BOOLEAN LOGIC MODEL FOR AN ENVIRONMENTAL PROTECTION PLAN ON A LOCAL ADMINISTRATION TERRITORY

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ABSTRACT:
Site selection for waste disposal is a complex task that should meet the requirements of communities and stakeholders. In particular the problems of disposal of damp olive residues and the wastewater left over from the mechanical pressing of the olives has induced the local administration "Città Metropolitana di Roma Capitale", following the directives of the law n° 574/96, to individuate the areas in which is permitted to spread the refuse to be used as compost; such refuse must respect the requirements as to "quality" as defined by the characteristics established by the law of October 19, 1984, n° 748, and its successive modifications. The areas in question have been determined by carrying out a comparison between the maps of the hydrological network, the morphology of the terrain, and that pertaining to protected areas, paying particular attention to terrains with a higher permeability in order to avoid the seepa ge of the residue waters into the underground water table.
Key-words: *Environmental protection, Rome, Olive oil presses, DEMs.*

1. INTRODUCTION

The use of GIS technology is still increasing after decades from its introduction, in fact the availability of free geocoded database boosts the possibilities of application to private companies and public agencies. The most recent GIS fields of interest span from urban planning (Dardanelli et al., 2015*)* to the planning and monitoring of agriculture (Zorer et al., 2013) and from environmental monitoring (Basile Giannini et al., 2011; Maglione et al., 2014*)* to archaeological and historic studies (Costantino & Angelini, 2010; Baglioni et al., 2013; Brigante & Radicioni 2014).

For the specific topic of waste management, even if modern landfills should accept the sole residual – and stable- fractions from waste valorization and recovery to reduce the potential adverse impacts, the identification of the most appropriate methodologies for landfill siting and operation still deserves great interest of the scientific community (Ekmekcioglu, Kaya & Kahraman, 2010; Rava 1989; Siddiqui, Everett & Vieux. 1996; Kao, Lin & Chen, 1997; Baban & Flannagan, 1998; Cheng & Chu, 2011; Al-Jarrah & Abu-Qdais, 2006; Sener, Lutfi Suzen, & Doyuran, 2006; Baiocchi et al., 2014; Geneletti, 2010; Kim & Owens, 2010; Aragonés-Beltrán et al., 2010; Behera et al., 2011; Maciel & Thomé Jucá, 2011; Tavares, Zsigraiová & Semiao, 2011).

Increasing awareness of environmental problems related to the waste management and disposal often results in enhancing the social conflicts. The "Not In My Backyard" and "Not in Anyone's Backyard" syndromes are becoming popular, increasing the pressure on the decision making process in many countries (Erkut & Moran, 1991, Morrissey & Browne 2004; Noble, 1992; McBean, Rovers & Farquhar, 1995; Lober & Green 1994; Chang, Parvathinathan & Breeden, 2008).

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2. DATA USED

In the areas in which olives are harvested and processed, careful attention must be given to the disposal of the residual liquids and damp residue. According to the national law of November 11, 1996, n° 574, the residual liquids resulting from the mechanical processing of olives can be used for agricultural purposes, through controlled spreading on lands destined for agricultural use, only if they have not been subject to any treatment or additives (with the exception of the waters for the dilution of the paste or those used in the washing of the machines).

The distribution of the residual liquids must be carried out in such a manner as to assure a suitable distribution and incorporation of the substances on the terrains, avoiding such consequences as endangering the water supply and causing damage to living resources and/or the ecological system.

The local administration in charge, "*Città metropolitana di Roma capitale*", has given itself the goal of individuating the areas which respond to the criteria laid out by the law n° 574/96 following an up-to-date methodology, which is to say, developing the entire planning in a Geographic database model developed in a GIS open source environment.

It was decided therefore to map out the existing oil presses so to individuate the areas of the *"Città Metropolitana"*, (**Fig. 1**), effectively interested by such a planning and therefore to implement in the GIS model all of the excluding factors foreseen by the norms, to wit:

a. Terrains which lie within 300 meters of water sources (wells and springs);
b. Terrains which lie within 10 meters of the edges of bodies of water;
c. Terrains which lie within 200 meters of cities or centers of habitation;
d. Terrains in which geological layers might come into contact with the water table, and anyway the terrains in which such layers have been identified at a depth less than 10 meters;
e. Terrains with a slope steeper than 15 degrees;
f. Terrains which are frozen, snow-covered, saturated with water or flooded;
g. Terrains with active crops of fruit or vegetables;
h. Forested areas;
i. Mines or quarries;
j. Gardens and areas of public use.

Points e, f and j are difficult to map out for various reasons, and the existence of such conditions can be more easily verified by each municipal authorithies which have the ultimate control with respect to the norms in question.

As to the terrains that lie within 200 meters of inhabited centers, it is not clear which definition applies: the authors are aware of two quite dissimilar definitions of urban zone. The *Codice della strada* (legal traffic code) defines an inhabited center as "the ensemble of buildings delimited by the access routes of the pertinent signals from the beginning to the destination," while the Istat (National Statistical Institute) defines it as "an ensemble of buildings intended as a continuous grouping, following the directives of the law n° 574/96, although with intervals of streets, gardens, squares or other such, composed of no less than 25 buildings an areas of public use with vehicular or pedestrian access to the street."

Not having the defined perimeters according to the *Codice della Strada* at our disposition, it was decided to use the definition given by the Istat. As for the strips of land with layers 10 meters below the surface, the guiding criterion in the choice of sites on

which to spread the refuse of olive processing needs to take into account the conditions of security of the strata with respect to the permissible hydraulic load.

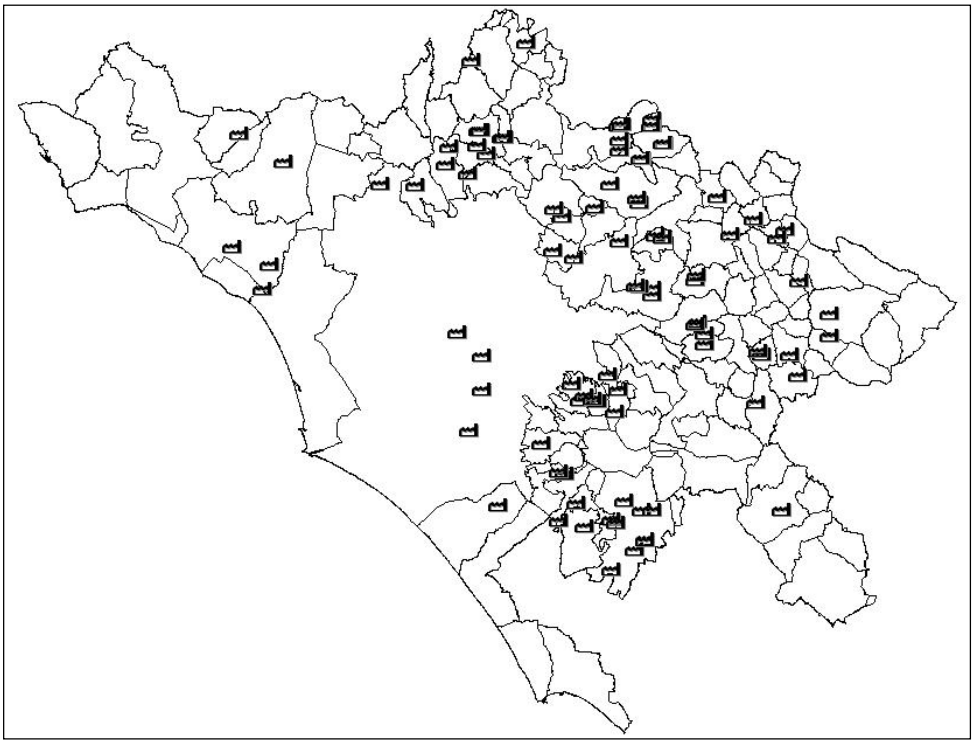

Fig. 1 Placement of oil presses in the territory of"Città Metropolitana" (figure is approximately 83Km. wide)

3. CARTOGRAPHIC CHARACTERISTICS AND GIS SOFTWARE USED

The gathering and elaboration of data was carried out with the QGIS software version 2.8.2 currently in use by the administration of the "Città Metropolitana", whose use is rather simple and, especially, versatile and completely free for an unlimited number of users.

The mapping layers implemented in the system have various provenances and so it was deemed necessary to choose a base system of reference on which to base the cartography. Because the transformation of the coordinates, in particular those from geodetic data, are critical operations within the context of the GIS software (Baiocchi at al. 2004), it was decided to refer the system to the datum most widely used in the various templates in order to minimize the transformations and seek to maintain the integrity of the data as much as possible.

On the basis of this criterion, the reference system used was UTM-WGS84-ETRF200 (zone 33) that is also the new official Datum for Italy (Barbarella 2014). One of the characteristics of this software is that it does not oblige the operator to refer every data entry within the same reference system as it transforms all of the coordinates in relation to the first map template. A very important and widely used instrument was the "Save as",

which allowed for the use of data provided by other GIS software and the exportation of the resulting data in such a manner as to be able to verify the result.

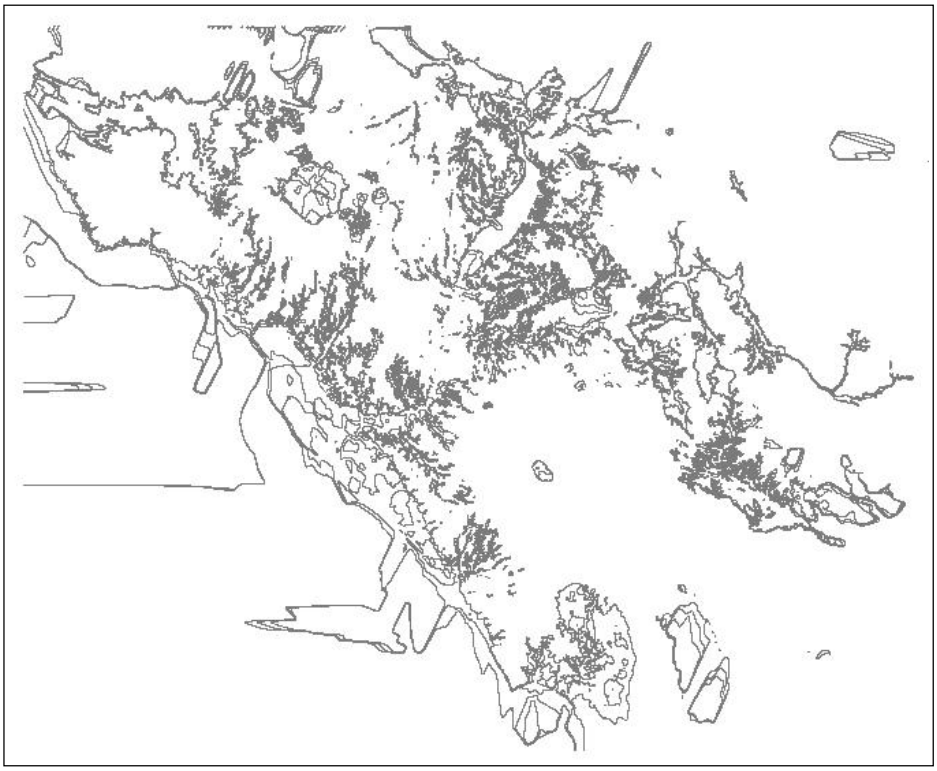

Fig. 2 Original isophreatic curves obtained by the comparison of the different DEMs (figure is approximately 83Km. wide) there are some obvious blunder outside of the studied area

However, the software, in its basic configuration, does not allow the user to elaborate the DEMs (Digital Elevation Models), an indispensible element in the process of realizing the map; in brief, a digital model of the elevations (i.e, the DEM) is a three-dimensional numeric representation of any outlined portion of territory.

For this reason, for the elaboration of the DEMs prerequisite to individuating the areas of elevated slope and for determining the areas with water-bearing strata close to the surface, the use of Gdal features (included anyway in QGis) was needed.

4. OLIVE OIL PRESSES

The available data for the individuation of oil presses on the territory included the name of the processors, their location and their approximate coordinates. However, the database was incomplete in several areas, and so a process of implementation and reworking of the available data was necessary; this work was carried out through cross-research employing Google Earth, the web-site of the telephonic White Pages and the *Via Michelin* site; this yielded the coordinates of the presses in the reference system UTM-WGS84 ETRF2000.

5. LOCATION OF THE SUPERFICIAL STRATA

The knowledge of the piezometric levels is one of the fundamental factors for the individuation of the terrains that cannot be used for the spreading of residual liquids and damp residue from pressing (as determined by the law 574/96),

The piezometric data, as made available by the Regional Administration of Lazio, could not be used in so far as the data did not refer to the local map but to the absolute orthometric level; to get around this problem it was decided to establish two DEMs, one for the contour lines and the other for the isophreatic zones. Once the two DEMs were realized, the Raster Calculator built a grid of isophreatic, obtaining from this a vectorial file of the isophreatic zones with the indications relative to the local map.

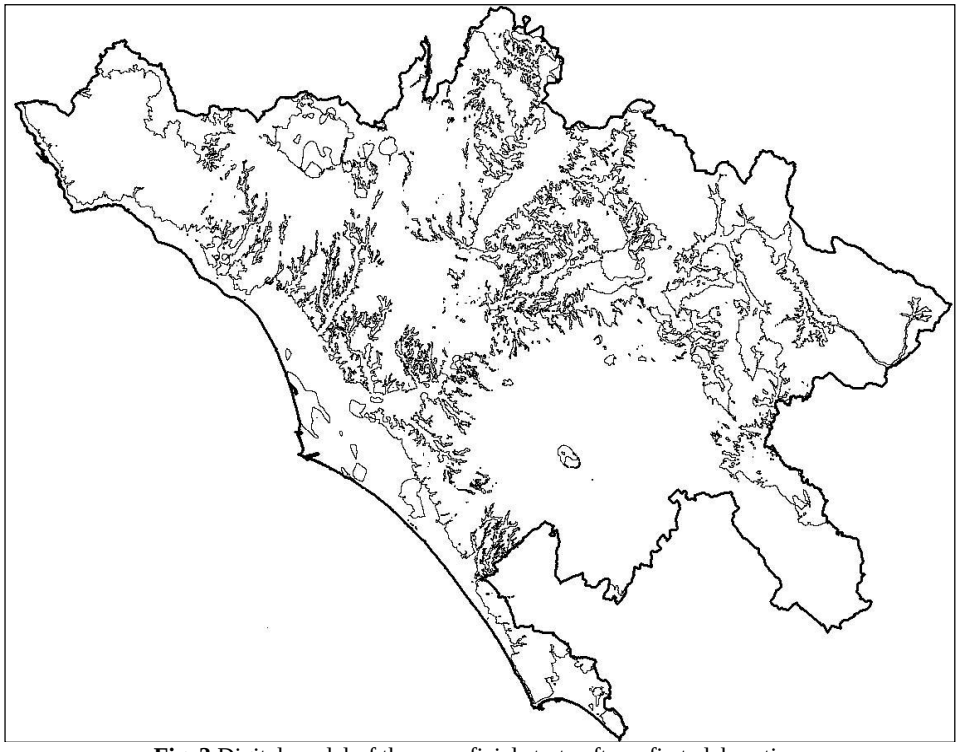

Fig. 3 Digital model of the superficial strata after a first elaboration

The fact that the DEMs did not completely cover the provincial territory led to occasionally incongruent results (**Fig. 2**); in any case, in the areas not concerned by the mapping for this reason it was necessary to effectuate a subsequent analysis to render the resulting data consistent with the starting data, (**Fig. 3**).

The elaboration of these data allowed the delineation of the first version of the map (**Fig. 4**), which should be considered preliminary and which can be adopted after careful verification.

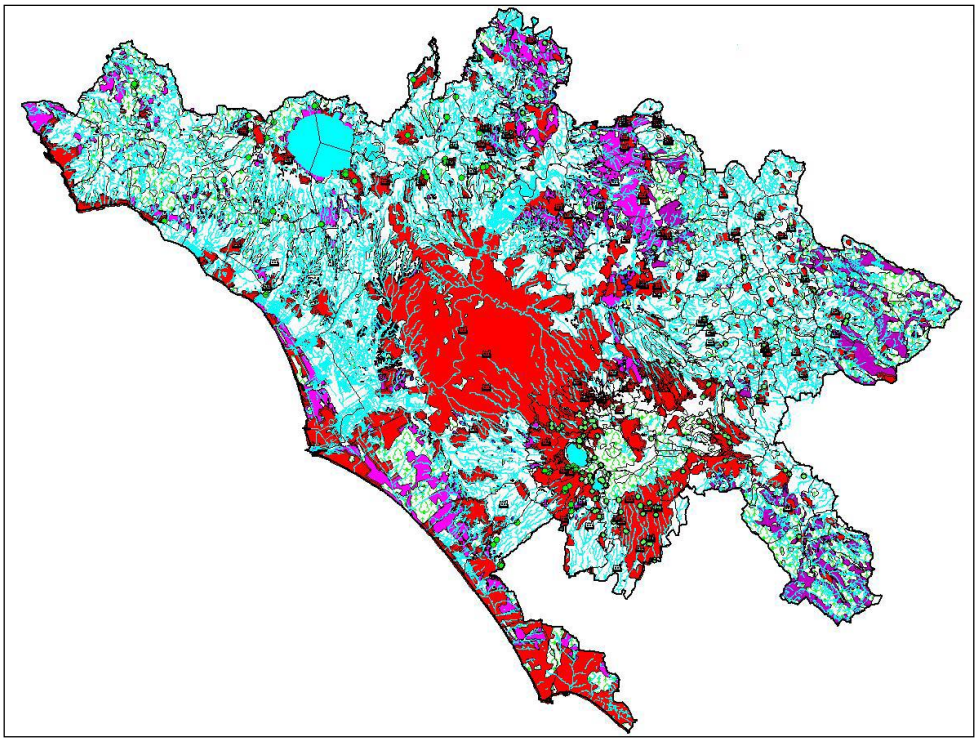

Fig. 4 Comprehensive overview of the various themes as currently implemented in the map

6. CONCLUSIONS

The use of a GIS multilevel like Qgis made it possible to give "real-time" indications for the mapping, allowing a comparative analysis of data from various sources.

he utilization of open source software has made it possible to surpass the inherent limits of the commercial versions of the software in the more complex elaborations.

This can help local administrations to develop also complex territorial models to make their studies and choices whit very little or no instrumental cost at all, focusing their resources on the implementation of the most efficient and suitable strategy for a sustainable development of the environment

A c k n o w l e d g e m e n t s

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