishment of a treatment plant for domestic wastewater for Azrou city. The procedure to follow is based on the use of Geographic Information Systems (GIS).

The results have yielded different thematic maps according to well - defined criteria. The overlay raster layers different criteria led to the selection of five areas with favorable site which No.1, located in Ait Haddou Ouqassou is highly favorable, given its proximity to the road network, the power grid and water system. The final assessment is effective only when it takes into account the views of stakeholders (politicians, managers, administrators, industrialists, environmentalists, soil scientists, hydrologists, hydrogeologists, geologists,

urban planners). The results confirm that the Geographic Information Systems are powerful tools of spatial analysis to provide valuable assistance in decision making, planning and land management.

Keywords: Azrou, domestic sewage, geographic information system GIS, choice of suitable sites, treatment station.

RESUME

Les eaux usées domestiques de la ville d'Azrou sont rejetées dans le milieu naturel sans aucun traitement. En effet, un premier rejet se situe à proximité des quartiers Boumeloul, Hay Tabadlit et Hay Arz, un deuxième au milieu des quartiers Tit H'sain et Kachla et un troisième rejet en amont de la source Ain Aghbal. Ces eaux, contaminées et polluées sont réutilisées directement dans l'irrigation des parcelles à forte activités agricoles en aval de la ville. Elles constituent un impact négatif sur l'environnement et peuvent causer des maladies tant chez les consommateurs que chez les ouvriers agricoles. La résolution de ce problème nécessite la mise en place d'une station dépuratoire des eaux usées afin de leur réutilisation sans danger en agriculture.

L'objectif principal de ce travail porte sur le choix de sites favorables à l'implantation d'une station d'épuration des eaux usées domestiques pour la ville d'Azrou. La démarche à suivre est basée sur l'utilisation des Systèmes d'Information géographique (SIG).

Les résultats obtenus ont permis d'obtenir différentes cartes thématiques selon des critères bien définis. La superposition des couches rasters des différents critères a abouti à la sélection de cinq zones favorables dont le site n°01, situé à Ait Haddou Ouqassou, est hautement favorable, vu sa proximité du réseau routier, du réseau électrique et du réseau hydrographique. L'évaluation définitive n'est performante que lorsqu'elle prend en compte les avis de différents intervenants (hommes politiques, aménagistes, administrateurs, industriels, environnementalistes, pédologues, hydrologues, hydrogéologues, géologues, urbanistes).

Les résultats obtenus confirment que les Systèmes d'Information Géographique, constituent des outils puissants d'analyse spatiale permettant d'apporter une aide précieuse dans la prise de décision, la planification et la gestion du territoire.

Mots clés : Azrou, eaux usées domestiques, pollution, système d'information géographique SIG, Analyse multicritère, choix de sites favorables, cartes thématiques, station d'épuration.

INTRODUCTION

In the city of Azrou, quantities increasingly important wastewater are discharged into the environment without any treatment. They are discharged just off neighborhoods of Hay Arz, Boumeloul and near an elementary school Iben Khaldoune. Another rejection, located within the city, happening in neighborhoods Ain Tit H'sain and Ain Aghbal where freshwater sources are mixed with wastewater discharges. These waters carry contaminants in solution or suspension of a chemical nature (organic molecules, heavy metals, nutrients, etc.) or microbiological (bacteria, parasites) that exceed certain thresholds, leading to an imbalance in the natural functioning of aquatic ecosystems. These quantities of pollutants, concentrated and discharged into the rural without any treatment, are at the origin of the relative pollution of rivers downstream of the city. The reuse of municipal wastewater for irrigation purposes can lead to health problems in the population. To cope with this situation, the wastewater must undergo treatment before being discharged into the receiving environment or reused in irrigation. The treatment of domestic wastewater uses physico-chemical and biological techniques. The present work aims to identify areas of least constraint, potentially favourable for the establishment of a wastewater treatment plant wastewater (STEP) for Azrou city. The geographical informations systems (GIS) as a tool for decision support in the selection of sites can make a great contribution in this direction.

OVERVIEW OF THE STUDY AREA

Located on the western slope of the Middle Atlas at an altitude of about 1250 m, the city of Azrou is one of the most important towns in the province of Ifrane. It is surrounded by mountains covered with green oaks and cedars. It extends over an area of approximately 785 ha. It is bordered to the north by the city of Ifrane and encircled by two rural municipalities of Bensmim and Tigrigra (Fig. 1).

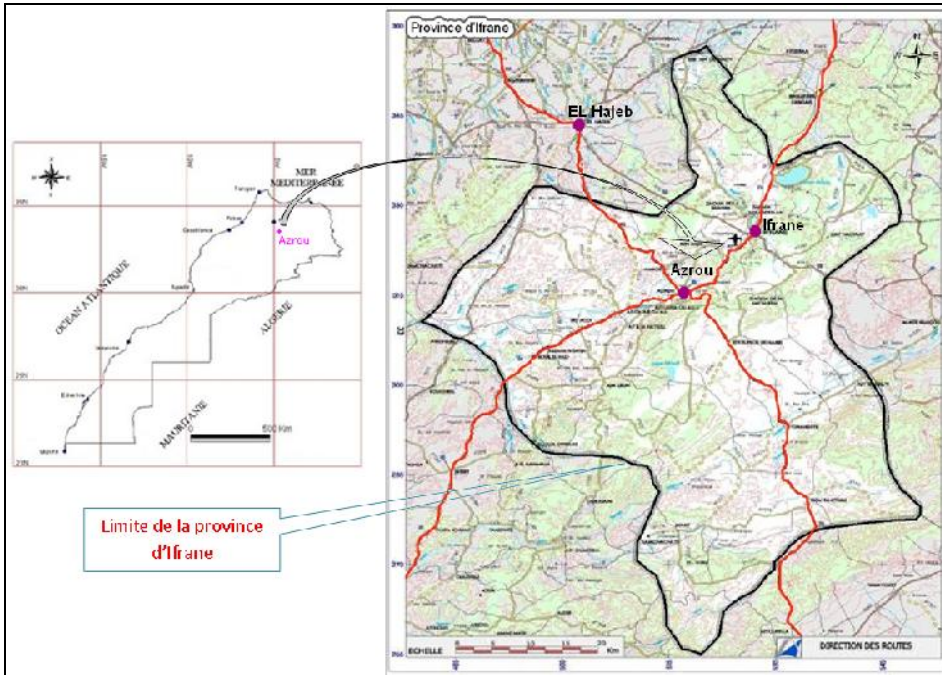


Figure 1: Location of the city of Azrou.

The study area is part of Azrou plateau, western part of limestone of Middle Atlas. It is a plateau formed by dolomite and limestone of Lias resting on soft Triassic series with red argillite and altered basalts (Fig. 2). These formations draw a large escarpment from 1100 to 1200 m above the plain of Azrou . The latter is an Appalachian relief linked to the landscape of the Moroccan central plateau (Martin, 1981). Inequalities of the plateau, due to breakage and flexures were hidden at the Quaternary by enormous outpourings of very fluid basaltic lavas whose emissaries descend into chaotic flows towards the plain of Azrou (Martin, 1981).

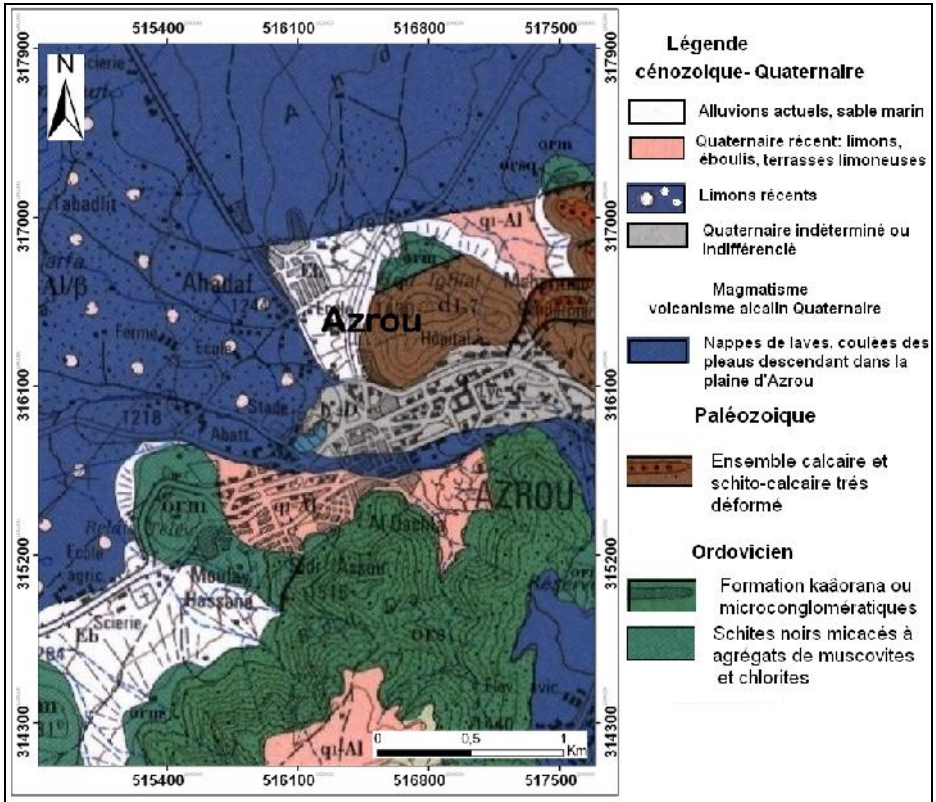


Figure 2: Geological map of Azrou region.

Materials and Methods

The methodology pursued is dictated by director scheme of the liquid sewerage waste that has defined the set of criteria to be met in full within the siting of the sewage treatment plant. It is based on mapping and analysis of various topics in the choice of sites for the WWTP. These criteria related to topography, planning, administrative boundaries, health protection, environmental interests and heritage protection, the hydrographic network, geological formations, etc. (Roy, 1985; Urein and Le Guern, 2004; Layadi, 213; Boufala & El Abassi, 2013). It helps to take into account a considerable amount of complementary information. In practice Arcgis 9.3 and Global Mapper are used as tools for mapping and data processing.

RESULTS AND DISCUSSION

The mapping of adequate zones for implementation of STEP in the Azrou area is carried out by using tools of ArcGIS software (Layadi, 2013). The principle of thematic maps of different selection criteria is based on spatial analysis. The maps represent spatial variations. The "Buffer" and "Union" ArcToolbox functions allow mapping of favorable and unfavorable for each criterion in the choice of the location of the STEP areas.

The estimate of the depth of the water table was based on interpolation (Kriging) of different piezometers available in the study area. With using the Raster Calculator of spatial analysis of ArcGIS software, the superposition of different raster layers for various criteria set by the director scheme for the siting of the STEP of Azrou provides the favorable areas that meet the predefined criteria.

The obtained results allow distinguishing five favourable areas for the implementation of the STEP future of the city of Azrou. The tool "Geometric Calculator" of Arcgis software determines the size of different sites and the function "Near" of ArcToolbox calculates the distance between the centroids of areas and existing infrastructure in the study area (Tab. 1 and Fig. 3).

Table 1: Evaluation of five favourable sites (ml: linear meter).

Favourables sites	Area in hectares	Remoteness of the rejection of the city (ml)	Remoteness of the electric mains (ml)	Remoteness of the road (ml)	Remoteness of the rivers (ml)		
					Moghra river	Tigrigra river	Aumout river
Ste 1	147,17	5383	420	736	133	2288	1995
Ste 2	41,90	5370	798	457	1041	1234	927
Ste 3	33,57	4774	175	339	2815	167	707
Ste 4	82,10	4594	245	458	3626	859	1539
Ste 5	109,81	6375	1090	575	6327	3369	3144

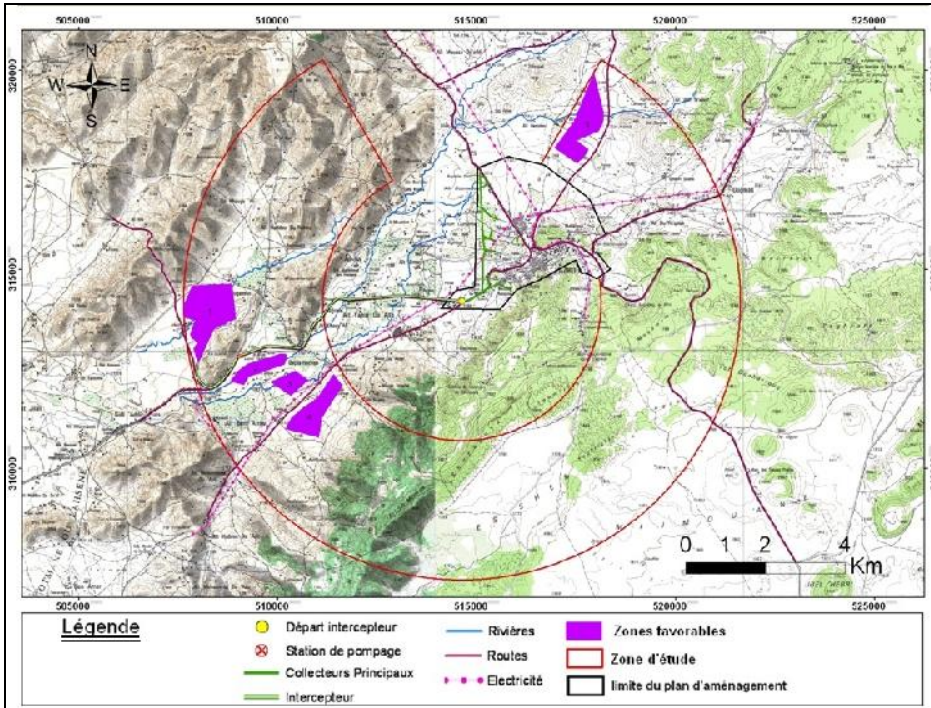


Figure 3: Synthetic maps to provide for policy-makers..

The comparison between the five suitable sites can be classified according to their size and proximity to existing infrastructure in the study area (Table 1). The analysis of the results indicates that the site 1 located in the Ait Haddou Ouqassou area (Fig. 3) is the most suitable for the implementation of the STEP of Azrou city. Indeed, it ensures the output of raw and treated wastewater drainage of watershed of Azrou city and prevents discharges into the natural environment by putting treated wastewater available to agriculture in a site overlooking agricultural areas potential of several thousand hectares. On the other hand this site is outside the urban area and very far from the cities. Its federal legal status, its size and proximity to existing infrastructure (roads, power grid and water system) favour this choice to minimize the investment cost.

CONCLUSION

The search of implementation sites of future wastewater treatment plant by the spatial and thematic analysis has allowed selecting 5 favourable sites. The site 1, located in Ait Haddou Ouqassou is highly favourable, given its proximity to the road network, power grid and water system. The results obtained in the present work confirm that Geographic Information Systems are powerful tools of spatial analysis to provide valuable assistance in planning. The final evaluation is successful if it takes into account the views of stakeholders (politicians, managers engineers, administrators, industrialists, environmentalists, soil scientists, hydrologists, hydrogeologists, geologists, urban planners). A final classification of the sites would be achieved. Note however that the spatio-thematic analysis coupled with multi evaluations offers solutions and therefore presents a decision support but in no case shall a decision instead of the makers.

REFERENCES

- BOUFALA M., EL ABASSI M. (2013). Apport de la géomatique dans choix du site favorable pour l'implantation de la station d'épuration des eaux usées au niveau de la ville d'El Hajeb. *Projet de fin d'études, Licence Professionnelle Géo-information et Modélisation du Territoire, Université Moulay Ismail, Faculté des Sciences, Meknès, 62p.*
- LAYADI A. (2013). Apport des SIG dans le choix du site favorable pour l'implantation de la station d'épuration des eaux usées au niveau de la ville d'Azrou. *Mémoire de Master spécialisé, Environnement et développement durable des territoires, Université Moulay Ismail, Faculté des Sciences, Meknès, 95p.*
- MARTIN J. (1981). *Le Moyen Atlas central, étude géomorphologique. Notes et Mém. Serv. géol. Maroc, 258 bis : 445 p.*
- ROY B. (1985). *Méthodologie multicritère d'aide à la décision, Economica, Paris, 180p.*
- UREIN P., LE GUERN C. (2004). *Caractérisation de zones favorables à l'implantation de sites de stockage dans le cadre du plan Polmar-Terre en Vendée. BRGM/RP-53489-FR, 38 p, 5 fig, 4 tab, 3. Ann Haut commissariat au plan.*