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Environmental applications based on GIS and GRID technologies

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In the last decades, the collection and use of environmental data has enormously increased in a wide range of applications. Simultaneously, the explosive development of information technology and its ever wider data accessibility have made it possible to store and manipulate huge quantities of data. In this context, the GRID approach is emerging worldwide as a tool allowing to provision a computational task with administratively-distant resources.

The aim of this paper is to present three environmental applications (Land Suitability, Desertification Risk Assessment, Georesources and Environmental Geochemistry) foreseen within the AGISGRID (Access and query of a distributed GIS/Database within the GRID infrastructure, http://grida3.crs4.it/enginframe/agisgrid/index.xml) activities of the GRIDA3 (Administrator of sharing resources for data analysis and environmental applications, http://grida3.crs4.it) project. This project, co-funded by the Italian Ministry of research, is based on the use of shared environmental data through GRID technologies and accessible by a WEB interface, aimed at public and private users in the field of environmental management and land use planning.

The technologies used for AGISGRID include:

- the client-server-middleware iRODS™ (Integrated Rule-Oriented Data System) (https://irods.org);

- the EnginFrame system (http://www.nice-italy.com/main/index.php?id=32), the grid portal that supplies a frame to make available, via Intranet/Internet, the developed GRID applications;

- the software GIS GRASS (Geographic Resources Analysis Support System) (http://grass.itc.it);

- the relational database PostgreSQL (http://www.posgresql.org) and the spatial database extension PostGis;

- the open source multiplatform Mapserver (http://mapserver.gis.umn.edu), used to represent the geospatial data through typical WEB GIS functionalities.

Three GRID nodes are directly involved in the applications: the application workflow is implemented at the CRS4 (Pula, Southern Sardinia, Italy), the soil database is managed at the DISTER node (Cagliari, southern Sardinia, Italy), and the geochemical database is managed at the DIGITA node (Cagliari, southern Sardinia, Italy).

The input data are files (raster ASCII format) and database tables. The raster files have been zipped and stored in iRods. The tables are imported into a PostgreSQL database and accessed by the Rule-oriented Database Access (RDA) system available for PostgreSQL in iRODS 1.1. From the EnginFrame portal it is possible to view and use the applications through three services: "Upload Data", "View Data and Metadata", and "Execute Application".

The Land Suitability application, based on the FAO framework for land evaluation, produces suitability maps (at the scale 1:10,000) for 11 different possible alternative uses. The maps, with a ASCII raster format, are downloadable by the user and viewable by Mapserver. This application has been implemented in an area of southern Sardinia (Monastir) and may be useful to direct municipal urban planning towards a rational land use.

The Desertification Risk Assessment application produces, by means of biophysical and socioeconomic key indicators, a final combined map showing critical, fragile, and potential Environmentally Sensitive Areas to desertification. This application has been implemented in an area of south-west Sardinia (Muravera). The final index for the sensitivity is obtained by the geometric mean among four parameters: SQI (Soil Quality Index), CQI (Climate

Quality Index), VQI (Vegetation Quality Index) e MQI (Management Quality Index). The final result (ESAs = (SQI * CQI * VQI * MQI)$^{1/4}$) is a map at the scale 1:50,000, with a ASCII raster format, downloadable by the user and viewable by Mapserver. This type of map may be useful to direct land planning at catchment basin level.

The Georesources and Environmental Geochemistry application, whose test is in progress in the area of Muravera (south-west Sardinia) through stream sediment sampling, aims at producing maps defining, with high precision, areas (hydrographic basins) where the values of a given element exceed the lithological background (i.e. geochemically anomalous). Such a product has a double purpose. First of all, it identifies releasing sources and may be useful for the necessary remediation actions, if they insist on areas historically prone to more or less intense anthropical activities. On the other hand, if these sources are of natural origin, they could also be interpreted as ore mineral occurrences. In the latter case the study of these occurrences could lead to discover economic ore bodies of small-to-medium size (at least in the present target area) and consequently to the revival of a local mining industry.