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The SITAI project for the industrial areas of Sardinia: from a GIS database to a web-based site selection tool

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Abstract

SITAI, Sistema Informativo Territoriale delle Aree Industriali della Sardegna (Geographic Information System for the Industrial Areas of Sardinia) is a product which is being developed in Sardinia by Osservatorio Industriale della Sardegna with the support of CRS4. The system has been conceived with three main aims. The first is to conduct economic studies related to site and resource optimization, through analysis of the firms, facilities and infrastructure available in the Sardinian region and within each industrial area. The second is to promote Sardinia's industrial parks and to offer a site selection tool to potential investors, providing an integrated and harmonized view of the various industrial sites by means of a web-based interface to the data. Finally, the system is being proposed as a common starting point for the implementation of facility management applications within the industrial parks. The core of the SITAI database is represented by a set of geographic layers for each of the 23 currently active parks, linked to detailed information on the available infrastructure, the existing utilities, the characteristics of the firms located in the area, and on the costs for siting a new activity. This information is complemented by a regional-level view of the transportation networks and administrative boundaries, allowing to perform complex analyses on the available information.
The project is now in its fourth year of life. After a prototype phase conducted in 1996-1997 on a single industrial park, the complete "desktop" version of the system has been implemented in 1998, and is currently being used by Osservatorio Industriale to provide, jointly with its other databases concerning the regional economy, a support to local policy makers, private companies, and consultants. During the past year, in addition to the development of the web-based interface to the database (released in May 2000) and the update of the database, one of the key issues faced has concerned the technology transfer towards the various actors involved in the project, either as data providers (i.e. the managers and the technicians of the parks), or as users (i.e. Osservatorio Industriale in their role as socio-economic analysts), in terms both of awareness raising on the potential of GIS-enabled applications and of training on the use of the system. The presentation will describe the features of the system, discuss some of the issues which have emerged as critical during the project, and present its possible further developments. In particular, we will focus on the site selection functionality offered by the web-based interface.

Introduction

While being more renowned for its natural resources, pre-historical archaeologic heritage and ancient traditions, Sardinia, the second largest island in the Mediterranean area, also hosts a system of 24 industrial parks offering, among all Italian regions, one of the largest industrial site supplies. The existing parks are the result of the economic development policy for Southern Italy adopted in the early Sixties and, essentially, based on the growth pole doctrine (Perroux, 1955). This policy pursued the industrialisation of the island trough the location in the industrial areas of propulsive heavy industry, such as chemical and metallurgical industry, which was intended to spread its positive effects thanks to vertical and horizontal integration with other firms. After two decades, this policy substantially started to show its limits. Several large enterprises, often sustained by consistent public incentives and subsidies, were closed. At the same time, the industrial parks were ignored by local firms (active mostly in traditional regional sectors, such as food or cork), which continued to locate themselves mainly outside the infrastructured areas (Loddo *et al.*, 1997). This trend is well highlighted even at a first level of analysis of industrial census data (Table 1): considering the mining and manufacturing sectors, as of 1998 only the 6% of the firms turn out to be located inside the industrial parks. Furthermore, the location dynamics for new firms between 1993 and 1998 confirm a decreasing interest for the industrial areas, with a quota of firms located inside the parks dropping to 3% off. Even though in a few cases this is due to the fact of some of the parks being nearly saturated, there are several sites which are currently under-exploited and need to identify new strategies in order to attract new firms.

The 24 industrial parks of Sardinia (Figure 1) are classified in three different categories. The first areas, created in the Sixties, were defined as ASI (“industrial development areas”). Changes in the regional economic policy led in the following years to the creation of smaller parks, defined as ZIR (“zones of regional interest”) and NI (“industrialisation nuclei”). The parks are managed by 16 Consortia, mostly composed by local administrations.

In order to complement its studies on the current trends in location dynamics within the region with new analytic tools, the Osservatorio Industriale della Sardegna, an economic research agency owned by the Sardinian Government, decided in 1996 to promote the SITAI project. Given the intrinsic spatial nature of most of the data related to the industrial parks, and the need to analyse these data in the regional context, it was decided to base the development of the system on a geographic information technologies (hence the name SITAI, Sistema Informativo Territoriale per le Aree Industriali).

In addition to providing a detailed picture of the characteristics of the industrial area system, and of the firms located therein, the aim of the SITAI project was also to exploit the same data to promote the areas still available for the settlement of new enterprises. The target is represented by small and medium enterprises from Northern Italy or abroad, since the actual dimension of the Sardinian industrial structure is *de facto* not sufficient to meet the regional industrial location supply.

Last, but not least, the interactions with the Consortia, required to retrieve the main information for the SITAI database, were to be directed also to raise the awareness of the technical and administrative staff of these subjects on GI technologies.

The working group for the project is composed by Osservatorio Industriale della Sardegna and Centro di Ricerca, Sviluppo e Studi Superiori in Sardegna (CRS4), an applied research centre operating in the fields of information and communication technology and numerical simulation. The project co-ordinator is also responsible for the economic data on the firms operating in the parks, while CRS4 has taken care of system design and development, and data integration issues.

Project history

The project has evolved through three distinct phases. Phase I (Sep. 96 – Feb. 97) was centered on the evaluation of previous similar national initiatives, on the acquisition of cartographic data from the SIFLIM database, containing information about all industrial parks in Southern Italy (Ficei Service, 1991). In addition to these evaluations and assessments, a prototype interface for a single industrial park was developed, as a first example of a desktop GIS-based access to the data.

Phase II (Sep. 1997 – Dec. 1998) saw a major revision in database structure. The SIFLIM database was adapted to the requirements indicated by Osservatorio Industriale, thus eliminating parts of the database considered not functional within SITAI (or less relevant in the Sardinian context), and designing specific solutions for a more efficient integration with other local information sources. Based on this data structure, a new data acquisition campaign was organised, providing detailed cartography, information related to the available facilities, and data on the active firms for each area. At the same time, a complete desktop version of the SITAI interface was implemented to provide access to the data via a typical medium-level GIS package. The desktop application allows the user to navigate interactively across the two levels of geographic data (region and industrial area) and to perform different types of queries in an intuitive and, where possible, guided fashion. Furthermore, the regional level view allows to evaluate the characteristics of the single industrial areas, especially with regard to site supply, in terms of the quality of the available services, the costs of settlement for new activities, the proximity to important infrastructures, and other parameters (Giacomelli et al. 1998).

The third phase of the project (Mar 1999-Mar. 2000) was centred on three activities: database update, design and implementation of the web-based access to the system, and training for Osservatorio Industriale and the staff of the Consortia. Having remarked that a full awareness on the advantages (and the demands) of GIS technology was not always acknowledged in the working group responsible for the supply of data to SITAI, the need for specific training modules directed to the staff of the Consortia was deemed as a high priority. Rather than proposing full training courses on GIS or on the use of a specific software package, the scope of the training modules was to “equalise” the quite strong variability from site to site in level of information technology facilities and skills. This was done with the aim of establishing a minimum common level of know-how (related to internet, databases, CAD and GIS) in order to facilitate the update process.

The development of the SITAI web site (SITAI WEB) was initiated in parallel with the other tasks, with the setup of a pilot site in June 1999 and the implementation of the complete version between October 1999 and March 2000. The site was presented to the public at the beginning of May 2000 and can be accessed at the URL http://www.crs4.it/sitai.

In addition to the above mentioned SIFLIM initiative, during all the project attention was given to contacting other subjects involved in the development of systems similar to SITAI. In particular, as a regional project we may cite SIGAIN (by INFO Murcia, Spain), while on a EU scale several exchanges with the coordinators of TEMISIA (currently under development within INFO2000) occurred.

Information content

The SITAI database contains two levels of information: region and industrial area level. At the regional level geographic data comprises a typical set of base layers (administrative boundaries, roads, railways, etc.), while at the area level, the available geographic data concerns perimeter and land parcels, buildings, facilities, water and electricity distribution networks and internal road system. The original 1:2000 scale CAD cartography from which the GIS themes have been extracted is also available, and provides a detailed backdrop at the area level.

The GIS data sets for the sites are structured with a certain level of generalisation (e.g. a facility such as a treatment plant is identified only by its perimeter). This level of detail is more than sufficient for the scope of the SITAI analysts or for promotion purposes, but the SITAI data (at least at the current stage) are not intended to be used as a base for complex facility management tasks or as official cartographic records. As for alphanumeric information, the set of data related to the characterisation of the industrial parks and the location dynamics of the firms was acquired for each area by means of a survey form. In particular, the Consortia were asked to document the availability of facilities and services and, for a selected set of structures (e.g. wastewater treatment plants and landfills), to provide specific information on their state. Compared to the SIFLIM database analysed in the pilot phase, a substantial difference is given by the fact that SITAI does not contain information related to progress reports on the projects for new infrastructures in a given site. These data are in fact extremely interesting and important in order to assess the performance of an industrial park; however, it has been preferred not to include them at this stage.

In addition to the core represented by the structured data, the system contains information referred to a single industrial area and is treated as an “annex” or “attachment”, such as images, free-text documents, and charts. While the supply of attachment data is not mandatory, it provides a certain degree of content customisation, which can be an interesting option for a Consortium.

Firm information is coded using the fiscal code as the identifier for an enterprise. This allows the Osservatorio to link the SITAI database to other important information sources, both internal (such as the regional statistical register of enterprises, ASTRI) and external, thus making possible the combined exploitation of previously unrelated data.

SITAI WEB

The desktop version of the SITAI interface was used during phase III of the project, providing support to the working group to accomplish several monitoring and coordination tasks. The system is also being used by Osservatorio Industriale to provide, jointly with its other databases concerning the regional economy, a support to local policy makers, private companies, and consultants.

While maintaining a tight integration with the core database and providing web-based mapping functionality, the SITAI WEB interface is focused on the promotion of the industrial areas. In this respect, SITAI WEB also provides the natural environment in which other types of more “communication-oriented” information, not available in the desktop version, easily find place.

SITAI WEB has been developed on a standard web server, using PHP3 scripting to handle dynamic generation of the web pages and database connectivity. The visualisation of the geographic data has been to Jshape, a publicly available applet.

The industrial park file

Starting from the main page, the SITAI WEB site is essentially structured in two sections (Figure 2): the industrial park "File" and the "Site selection page". For each industrial area, the "File" provides a consistent description of each site, reporting location, main types of economic activities, parcel availability, settlement costs, and contact information. Each file contains the hyperlinks to two dynamic maps of the area (showing a general layout and the distribution of available parcels). The comparison between the corresponding sections in the files of different industrial parks is simplified by using the "advanced menu" option, which offers a menu-tree based access to the files. This can represent a convenient approach if navigating the site with the aim of cross-evaluating different sites.

The site selection page

The site selection page allows to query the SITAI database for free lots, according to a set of user-defined selection criteria. These are divided in lot-related requirements (surface range and type of activity to be located), and site-related requirements, including facilities serving the industrial areas and distance of these from ports, airports and railway stations. The constraints on the site-related selection criteria can be enforced independently one from another, thus allowing to easily perform complex query patterns. To include a sort of “fuzzy” control on parcel area requirements, rather than letting the user select an area range among a set of fixed options from

the input form (e.g. "up to 5000 m^2", "from 5000 to 1000 m^2", etc.), the input parameters are defined in terms of a reference area plus/minus a percent value (e.g. 4000 m^2 ±10%), which are both specified by the user (Figure 3A).
The result of a site selection query returns for each area a list of the available parcels responding to the input criteria (if present, Figure 3B), with the option of invoking the dynamic visualisation of the query result (Figure 3C). Furthermore, in order to facilitate the evaluation on the site-related parameters which have been specified by the user, a comparative table is generated, highlighting with a simple color-based scheme the sites for which a better ranking has been obtained (Figure 3D). It should be noted that these rankings are relative to the input parameters specified, so they should not be adopted as an absolute assessment of an industrial park's location "appeal", which should be evaluated by means of specific and more complex indicators.

It should be noted that the information pertaining to different Consortia may be (and typically are) referred to different dates; for this reason the date reference for each site is returned together with the query result. It is in any case recommended to contact the managers of the selected areas for additional information or to verify the possibility of obtaining a re-parcelation of the lots (if the activity to be located requires the union of two or more lots, or the division of an exceedingly large one),

Other functions

The web version of SITAI provides also other functionality which is not available in the desktop interface and which reflects its more "communication-oriented" nature. For example, the industrial area file contains a section that can be used by a Consortium to send communications to be displayed in a "latest news" format, such as the notification of ongoing maintenance in a certain zone of the park, or the announcement of the activation of a new service.

Database maintenance and update

Issues and strategies

Excluding the region level information, which in SITAI WEB is confined to a "backdrop" function, the vital data for the updating of the database is to be wholly provided directly by the Consortia. During phase II, all data for a single area was acquired through a limited number of iterations, corresponding to three distinct sets of information (cartographic data, industrial area characterisation and land parcel-enterprise dynamics). This approach is rather straightforward from the coordinator's point of view, and is quite practical in the first steps of data loading, but also inevitably leads to potential problems for the Consortium, in terms of concentrated workload. Furthermore, considering that each Consortium substantially operates independently, it is rather difficult to configure (and to impose or obtain consensus on) an update procedure insuring the arrival of data from different Consortia following a pre-set schedule, and –eventually- referred to the same dates. For these reasons a substantial effort was made, in the definition of the update procedures, to subdivide the three above mentioned information blocks into a set of smaller units. In this case the coordinator can modulate its requests towards the Consortia and, by consequence, a Consortium can distribute its SITAI update "chores" with a higher flexibility. At the same time, this approach provides the coordinator with a data model on which the monitoring of the overall update activity can easily be implemented.

The data flow is structured so that all updates are transmitted from a Consortium to the Osservatorio Industriale, where data undergo a first validation. The files are then forwarded to CRS4 (where the system is currently hosted) for a second validation and, finally, loaded in the SITAI database.

Definition of the update procedures

The entities and relationships stored in the database have been analysed with respect to temporal dynamics. Excluding the information for which changes in time have not been considered relevant within SITAI, temporal variations can be either tracked by using a single date reference, following a time-stamp mechanism, or by using a two-date scheme, thus storing the beginning and end date for a given attribute or relationship. With this option a persistent state can be described by not providing a value for the "end date" item, and simple incremental updates can be implemented. The choice between the two update schemes is not necessarily univocal for a given element, and has been identified by taking into consideration the actual complexity of a given block of information and the expected frequency of the updates. For example, geographic layers, planning directives, or cost information are tagged with a single date. Vice versa, the relationship between land parcels and enterprises, or the relation indicating the facilities serving an area are tagged with a two-date reference.

The update procedures have been automated in their most critical or complex steps by means of a set of software utilities. In particular, in addition to handling the update of the parcel-enterprise relationship tables and

the registration of geographic updates, the utilities also take care of the re-generation of the desktop GIS interface, which is recommended when a new version of a geographic layer is added in order to “refresh” the links between the geographic data and the alphanumeric sections stored in the GIS package’s project files. The generation of reports and statistics related to the update process is also accessed through these utilities. The update utilities have also been designed to account for typical errors or inconsistencies in the input data, such as the omission of a firm’s fiscal code, allowing to proceed with the update process with a set of temporary firm IDs. This way an update can be committed to SITAI immediately, and the retrieval of the missing fiscal codes (which in certain cases may require a consistent amount of time) can be re-scheduled as a separate task.

Future developments

In its current version, SITAI WEB provides a homogeneous set of information that would be probably impossible to gather and organise for a single investor or analyst and, thus, represents a valuable resource for all subjects interested in Sardinia's industrial park system. Clearly, the main priority should be to insure that the database is kept updated. While from a technical point of view new data can be fed to SITAI on a daily basis, considering the actual dynamics in the industrial parks (and given the resources available for the year 2000) it has been planned to queue the incoming data and to organise the process with a batch scheme, resulting in an update every 2-3 months.

New content

The information offered by SITAI WEB can surely benefit from the integration with other content sources. From the point of view of economic analysis, a tighter integration of SITAI with the above mention statistical register of enterprises (ASTRI) would represent a substantial improvement.

Furthermore, in order to provide an even richer level of information on the geomarketing side, SITAI WEB should provide a more detailed economic overview of the region, with a specific focus on information such as incentives or labor skills, which are of particular interest for a potential investor. In this respect, it should be mentioned that Osservatorio Industriale already provides an on-line access to information on the incentives available for new economic activities in Sardinia, so the integration between the two databases can be seen as a feasible option in the near future.

New tools

The software solutions adopted for SITAI and SITAI WEB are extremely open. During phase II of the project it was possible to undertake the (initially unplanned) integration of SITAI database with another pre-existing database managed by Ossind with only a minor pre-processing. Furthermore, during the final steps in the development of SITAI WEB, the working group also started to provide a customised access to SITAI WEB for a web-based service promoted by Sardinia's Business Innovation Centre (BIC) and directed to provide information support to local development initiatives such as the “Piani integrati d’area” or the “Piani di azione locale”, which are being proposed in Sardinia and other regions as new economic development initiatives, encouraging the cooperation between public and private sectors.

The SITAI WEB “engine” is already enabled to support multi-language content. At the time of writing, however, the localisation of the site has been only partially completed for english, and for this reason navigation is possible only in italian. A bi-lingual SITAI WEB should be available by the end of the year.

Of course, while we believe that the existing interface can provide a satisfactory support to the user, many of the functions can be improved. In addition to possible enhancements which were identified during the development of the system, but put "on stand-by" in the working plan, we hope that users accessing the site and -especially- the Consortia, will be stimulated to communicate their *desiderata*, thus providing the indispensable complement to the "to do" list grown during the development phase and contributing to a prospective phase IV of the project.

Conclusions

Of the three aims set out in 1996 for the project, we can state that SITAI has fully met its first objective, since the system is being used routinely by Osservatorio Industriale. Greater benefits to the economic analyses which represent the core product of the Osservatorio are expected to be reached gradually, with the internal resources being re-allocated from development to use of the system, and with the update activity being reduced to a mere administrative task.

This scenario, however, also relies on the effort of the Consortia, which have not always responded in the same way to the update requests (and to the regional government’s official recommendation to support the

maintenance of SITAI): while several parks have sent three or four updates in one year (from June 1999 to June 2000), there are a few subjects which have been less co-operative.
Another issue is given by the fact that, in spite of the documentation distributed to the working group, the "validation phase" prior to insertion of the updates has in many cases turned into a substantial re-editing of the data, due to discrepancies between the transmitted data and the published specifications. Typical problems are represented by CAD-GIS conversion, lack of georeferencing information and inconsistencies in parcel labels and reference dates. While some of these problems could be handled quite efficiently by the database maintainer by adopting, for instance, specialised data conversion software, we believe that such issues should be solved at the source level. In this respect, the need for more in-depth training for the staff of the Consortia remains as a high priority.

The idea of proposing a common facility management tool to the industrial park managers, which was initially posed as one of the objectives of the SITAI project, has been to a certain extent relaxed. More realistically, the system is now being proposed as a common basis with which more specialised facility management tools (either existing, or to be implemented) should be related. In fact, an effort has been made by the working group to promote SITAI towards the Consortia more as a framework in which their data can be integrated at the regional level, rather than as a specific software solution requiring *ad hoc* investments.

The attempt to "force" the existing legacy systems used in the industrial parks (mostly CAD-based and with separate archives for cartographic and alphanumeric data) to interact with SITAI on these grounds has also been undertaken with the aim to stimulate a "balanced" demand for GIS technologies: the larger Consortia (and/or those already well equipped with hardware, software and human resources) might consider the option to interface with SITAI by leveraging their systems to fully-fledged facility management solutions. Facing the same situation, the smaller subjects may be satisfied -or find it more convenient- to adopt simpler strategies, either by implementing less complex software solutions, or (in the worst case) by maintaining the date policy followed during 1999.

In all cases, SITAI's update should be insured with the current frequency (or more), thus allowing to maintain the system as a reference for the promotion of Sardinia and its industrial areas via web. At the same time, any expression of interest by the Consortia for GIS technologies, in addition to improving the performance of SITAI WEB, may open new opportunities for local and national SMEs operating in the GIS sector.

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Sistema de Información y gestión de áreas industriales (SIGAIN), http://www.sueloindustrial-murcia.com
Territorial Multimedia Information System for Industrial Areas (TEMISIA), http://www.temisia.org.gr

Figure 1

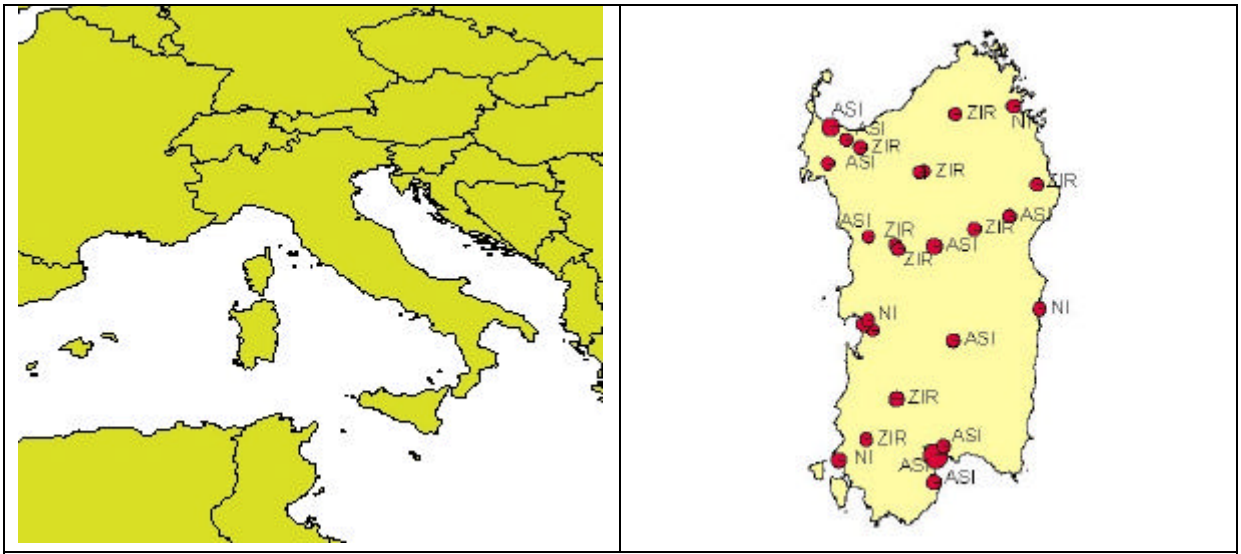

Figure 1: *The position of Sardinia in the Mediterranean, and the distribution of its industrial park system. The parks are classified as ASI ("industrial development areas"), ZIR ("zones of regional interest") or NI (" industrialisation nuclei") and are managed by 16 Consortia.*

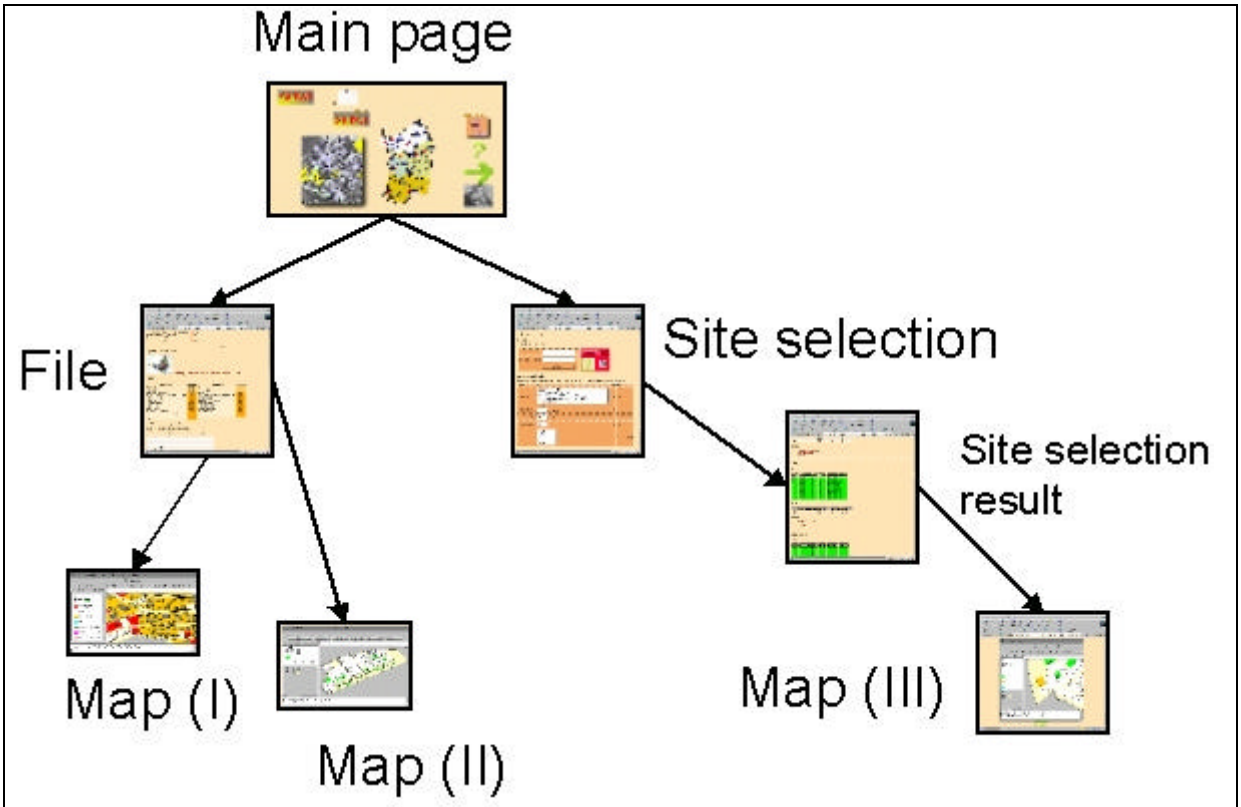

***Figure 2**: A scheme of the SITAI WEB site. Dynamic map visualisation can be invoked by the user from three different points, to complement either the information on a given industrial park, or the result of a site-selection query.*

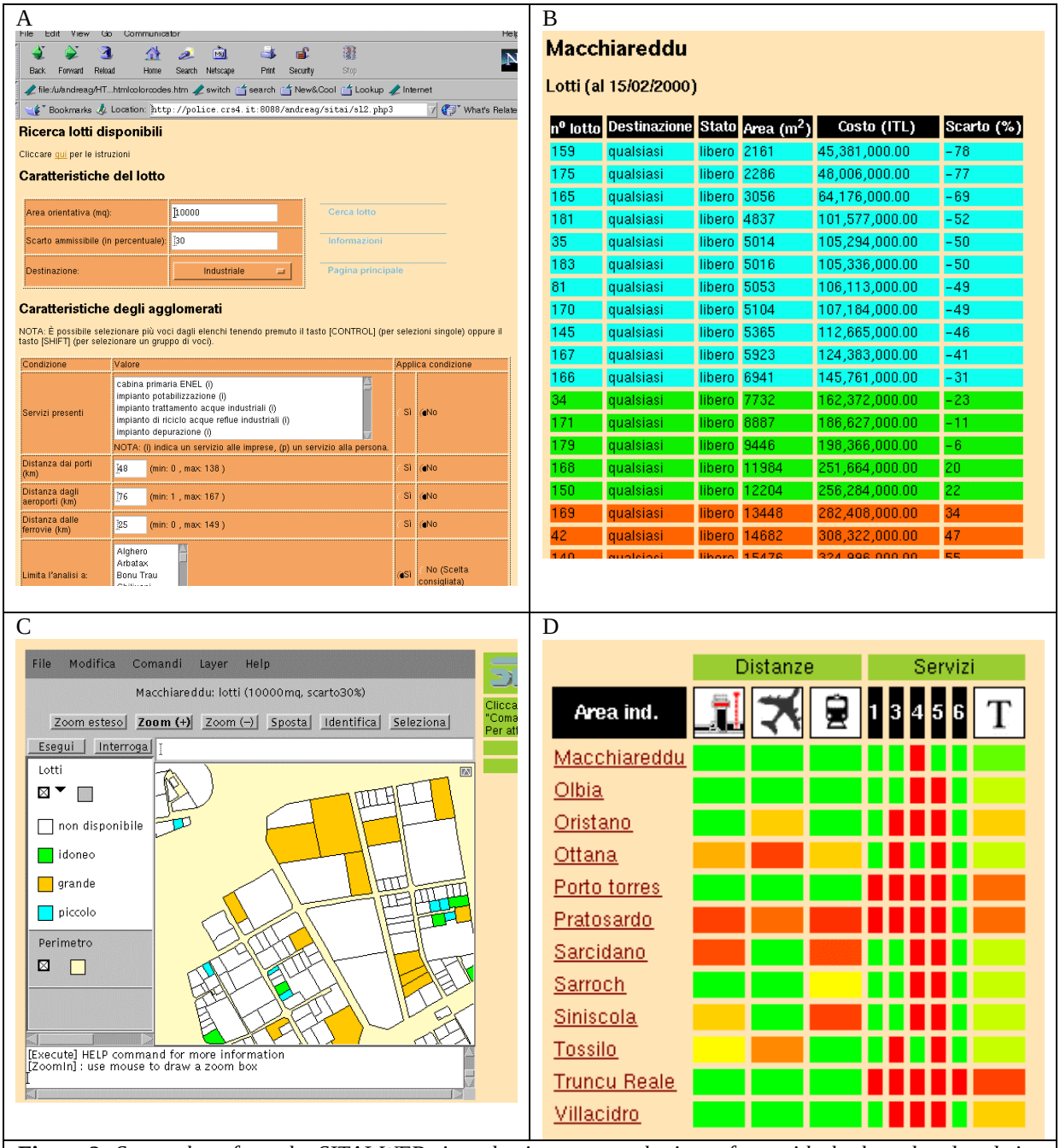

Figure 3: *Screenshots from the SITAI WEB site-selection pages: the input form with the lot-related and site-related parameters (A). A sample of a result table (B) and of the corresponding map (C). The table also reports on parcel costs and percent deviation with respect to the desired area for the resulting lots. Lots displayed in cyan or orange are out of the specified area range, but are in any case proposed for visual evaluation. (D) Shows and example of the "quick comparison" table which allows to identify the best ranking sites (highlighted in green color) with respect to each of the required facilities, while less suitable parks are identified on a color scale from red (worst) to yellow (best). It should be noted that these rankings are relative to the input parameters specified, so they should not be adopted as an absolute assessment of an industrial park's location appeal, which should be evaluated by means of specific quality indicators.*
The web site is in Italian, but the generation of the dynamic pages already includes support for multi-language content. An English version of SITAI WEB is expected within the year 2000.

	Inside parks	Outside parks	inside/outside*100
Situation as of 1998	667	11329	6
New firms from 1993 to 1998	96	3323	3

Table 1: *Firm location in Sardinia for the mining and manufactoring sectors (Osservatorio Industriale della Sardegna and CERVED)*