ENVIRO: A WEBGIS TOOL FOR MANAGING PLANT/PEST/PATHOGEN INTERACTIONS

ENVIRO: UN'APPLICAZIONE WEBGIS PER LA MODELLISTICA DELLE INTERAZIONI PIANTA/PARASSITA/PATOGENO

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Abstract

Software, computers and sensor networks allow nowadays to interact with a huge amount of spatial temporal scientific data, to simulate earth systems processes and to explore potential political responses. Global climate modelling and global climate change simulations are two areas where computers science had an impact and managed to tackle data volume and processing time issues. As a direct consequence the accessibility to climate change models and scenarios for environmental scientists is improving. In the ENVIROCHANGE project we developed the ENVIRO platform, a tool which uses open source software and offers a user-friendly interface to integrate weather-driven Ecosystem Modelling (EM) and study the effects of climate change for Trentino's major agricultural pests.

Keywords: GIS, modelling, phenology, climate.
Parole chiave: GIS, modellistica, fenologia, clima.

Introduction

Global climate modelling and global climate change simulations are two areas where computer science is having a major role, considering the large amount of data and the processing issues. As a direct consequence, the accessibility to climate change models and scenarios for environmental scientists is improving. However, access to all design and computing details which may have effects on results should always be allowed. ENVIRO was developed in the wake of S.M. Easterbrook's idea: environmental scientists and policy makers need new tools to come out of the modelling "black box" paradigm and keep experiments transparent and repeatable. Within the Envirochange project, environmental, agricultural and socio-economical scientists specifically required a platform to implement, validate and reproduce their field experiment using past climate data and future regional climate change projections.

Methods

The platform is designed for two groups of users: scientists, to predict how plant / pathogen systems react to climate change, and policy makers, interested in simulating and mapping the change of agricultural policies for the two main crops of Trentino, grapevine and apple. The platform is modular, with a typical WebGIS client server architecture. It follows the international standards established by the Open Geospatial Consortium (OGC) for geodata transmission and geoprocesses, making it completely interoperable.

The main objective of ENVIRO is to give access to regional and continental time series of climate data from the past and future climate change scenarios, together with phenological models for grapevine and apples and their pathogens and Trentino administrative and statistical geodata. The application server of the platform works with the following OS software packages:
• *The database*: PostgreSQL with its extension for spatial objects PostGIS

• *GeoServer*: a web mapping server to publish and give access to geospatial data with OGC standards
• *52north* and *pyWPS*: web processing services (WPS) for scientific geospatial computing
• *Hypertext Preprocessor* (php): to automate the creation of statistical reports
• *HTML 5*: online graphs can be provided by applications and scripts.
See a graph of ENVIRO architecture in Fig. 1.
Temperature and precipitation maps are computed using the homogenized observations of air temperature and precipitation recorded at 53 weather stations of the local office for weather and climate (Meteotrentino). Based on climate scenario A1B, two temperature and precipitation daily datasets were downscaled for future climate projections 2021/2050 and 2071/2099. In
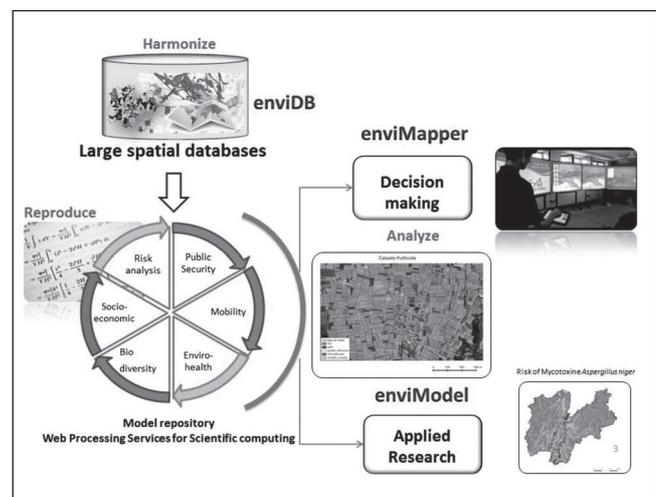

Fig. 1 - ENVIRO's architecture.
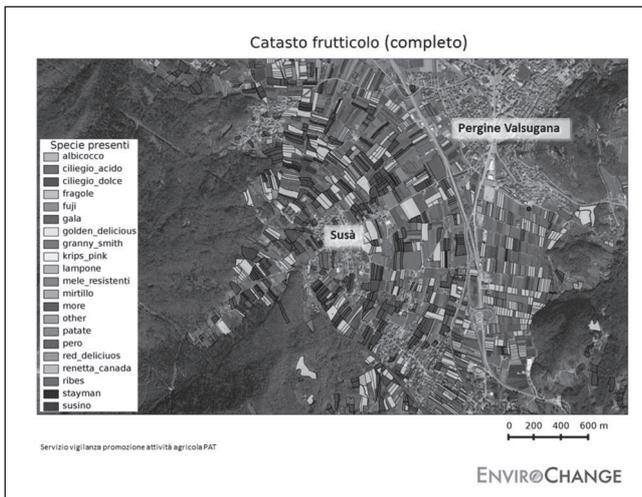Fig. 1 - Architettura di ENVIRO.

Fig. 2 - *A detail of the fruit cadaster map in Valsugana.*
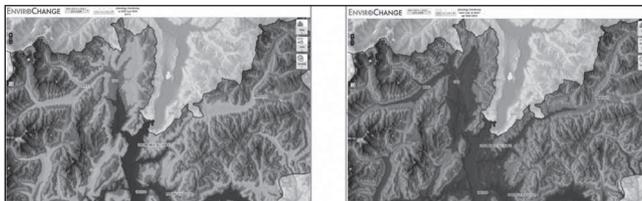Fig. 2 - Dett. della mappa catastale frutticola in Valsugana.

Fig. 3 - *Chardonnay phenology, late August: comparison 1967-2000 and 2071-2099.*
Fig. 3 - Fenologia dello Chardonnay, tardo agosto: confronto tra 1967-2000 e 2071-2099.
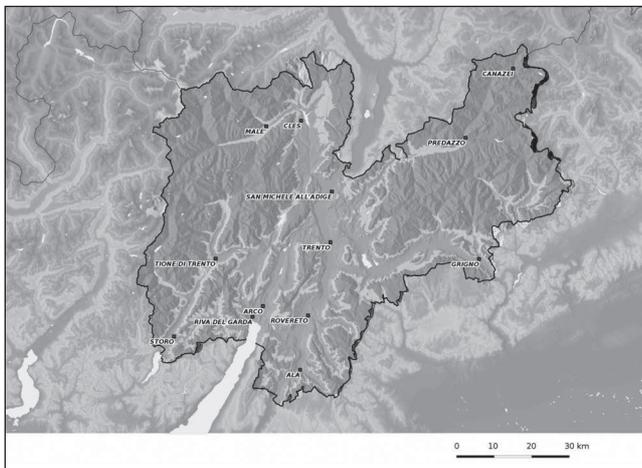

Fig. 4 - *ENVIRO's projected (2071-2099) "thermo-wetness" map for aspergillus modelling, scenario A1B.*
Fig. 4 - Mappe di proiezione (2071-2099) di "termo-umidità" da ENVIRO, per la modellistica dell'aspergillus, scenario A1B.

enviMapper the user can choose a list of 30 future climate projection realizations. Researchers can map plant and pathogen dynamics in real time for the chosen climatic series using the bounding box of the visualized map. The following nine models are implemented and already available in ENVIRO: Huglin bioclimatic index, Chardonnay phenology, Merlot phenology, Apple phenology, *Lobesia botrana,* Powdery Mildew, *Botrytis Cinerea,* Downy Mildew, Mary Blight.

Results and Discussion
The *enviGRID* panel interface facilitates the use of large spatial temporal data like climate change datasets. To navigate and guide the users in the exploration of data, *enviGRID* can use different aggregation scales defined through a grid, each entry defined by resolution in time (daily, monthly, or yearly) and space (raw data, parcels, municipality). With these inputs, the system loads in the WebGIS interface all data, models and variables that match the selected time frame. E.g.: producing a graph of the daily status of phenology for a point in the landscape and for a step in time (past or future time windows); selecting a parcel, and analyzing the timing of its risk peaks on the graph, e.g. compare the number of peaks between two time windows. Within the web mapping interface the user can customize risk maps. Using the base map, *static layers* (cadaster, contour lines of variables, DTM, etc), or *variable button* (weather, climate, environmental models) the user can add one or more geographical layers and create his/her own map composition. The interface provides the *time slider*, a dynamic geospatial data visualizer that maps the time evolution of environmental phenomena.

Conclusions
ENVIRO represents a state-of-the-art WebGIS prototype created to improve availability and accessibility to climate data and climate change scenarios. It also provides an effective web-processing framework for scientific computing, able to map the impact of climate change on agricultural systems at a compatible scale for environmental studies and policy decision. To allow scientists to reproduce their models, test and validate their simulations on different datasets and in different geographic locations, ENVIRO is a first step out of the "black box" modelling paradigm. This prototyping phase was focused on Trentino and its two main crops (apple and grapevine). However, ENVIRO is a scalable tool and could be extended to other regions or to other research contexts and applications as. e.g., hydrology, forestry, ecology, entomology, etc. The final goal would be to make ENVIRO a central repository for spatial data and spatial models that benefit from the availability of climate change scenarios at regional scale.

http://enviro.fbk.eu/
http://www.envirochange.eu/