ENVIMODEL
scientific workflow and geoprocessing for climate change

FBK-MPBA
Predictive Models for Biomedicine and Environment

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Presentation Roadmap

**ENVIRO**
- Concept and architecture

**EnviDB**
- The spatial temporal database

**EnviMapper**
- To map vulnerability to climate change

**EnviModel**
- A framework to integrate and share data, analysis tools and models

**Outlook**
- Results summary and future tasks

**Demo**
- A quick tour (Sept 2010)
ENVIRRO concept

- New-generation WebGIS that interfaces agricultural plant-pathogen research models with rich catalogues of geographical resources and experimental data
- Both viable for research and decision-making, with a strong support of reproducibility
- Structure: hub platform for climate change and environmental risk studies
ENVIRO concept

- Research
- Decision making
- Reproducibility
- Meta information
- Collaboration & interaction

- Cluster
- GPGPU
- Cloud computing

- OGC
- Interoperability
- Accessibility

- Climate change hub
- Regional scale
- Plant and pathogen Experimental data

- Spatial temporal data

WEB
HP computing
Model
ENVIRONMENTAL tools essentials

1. EnviDB
   - OGC WebServices for geodata
   - OGC WebServices for geoprocesses

2. EnviMapper
   - EnviMapper

3. EnviModel
   - EnviModel
1. ST-DataBase

- **EnviDB**
  - Raster maps
  - Vector data
  - Statistical data
  - Interpolation algorithms

2. Application server

- **Apache / Tomcat**
- **Geoserver**
  - WMS
  - WCS
  - WFS-T
  - pyWPS
  - 52n WPS

3. User Interface

- **GeoExt**
- **ExtJS**
- **OpenLayer**
- **Nasa World Wind**

**EnviModel**

- **Charts**
  - Moograph
- **Model Workflow**
  - Webworkflow interface
- **Data**
  - Sample data
- **Info**
  - Meta Information

**EnviMapper**

- **PNG / JPG**
- **XML / URL**
- **GeoTIFF**
- **XML (GML)**

**Risk models**

**Orchestration Engine**

- **Prudence WORLDCLIM**
- **Real time observation**

**Risk models**

- **Input**
  - CC scenarios
  - SOS

**Workflow**

- pyWPS
- 52n WPS
- Orchestration Engine

**EnviModel**

- **Data**
  - Sample data
- **Info**
  - Meta Information
1. EnviDB

More than 1.5 TB spatial temporal data
- Meteotrentino 600 GB, future climate projections 300 GB

- Context map
  - Aerial photo, hillshade, Open Street Map (OSM)

- Static spatial data
  - Cadastral vineyards, municipalities, places names

- Variable spatial data
  - Climate data, plants and pathogens models
Data (year 2)

Agricultural data

– Cadastral vineyards: “potenziale viticolo”

**Catasto**
1,621,280 parcels

**Potenziale viticolo**

**Catasto Viticolo**
46,781 parcels
- Number of tree stumps
- Irrigation
- Cultivation form
- Plan spacing
- Variety
- ...........

![Catasto viticolo map](image)
Climate data

- Continuous surface for T, P (daily and hourly) 2001-2008
- Prudence
  - 12km spatial resolution
  - Daily t min, t max, prec
  - control 1980-1990
  - Scenarios: 2071-2100

(Prudence project 2010, http://prudence.dmi.dk/)
2. enviMapper

Map vulnerability to climate change at different aggregation scales (time, space)

- **Map**: set of tools to interact with spatial temporal data
- **Time slider**: spatial data in multi temporal scale
enviMapper (mockup 2010)
Map

- **Base Map**
  - Add a context map
    - Aerial photo, hillshade, Open Street Map OSM, etc.

- **Add Data**
  - Add a static layer
    - Wine cadastral, pathogens sampling points, etc.

- **Add Variables**
  - Add a variable in time
    - Climate, plant, pathogen, bio index etc.

- **Info panel**
  - To inform user on layer properties
    - Layer list, legend, layer metadata

- **Save map**
  - Save a map to load again or to share

- **Export map**
  - Export a map different formats
Time Slider

Tool to animate maps in time

- Hourly, daily, weekly, monthly, yearly
3.enviModel

- **Framework** to integrate and share data, analysis tools and models for plant and pathogen behavior and their interaction
  - Collaboration, interaction, reproducibility, Web application
- **Scientific workflows**
- **Metadata**
EnviModel

Bounding box
Projection
Resolution

Data

Geoprocesses

Vitis Vinifera
• Phenology
  • Chardonnay
  • Pinot Noir

Malus communis
• Phenology

General tools
• Save result
• Overlay

Precipitation Series
Temperature Series

Vitis Vinifera Phenology
Input:
Output:
Related

Scientific Paper
Sample data

Save
Export
Execute
Cancel
Main features

- **Web Geoprocessing engine**
  - WPS technology
- **Web interface for scientific workflows**
  - Galaxy tested as an ENVIRO component
  - JSPlumb + ExtJS
- **Orchestration engine**
  - Galaxy
  - Kepler and Hydrant actual testing phase (Pratt, 2010)
- **Tools for metadata**
From Model to WPS & Workflows

Model written in R

Translated into modules using GeoTools (Java GIS toolkit)

Modules represented from workflow tool

Orchestration Engine

Blocks are chained together and processed

Data

WXS
WPS

March 2010 ENVIROCHANGE Workshop

“WPS and scientific computing for climate change: informal day”

52north, pyWPS, Zoo Project and applications

• 52north implemented for testing using Geotools
  – GeoTIFF via WCS (Web Coverage Service)
  – Output loaded in Geoserver via REST plugin
  – Models implemented

1. Lobesia Grape
2. Powdery Mildew Grape
3. Phenology Chardonnay
4. Botrytis Cinerea Grape
5. Huglin Index
6. Downy Mildew Index in development
7. Mary Blight in development
• Web scientific workflow editor for Bioinformatics
  – Written mainly in Python
• Model interactions
  – Create, Edit, Execute, Share, Model metadata
Extending Galaxy for WPS

**Pro**

- Web workflow interface
- Easy to access and use
- Easy to implement new tools using different programming languages

**Cons**

- Monolithic, hard to integrate
- No API
- Built to use locally stored data
JS Plumb

- Web workflow editor provides a means to visually connect element using a Canvas element
  - jQuery or MooTools
  - Possible to integrate with ExtJS in the ENVIRO interface
  - OS extend the code and tailor it for ENVIRO
Orchestration engine

- Chaining processes: Orchestration engine interprets events submitted to a server and acts on them according to defined computer processes
  - Galaxy (Python)
  - Kepler (Java)

- Both hard to extend
- 52north bpel service (FOSS4G 2010)
Kepler for Envirochange

Used as orchestration engine (Pratt, 2010)

- Extended to execute requests to WPS
- Created new Java classes that execute WPS request and parses xml outputs
- Servlet to interface with the workflow editor based on JSPlumb
Extending Kepler for WPS

**Pro**
- Easy to deploy new actors using Java programming language
- Lots of actors already deployed

**Cons**
- Not a web application
- Kepler Workflow actors quite complex
Conclusions

• WPS are the right technology to implement heavy scientific computing on geodata in a multidisciplinary project
• Galaxy represent the state of the art of web scientific workflow interface
• Geoinformation needs a web workflow interface easy to integrate
  – Rich API set
  – Interface to easy interaction with OGC services
  – Orchestration engine that allows the workflow output to be translated into WPS
The end