Development of waste management plan in an open source WebGis

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Abstract

Presently the reduction of some existing and operational dumps is a serious problem in Italy. For the necessity to fulfil the requests of the new rules and regulation, (e.g. "Decreto Ronchi"), it needs to individualize new sites for the treatment and the recovery of the waste.
The regulation is very complex and it reduces, up to complete elimination, the waste disposal; it has to be replaced by systems of separate collection finalized to recycle material and, subsequently, to the transformation in energy of the only residual part.
The integrated system of treatment of the waste must be organized in "ambiti territoriali ottimali" (optimal areas) to reduce the punctual pressures on the territory and to minimize the waste transportation that can create uneasiness to the population both in the normal activity, and in case of accidents.
The assignments of the provincial administrations concern several aspects, between them we'll illustrate the methodology used to individualize the areas unsuitable for the location of new plants for waste treatment.
Presently the directions of the Lazio Region are collected in the " Piano straordinario" (extraordinary plan) (regional rule 10/10/03) and they articulate in more than 20 different factors; the considered aspects are presently only the excluding one and those of "Attenzione progettuale" (project attention: factor to be evaluated in the project phase), cause this a first step of the fulfilment of the project; subsequently the areas not subject to factors of exclusion ("white areas") will be classified as more or less suitable regarding the preferential characteristics.

1. Cartographic and GIS characteristics of the plan

The cartographic layers implemented in the system have been released by different agencies, with different software and georeferenced to different cartographic systems so it was necessary to evaluate which format and coordinate system use as a base for the plan.
Since the transformations of coordinates, and particularly of geodetic datum, are critical operations inside a GIS software (Baiocchi et al. 2004) we have decided to refer the plan to the datum more used in the various layers so that to minimize

transformations and to keep the integrity of the original data. According this criterion the reference system used has been the cartographic system Gauss-Boaga (West zone); the cartographies referenced to other systems (mainly UTM-ED50 33 north zone) have been converted in the system of reference through the tool "Universal translator" of the software "Mapinfo 7.0".
The plan has initially been implemented in the system Mapinfo 7.0, mainly because it is the most spread software inside the Provincial administration of Rome, but also for the easiness of use and the versatility in the management of data in different formats and systems of reference. The only limits of the program are mainly a reduced management of the georeferentiation of the raster files and a complex management of the raster files itself during the plotting steps.
The software allows to convert and to acquire "on the fly" the different GIS and CAD format through the command "Universal translator". In Mapinfo the map visualization window is reported to the coordinates system of the first opened layer, if the following ones are georeferenced to different systems they are automatically converted in the geodetic system of the window. The option is very useful for inexperienced users, but the precision of such transformations has to be evaluated carefully.
Recent experimentations on some areas of the Italian territory, among which the area of Province of Rome (Baiocchi et al. 2004), have found a maximum error in geodetic datum transformations, using precedent versions of the software "MapInfo", of less than 8 meters, this is fully compatible with the mapping error acceptable considering the scale of the plan (1:50000- 100000; maximum error 10-20 m).

2. Description of the implementation of some layers

Some Layers have been inserted in the system without big changes in comparison to the original data furnished by various authors; other ones requested a careful job instead, both in the phase of elaboration and of implementation of the database. In the following paragraph, among the various aspects considered, we will illustrate only some of the most meaningful to underline the complexity and the way of interpretation that, in some cases, has been necessary.

2.1 – Flood and hydrogeologic risk areas

The territory of the Province of Rome, regarding the hydrogeologic risk, is under the control of three different "Autorità di bacino" (River Authorities): Tevere River, Liri, Garigliano, Volturno River and Latium Regional Basins. The different authorities have different histories and evolutions so that they developed their plans in very different way according their characteristics. According to rules and regulations it has to be considered the lines of the authorities of basin, mainly regarding the areas that present risk and dangerousness of landslide and flood as stated in the "Decreto

Sarno" (national law, regarding flood risks, released in summer 1998 after the big landslides in the Sarno area of Campania Region)
The rule states that is not possible the location of waste treatment plants in areas where the estimated risk of flood could be repeated in less than 200 years; the authority of the Liri Garigliano - Volturno, has considered instead areas interested by the floods with period of 300 years so that it was necessary to establish a methodology to homogenize originally different data. The different Authorities organized the classifications according to different logics, some of them use only the denominated buffers A, B other ones the distinction among areas of flood or landslide risk and dangerousness denominated R1, R2… P1, P2. Therefore it has been necessary to study criterions the areas have been assigned to the various classes and therefore to build a new coverage distinguishing areas of attention and exclusion according to foreseen to the already quoted legislation.

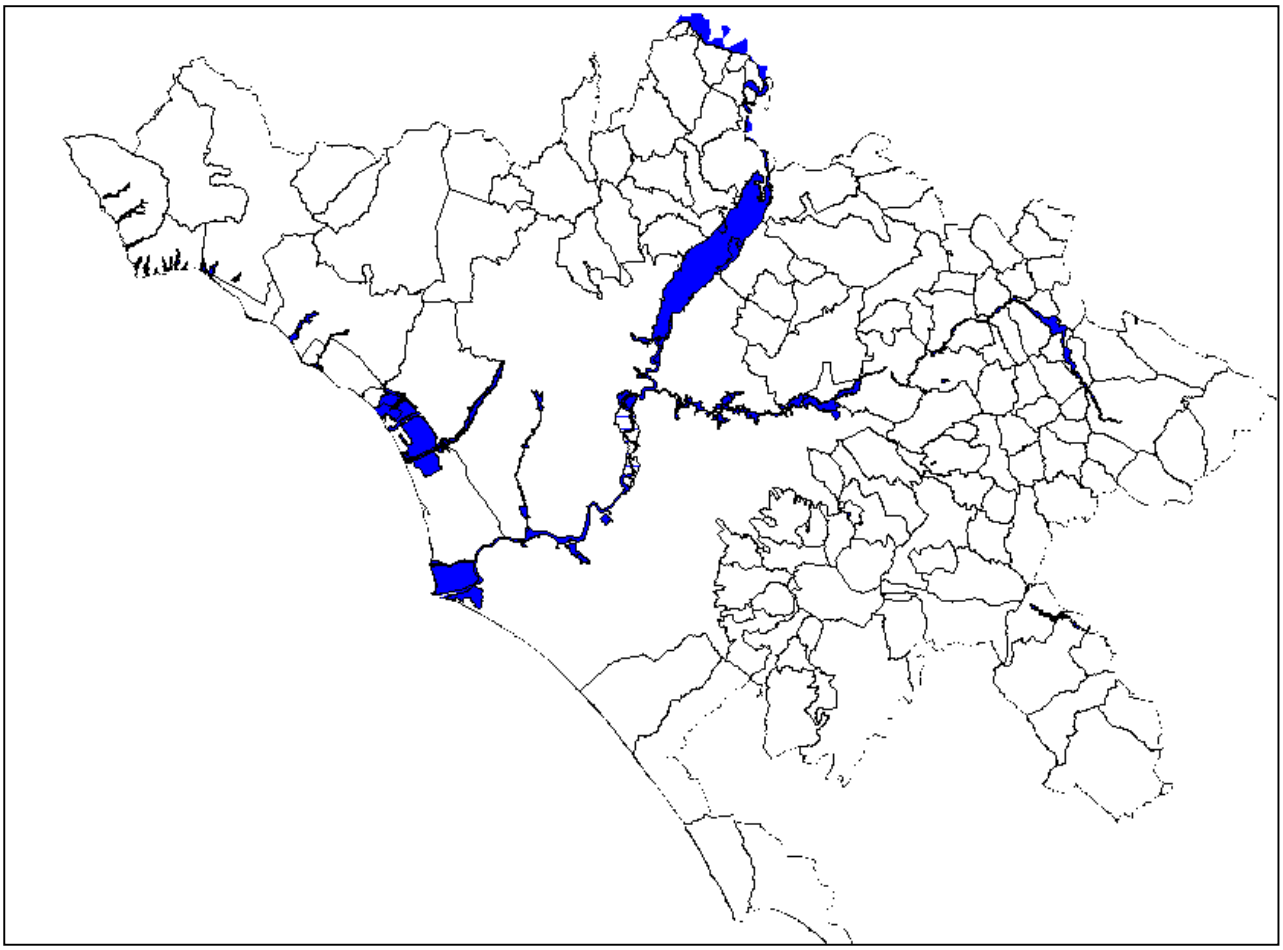

Fig. 2.1 – flood risk areas

2.2 - Distances from the inhabited centers
This coverage binds a big part of the territory of the Province of Rome and the interpretation of this part of the body of legislation is complex.

The body of legislation is very articulated and, in some steps, contradictory, also because the urban zones are defined according to two different criterions: the "Codice della strada" (the book that contains the official rules for drivers) criterion and a second definition very similar to one of the ISTAT (Italian institute for statistics).
The Highway Code defines the inhabited centres as the whole buildings complex delimited along the streets by the special signals of beginning and end; while the ISTAT definition mentions: "a complex of buildings as continuous group, even if alternated with roads, squares, gardens or similar".
The perimetration of the areas according to the "Codice della strada" is not available, it could be realizable through mosaics of all the cartographies of single municipality but such work (already in progress in other branches of the Provincial administration) is not the aim of the present project. For such reason we decided to use the perimetrations of the ISTAT: these delimitations, not very updated, surely are released by a government agency and then they have been adopted.

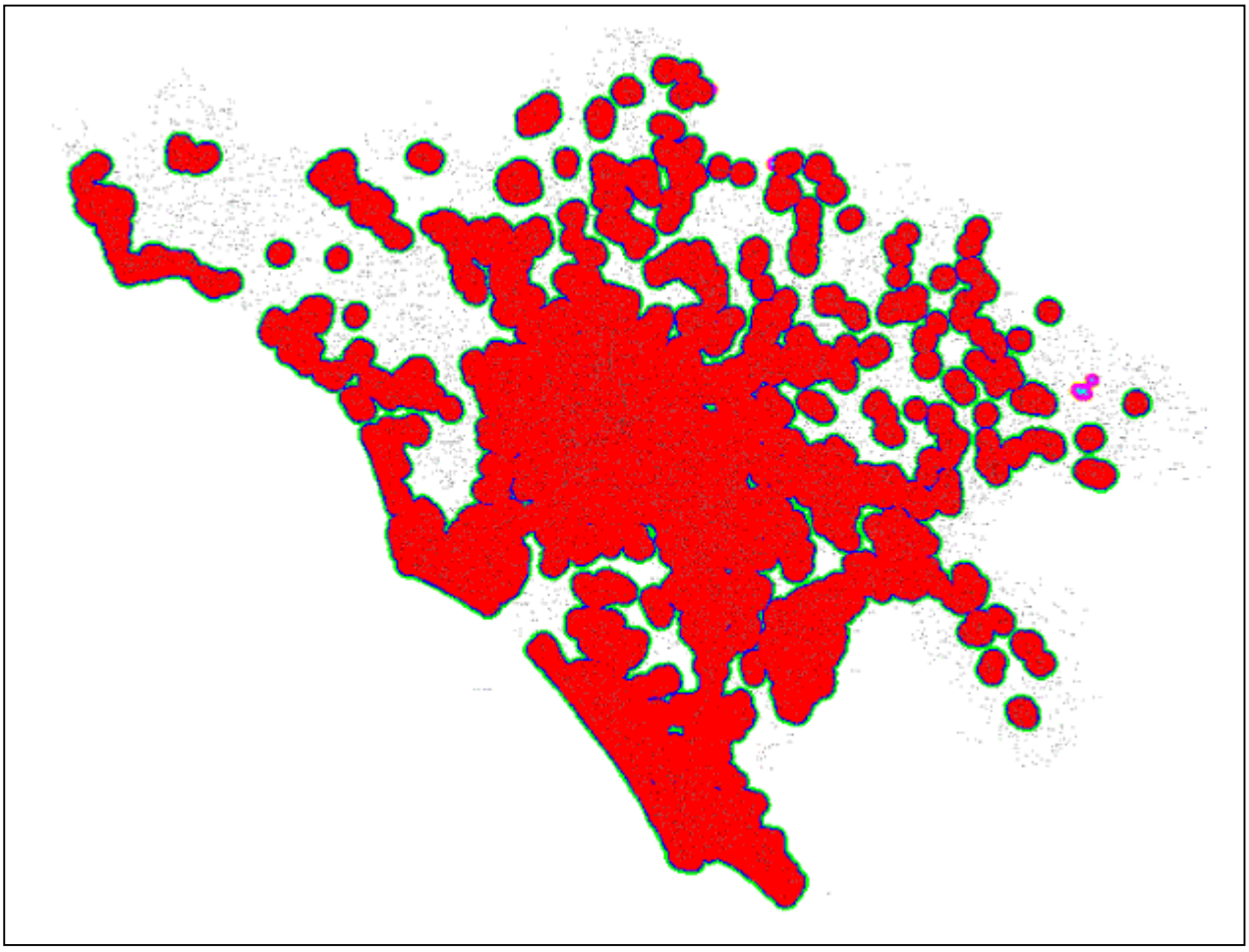

Fig. 2.2 - Distances from the populated centres

The vectorial file contained in the associated database the number of inhabitants for polygon but not the number of the buildings, discriminating factor for the rules of

reference. The rules predicts in fact diversified buffer for populated areas with more or less of 25 buildings, therefore it was estimated at least 2 inhabitants for building and so applying the most restrictive rule to the inhabited centres with more than 50 inhabitants and the more limited buffer to the areas with 50 inhabitants or less.
The buffers are also diversified regarding the type of plant, with widened distances for dumps and plants that changes waste in energy; to have an open prospective of all the buffers we organized to put the most narrow coverages on superior levels to the wider layers (Fig. 2.2).

2.3 - Buffers of distance from roads
The normative fixed different buffers of respect according to the street type:

Type of roads	Buffers of respect (m)
Highways	60
Roads of great communication	40
Average importance roads	30
Roads of local interest	20

Fig. 2.3 - Buffers of distance from roads

The distances must be measured from the border including benches.

As we haven't any file where the width of the road is suitable, it has been necessary to use vectorial cartographies that simply bring representative polilines and, for such reason, opt for a reconstruction for defect of the least estimable widths of the roads themselves.
For this reason, to calculate the respect buffer we estimated the width of a lane adding in the case of highways also the bench, so that we esteemed for the highways a least wideness of the whole road of 23 ms, of 10.5 ms for the main roads and of 6 ms. for provincial roads and the other roads.
The value esteemed, has been calculated from the centre line, buffer included, therefore it has been of 71.5 ms. for highways, of 45.25 ms. for the great comunications roads and of 23 ms. for the other roads.

3. WebGis implementation

One aim of this work is to allow also third part users to access data and results. Public and private agencies, societies and also simple and non-techical users must have a simple and quick access to the public information. Information sharing arises non-trivial problems about the definition of which and how many data have to be made available to the various classes of users. Moreover, the complexity of e-governance policies is extremly high, requiring appropriate solutions. Data have to be validated and therefore be published and made easily and friendly accessible to users. These requirements are common and generally well satisfied for text information published over the Internet, while for geo data it is less usual and standards and documentation are here often lacking.
Definition and structuring of a management and distribution system are currently under development. Definition of standard protocols is also a relevant activity to guarantee efficiency, simplicity, integrity and portability of the information and of the information publishing. Data have also to be accessible with the highest degree of independence from the software solutions adopted by the users. In general this kind of requirements for the geo-data publishing and managing over the Internet are carried out using WebGis applications. Most diffuse WebGis present features hardly enough to guarantee the good data management and to cover users' needs.
Many solutions are today available for the realization of WebGis services, from the web and map servers to DBMSs, each one with pros and cons and with significantly different TCO (Total Cost of Ownership). "Free" and "Open source" solutions offer relevant advantages with respect to commercial products, the absence of licence fees is just one of these. The possibility to access source code gives the users the possibility to well understand software functionalities and operation. Moreover the possibility to take part in the software development and improvement is also available. This kind of solutions often follow global standards (Open Gis Consortium) which play an essential role to permit deep interoperability between different solutions. Proprietary software usually is like a "black box", data management and analysis are very often performed using closed (read unknown) formats and

procedures. The adoption of open and standards formats and procedures allow the definition of hybrid solutions, where commercial and "Free - Open" solutions can correctly and easily interoperate and exchange data.
The WebGis under developing employ only "Free" and "Open source" products, the server web services are managed by Apache while DataBase applications are performed using PostgreSQL and its spatial extension PostGis. Users accesses along with data management and analysis are fully performed by PostgreSQL, both the geometrical and the semantic information are handled within the DBMS and made available to the users by means of standard SQL statements. Topological extension is also added to the PostgreSQL DBMS to gain complex functionalities to perform data consistency checks and use. Internet mapping is performed by MapServer which native and efficiently works and interacts both with the Apache webserver and PostgreSQL. Dynamic information is also made available through use of PHP and JavaScript extensions.

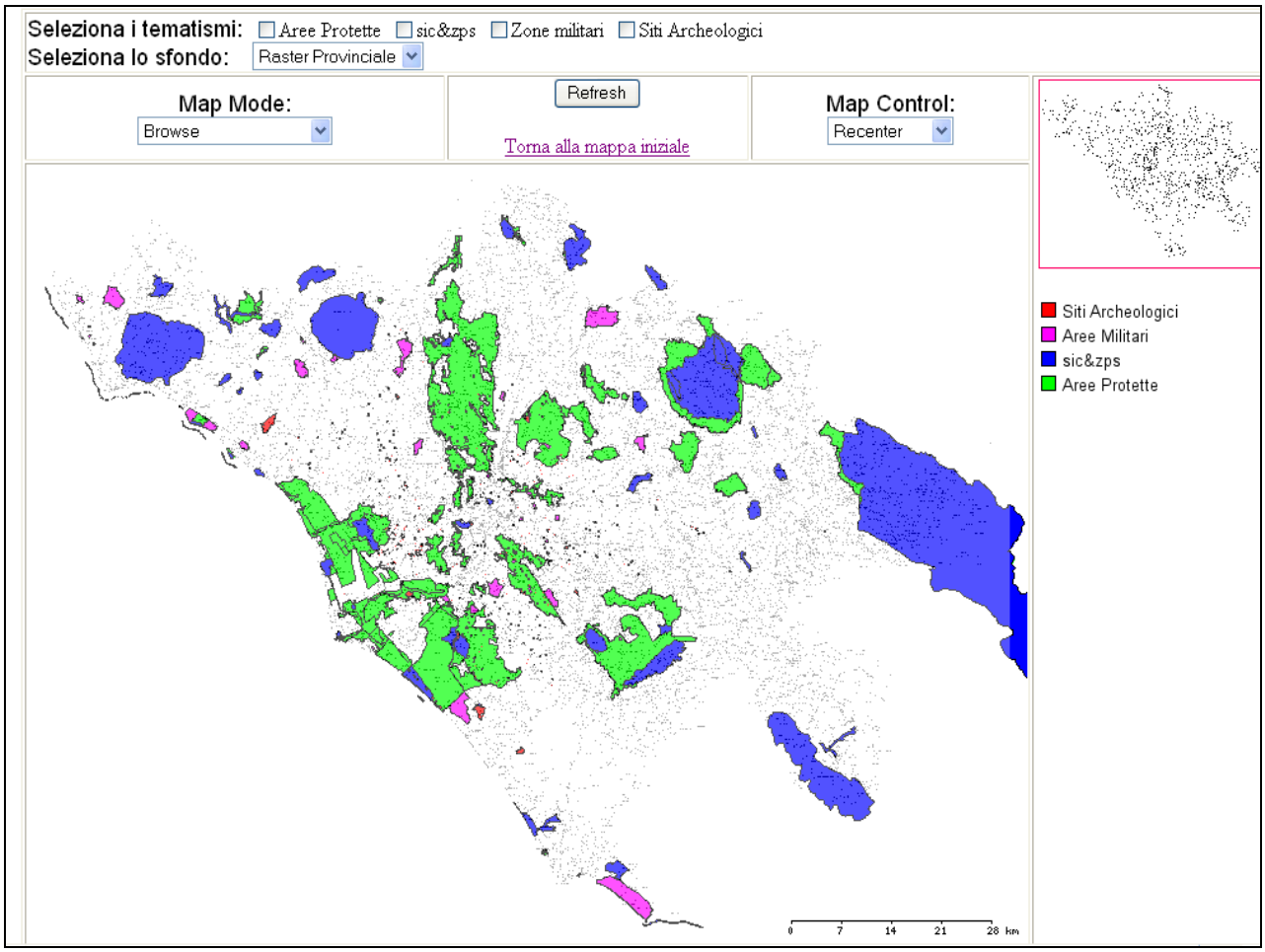

Fig. 3.1 – Layout of the WebGis developed

Currently, the main system feature permits the definition and the visualization of areas of high environmental value, the system allows the characterization of areas to protect from the realization of big facilities for the storage and the treatment of garbage materials. Safe zone buffers have also to be defined to guarantee facilities

to be builded far enough from these environmental areas. Many information levels can be integrated to permit a correct definition of such areas and these levels are to available for the analisys within the WebGis. This information can be ovelaied to allow the characterization of constrains to the geographical localization of the waste dumps.
The WebGis allows the visualization of the information levels, they can be active (visible) or not active (unvisible). To each information level attribute tables are linked and managed by the DBMS. Punct queries can be performed and used to gain information about a specific information level at specified location, the queries results display the semantic information stored within the DBMS tables. Map navigation is also possible and improved by the availabily of zoon and pan functions. The basic information level (background) can also be activated by the users by mean of a simple check box: the topografic map is displayed by default. Further information layers and functionalities will be available in the final version.

4. Layout of different layers and perspectives of development

The implementation of the various factors required for a complex work of transformation, interpretation and, in some cases, redrawing of the available data.

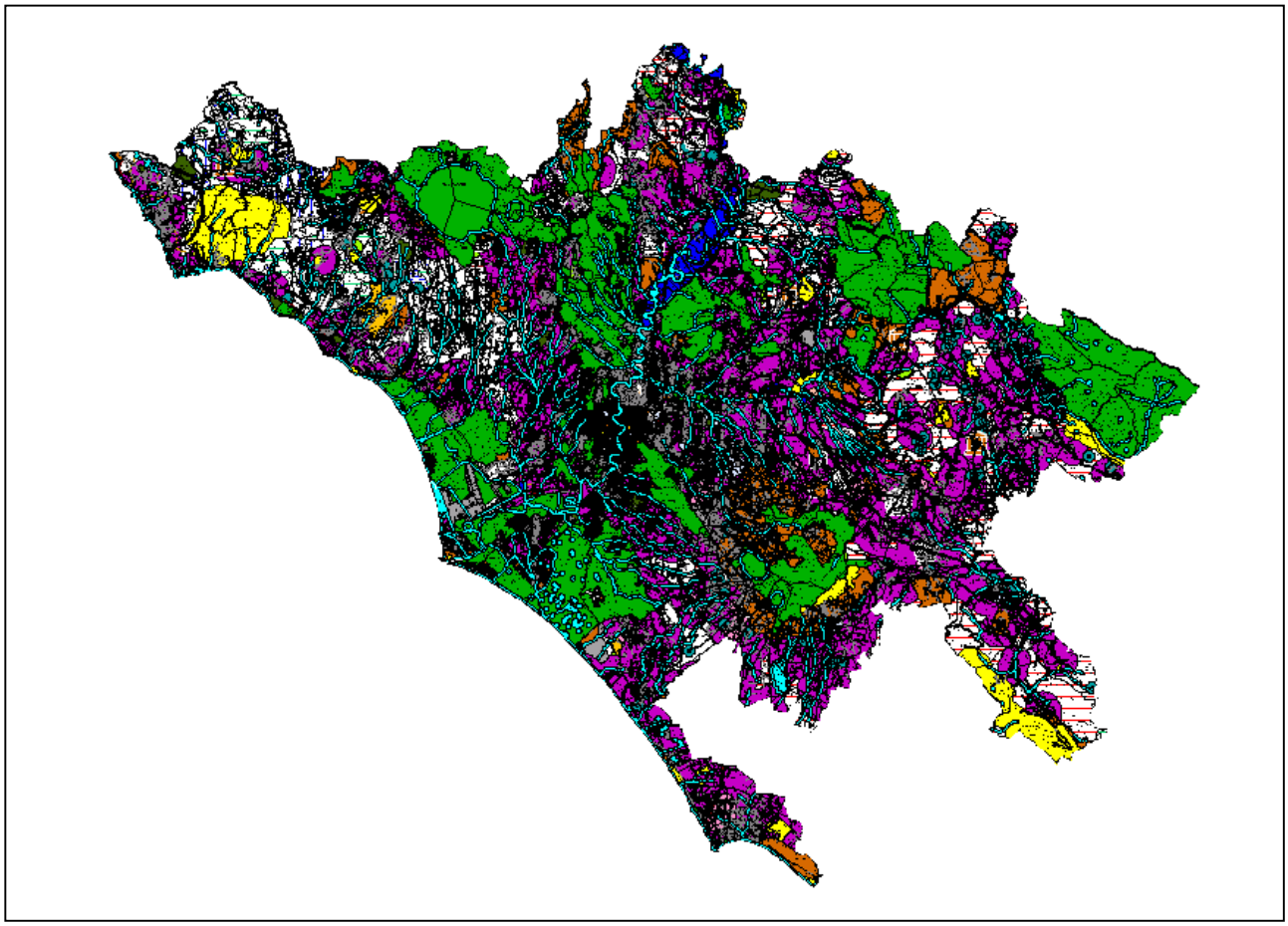

Fig. 4.1 - vision of the different layers presently implemented, where the available areas are highlighted (white); continuous coloration: factors of exclusion, outlined pattern: project attention areas

The versatility and the possibilities offered by the GIS environment allowed to draw new cartographic coverages from preexisting data in alphanumeric and vectorial format.
From the fig. 4.1 the development of the plan can be observed as it's presently developed (september 2005). The visualization shown is the one proposed for the paper version where project attention layers have been represented by strip patterns while exclusion layers have been represented as continuous pattern; usually there is not interest to appraise factors of attention in the areas in which factors of exclusion subsist.
The "white areas" are observable, on paper version, but GIS queries are surely the most effective way to deepen the analysis of the various layers in the possible areas of interest; it is possible to know what factors concern a specific portion of the territory, or to turn on and off the various layers present in the same zone.

Conclusions
Regarding the factors of exclusion they are correctly implemented for a percentage estimable around 80%. Some layers have to be implemented as, for example, those which are municipality competence (presence of areas of residential expansion, perimetration of the civic uses, etc.), and the new protected areas plan (law 1497 / 39).
For the factors of project attention, there are some layers that must be interpreted and realized "ad hoc" as the areas of particular agricultural merit and interested by DOC cultivations and the factors of protection of the quality of the water resources.
At the end of this first phase it needs to observe that the "white areas" are a little percent of the territory, but they could be enough for the demands of the Provincial administration with a suitable planning.
It remains still to develop the classification of "white areas" territories regarding preferential factors.
The WebGis is currently under development and testing but it has already been possible to verify its stability and the efficiency of the interoperation between the various software employed. The WebGis presents large margins of improvement, the possibility to place side by side classical features, such as remote visualization and query of the data, and innovative feature, such the possibility to download data and to remotely updade geometry and semantic information, is currently object of study.
Along with the definition of the contents that will be published, the needs of the various classes of users which will be allowed to access the WebGis are also under careful analysis.
A paper version, 1:100.000 scale, will be realized to made possible a complete and immediate vision for the preliminary analyses. This project will be surely a support for the decision in the "white areas" and a data base on which to plan the integrated system of the management of the waste for the Provincial administration of Rome.

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References
Baiocchi V., Mascia S., Tanga E., Vitti A., Zatelli P., Zottele F. (2005): "SIG et déchets". *Géomatique expert*, v. 44, pp. 42-47
Baiocchi V., Bortolotti C., Crespi M., Del Moro M.A., Pieri S, (2004): "Accuratezza delle trasformazioni tra Datum e sistemi cartografici nazionali: implementazione nei software di maggiore utilizzo nelle applicazioni GIS" *Proceedings "Convegno ASITA 2004"*
Cima V., Maseroli R., Surace L. (2003): "Manuale Cartlab 2"
Regione Lazio (2005): "Piano degli interventi di Emergenza nella Regione Lazio" pp. 74-83