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Final NNR Garp3 Modelling and Simulation Workbench Release

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(University of Amsterdam,September 2007)

The university of Amsterdam has released a new version of the free Garp3 workbench for qualitative modelling and simulation in the final month of the project. This will be the final release of Garp3 in the context of the NaturNet-Redime project. The usability and functionality of Garp3 has come a long way since the start of the project. Initially, three separate applications were needed to build qualitative models (Homer), to simulate them (Garp), and to visualise their results (VisiGarp). These programs differed in terms of interfaces, and look and feel. Within the NaturNet-Redime project, these tools have been integrated into a unified workbench for model building, simulation and simulation visualisation [1]. Furthermore, new functionality has been added to open multiple models, reuse parts of models (using copy/paste), share, search for, and download models via the web (using the Web Ontology Language import/export functionality and a qualitative model repository) [2]. Another major change was the inclusion of the new Sketch environment that allows modellers to formalise their initial ideas about system's behaviour and refine these ideas into a representation that is close to the actual qualitative model representation [2].

During the last half-year the software development focussed on making the Garp3 workbench accessible to an even greater audience [3]. The first significant addition is multiple language support (see Figure 1). In the latest version of Garp3, modellers can translate their models into any of the ISO 639-2 languages. This makes it possible for modellers and stakeholders to develop and interact with models in their own native language. If desired, the terms used in the model can be stored in all the available languages. As a side effect of adding the multiple language support the existing copy/paste functionality and the OWL import and export functionality had to be improved to also deal with model translations.

Garp3 has had tooltip support from its initial release. However, in the latest version of the software this functionality was significantly improved. In the simulation results, remarks made by modellers on model ingredients are all gathered and shown in tooltips. This was a non-trivial task, since the simulation engine uses a pure Prolog program code representation compared to the object-oriented model building environment. The end result is that tooltips in the simulation results now integrate remarks originating from model ingredient definitions, ingredients in scenarios, and ingredients in multiple model fragments, and specify where they came from. As a result modellers can now store their considerations for creating an ingredient, whenever they create a model ingredient. When working with a model these considerations are shown as tooltip when hovering the ingredient icons with the mouse. This makes the simulation results more understandable to stakeholders.

To support modellers who are not yet fully proficient with the use of Garp3, a contextual online help system was developed. This system allows users to directly access the documentation that is relevant to their current task. Part of this system is a set of 351 web-pages on the Qualitative Reasoning and Modelling Portal (http://www.garp3.org) that replaces the two old user manuals [4,5]. These new web-pages are not just plain copies of the parts of the user manual, but a complete reworking in a more informative and understandable format. Each of these pages describes the current window, the tasks that can be performed, and the available short-cuts. Furthermore, each page links to pages describing the menu options, additional features, related tasks, used icons, and used definitions (in a glossary). Finally, each page links to a page describing each of the icons used in the window. To access these help pages, each window in the Garp3 workbench now has an owl help-icon in the upper-right corner. Clicking on this icon opens the documentation webpage describing that particular window, removing the need to browse through thick user manuals.

To support modellers in improving their simulation results a tracer was added (see Figure 2). This tracer shows the inferences made by the engine during the simulation of a model. This functionality aims to explain why a model exhibits certain behaviour to the modeller in an understandable way. The goal is to make it easier for modellers to change their model to generate the expected behaviour. By default, the tracer shows a general overview of the reasoning done by the simulation engine. This view is meant to detect main issues and problems (if present) in the reasoning. The interface makes it possible to manipulate the tracer to show the specific type of reasoning in which such an issue occurs. This information helps the modeller adapt the model to resolve undesired issues.

In order to detect potential faults in models, a proof of concept of a trouble-shooter was added to Garp3. The trouble-shooter is the first step towards an automated debugging facility in Garp3, and is integrated with the model-building environment of Garp3. This trouble-shooter detects possible faults in models based on a set of diagnostic rules, and determines the probability that this fault may actually occur during simulation. Selecting one of the possible issues explains what the issue is, and directs the modeller to a Frequently Asked Questions entry on the QRM Portal that explains the issue and how it can be fixed. The goal of the trouble-shooter is to detect the most frequently occurring problems modellers face without having to use the tracer, and to suggest changes to the model that may resolve these issues. Notice that, during this last half year of the NaturNet-Redime project a significant number of new frequently asked questions entries were added to the FAQ page help modellers resolve their modelling issues [6].

Finally, there were improvements to the Sketch environment, significant improvements to the reasoning engine as such, the simulation preferences and the multiple model support [6]. In the simulation environment a new visualisation of the state graph was added: the table view (see Figure 3). This visualisation makes it easier to deal with simulations that generate a lot of states. The latest version of Garp3 is available on http://www.garp3.org.

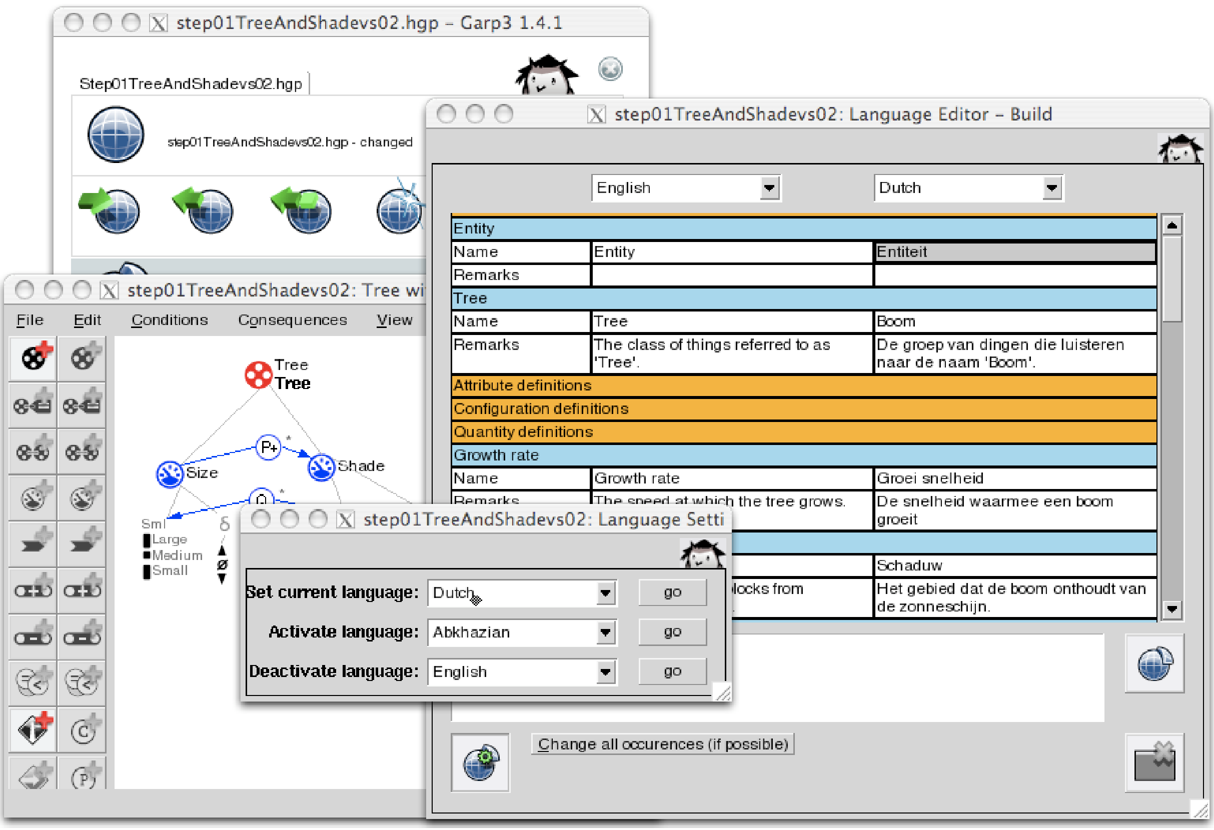

Figure 1: The multiple language support allows the translation of model ingredients into different languages.

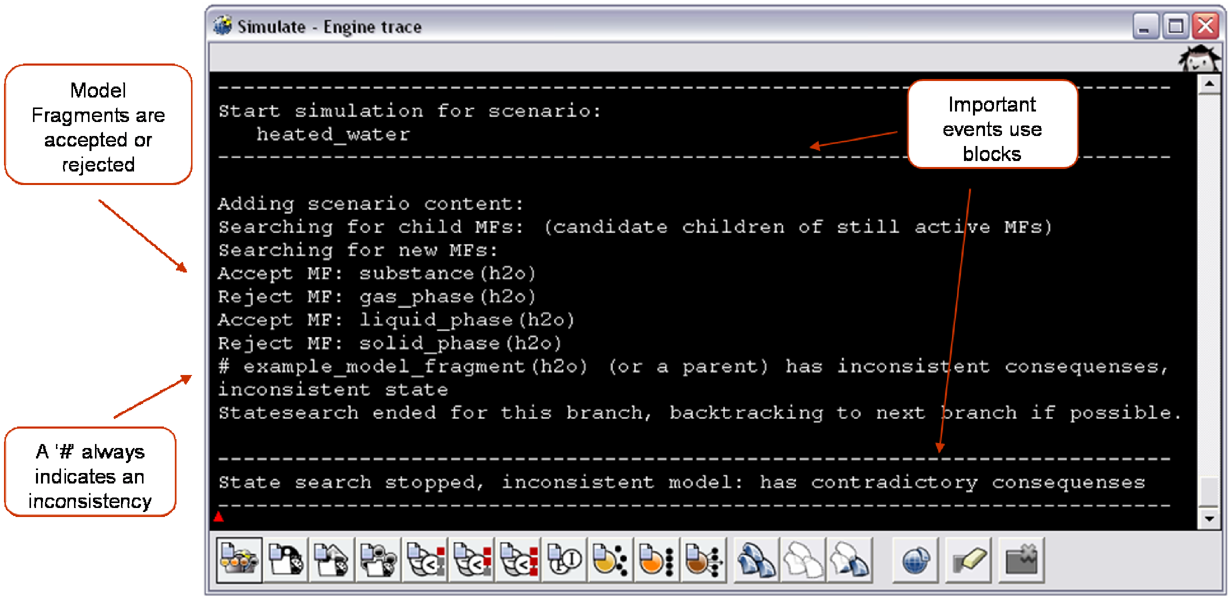

Figure 2: The Tracer shows a general overview of the reasoning during the simulation.

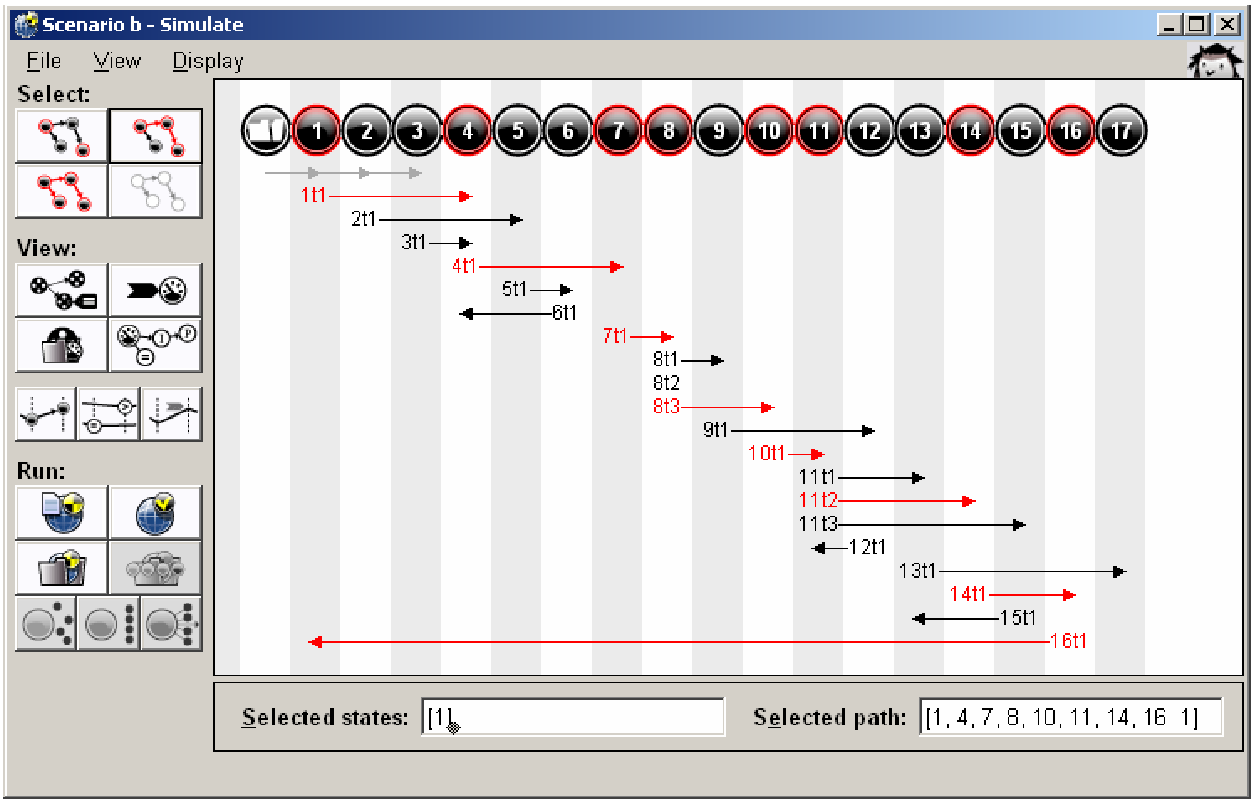

Figure 3: The Table view in the simulation environment makes it easier to analyse large simulations.

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Integrating Case Studies in a Large Qualitative Model on Sustainability

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As the NaturNet-Redime project reaches the end and its five case studies are finished, an important task is being completed: the creation of a library of model fragments exploring relevant concepts about sustainability, selected among qualitative models produced in the case studies, complemented with interesting additional models. This article summarizes the work done for building the library and show how this task will benefit stakeholders willing to have a better understanding of sustainability.

The models produced in the project were designed to represent sustainability in water basins that had been changed by human actions and are now being someway and somewhat recovered. Two case studies, the Danube Delta Biosphere Reserve (Romania) and River Mesta (Bulgaria), addressed basins that were modified in the past but now are areas under protection. Accordingly, the topics addressed in the models produced explore natural aspects of these ecosystems. The Riacho Fundo basin (Brazil) was designed to show the transformation of a natural ecosystem into rural and then to urbanized areas. The last two case studies, River Kamp (Austria) and River Trent and River Great Ouse (England) explore sustainability issues in water basins that have been transformed in many aspects and are now under human management.

The problem addressed by the NaturNet-Redime team is how to organize a large library of model fragments based on the case study models. Such models address specific problems and it is necessary to organize the simulations in a way that stakeholders could access to multiple, alternative models that differ along a variety of dimensions. The final numbers are quite impressive: 112 entities involving 201 quantities, organized in 414 model fragments integrated into a unique qualitative model, from which it is possible to run 202 different simulations.

Literature on Qualitative Reasoning report the use of *perspectives*, implemented by means of *modelling assumptions* as a possible solution for this type of problem. Perspectives provide different views of the same knowledge domain encoded in the library (in our case, sustainable development). When the user assumes a certain perspective (s)he provides the context for exploring different parts of the library, selecting knowledge to be included in models and running of simulations. Implementing the perspectives in a large library can be done by using modelling assumptions. Assumptions restrict the selection of model fragments and keep the simulations within clearly defined limits. If the assumptions are made clear, the user can create a context to assess the simulation models provided by the library. For example, the user can assume that certain quantities are stable and parts of the system are in equilibrium for building a particular model and running certain simulations within the library.

The Riacho Fundo case study was a testbed for combining different models and implementing a common library of model fragments (Salles et al., 2007). For this case study, three basic perspectives were defined: *Rural*, *Semi-urban* and *Urban*. The *Rural* perspective focus on human activities aiming at exploring natural resources for agricultural purposes. The *Semi-urban* perspective explores the changes in land use that transform natural and agricultural areas into urban areas. The *Urban* perspective addresses the city and its physical infrastructure, its dependence on resources coming from outside and its own metabolism. These perspectives combine economic and social aspects is related to economy, governance, culture and human well being. These three perspectives are not the only possibilities. In fact, it is possible to have elements from all of them combined in a single simulation model, and to create new perspectives when representing specific situations.

The table below presents the main concepts addressed, organized in three perspectives, in the Riacho Fundo case study models:

	Perspectives		
Land use	*Urban*	*Semi-urban*	*Rural*
Main problems	Drainage system; flooded areas; transported garbage and damage caused by floods	Urbanization; water infiltration; and soil erosion	Erosion; loss of water resources and biodiversity
Economic features	Services: garages	Industry: textile and food industries	Agriculture: cattle; crops
Soil	Impermeable soil	Soil particle aggregation	Soil fertility
Water resources	Effects of uncontrolled flow of water run off and of the drainage system	Effects of erosion and underground water on springs and rivers	Effects of erosion and underground water on springs and streams
Biological entities	Mosquitos, Pathogens	Vegetation	Vegetation; Vertebrates; Capybara
Human	Economic activities; Human well-being: garbage and water related diseases	Economic activities	Economic activities
Agents	Rainfall	Urbanization	--
Sustainability	Control of diseases; Control of residues	Water quality; Control of residues	Soil fertilization; Reuse of residues

Table 1. Overview of the main concepts addressed by the Riacho Fundo model.

Integrating the other models

The urban, semi-urban and urban Riacho Fundo case study models were combined with other models and the Library eventually included model fragments with topics related to

(a) food web, nutrient cycling, heavy metal pollution and human health in the Danube River Delta (Romania);

(b) the effects of pollution, erosion and physical factors (aeration and diffusion) and biological factors (photosynthesis and respiration) on dissolved oxygen concentration in waters of the River Mesta (Bulgaria);

(c) Stakeholder participation, along with scientists, planners and groups of interest in the ellaboration of sustainability plans. The effects of these plans and of sustainable actions on ecological integrity and human well being in River Kamp (Austria);

(d) Water abstraction from a river in order to generate energy, that was commercialized in River Kamp basin (Austria);

(e) the effects of different environmental factors on salmon life cycle and the rehabilitation of fishery in River Trent and River Great Ouse (England);

(f) the consequences of deforestation on biodiversity, new food and medicine production, erosion, uses of water, agricultural production and the GDP;

(g) the effects of petroleum market oscillations on energy availability for industries, transportation and human uses; the use of solid fuels as an alternative for petroleum gas in domestic activities; as consequences, the model explores different types of respiratory diseases and of global warming as consequences of petroleum consumption.

Of course, the three perspectives used in the Riacho Fundo were not enough to capture all the possibilities in the library. We decided to classify two groups of perspectives: (a) case study-based perspectives; and (b) thematic perspectives. The former group included seven perspectives that better described the case study as they were presented; the 14 thematic perspectives explore combinations of simulations that address similar or related concepts in different case study models.

The final result can be summarized in the following table:

Types of perspective	Perspectives
Case study-based	Natural ; Rural ; Semi-urban ; Urban ; Natural resources exploitation ; Natural environment rehabilitation ; Social
Thematic based	(I) Natural systems; (II) Natural disasters; (III) Human explores natural resources; (IV) Environmental effects of human activities (in interaction with natural factors); (V) Energy; (VI) Economy; (VII) Education and trainning; (VIII) Science and Technology; (IX) Legislation; (X) Stakeholder participation; (XI) Governmental plans and activities; (XII) Management actions for sustainability; (XIII) Human health; (XIV) Human well being

The interested reader can find details of these 21 perspectives and the simulations included in each group in the Deliverable D6.7.1 (Salles and Bredeweg, 2007), available in the NaturNet – Redime portal (www.naturnet.org).

Technically speaking, perspectives can be implemented by using explicitly represented assumptions and other modeling primitives, including hierarchies of entities and model fragments, attributes, alternative quantity spaces for key quantities and alternative representations of key concepts. The consequences of adopting a given perspective in a simulation are determined automatically by the reasoning engine based on the encapsulated knowledge relevant to the perspective (Bredeweg et al. 2006).

Conceptually, modelling assumptions fall into two categories: simplifying and operating assumptions. Simplifying assumptions are used to make explicit how knowledge details such as the underlying perspective, approximations, and level of granularity are represented in the model fragments. Simplifying assumptions are classified as (a) ontological assumptions, to provide the vocabulary used in the model, explicating what kinds of things exist and what sort of relationships between them can be held; (b) grain assumptions, to define the level of details represented in the model, perhaps aggregating some features and ignoring others; (c) approximation assumptions, to make models that are easy to use, sometimes at the cost of accuracy; and, often intertwined with approximation assumptions, (d) abstraction assumptions, used to reduce the complexity of the modelling language, usually reducing information available and increasing ambiguity.

Operating assumptions are used to manage complexity. In a way, they give focus to the simulation, by implementing constraints so that the model describes the behaviour relevant for answering specific questions.

Three types of operating assumptions are considered here: (a) *local restrictions*: restrictions on quantity values implemented by means of inequalities between quantities and constants (e.g. number_of >0); (b) *operation mode*: a 'general assumption' that controls a collection of local restrictions; and (c) *steady-state assumptions*: determine that all derivatives for some class of parameters have value zero. Ultimately, operating assumptions increase the efficiency of the simulation by ruling out entire classes of behaviour (e.g. immigration and emigration in population dynamics), and by indicating the range of parameter values for which such approximations are valid (for example, birth rate can only exist when number_of >0).

Simulations generated from the library are expected to be easy to understand and to manage, as they represent complex phenomena with different levels of granularity, either exposing or hiding details in different contexts and using adequate vocabulary (for example, about erosion). Alternative views of certain aspects (for example, soil fertility and resource inflow for agriculture) should allow for better understanding of how different factors influence human actions in the basin. Finally, the use of operating assumptions implemented as correspondences and exogenous variables keep the size of the simulations within manageable limits.

Garp3 (Bredeweg *et al*., 2006) is an interesting tool for implementing compositional models, as it provides a unique modelling language for expressing both model components and assumptions constraining their use. Some of Garp3 modelling primitives, such as entities and configurations, attributes and agents are particularly useful for implementing perspectives. Model fragments, inequality relations, correspondences and exogenous quantities are particularly suited for implementing both simplifying and operating assumptions.

Finally, we expect that soon the results of the qualitative modelling effort of NaturNet – Redime will be available not only for European and Brazilian stakeholders, but for users all over the world, in the web sites http://hcs.science.uva.nl/QRM and www.naturnet.org. We hope you will enjoy it!

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Evaluation of the Riacho Fundo Qualitative Model

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The Riacho Fundo qualitative model, a product of the Brazilian case study run by the University of Brasilia in Naturnet project, was evaluated by stakeholders. The Riacho Fundo basin is located near Brasilia, the new capital, and changes in land use are held responsible for major changes in the area, including deforestation, erosion, loss of biodiversity and water resources, and decrease in economic productivity. Urbanization is also a problem, as urban infra-structure, such as the engineered drainage system, is lacking. The model includes three sets of simulations, each providing a perspective to the sustainability regarding the basin, namely the Urban, Semi-urban and Rural perspectives. Each of these viewpoints, created to represent problems identified by stakeholders in the region, explore different but complementary aspects. Urban areas deal with the lack of drainage system and, as consequence, with flooding, mosquitoes, transported garbage, pathogens and other aspects that affect the human well being. Semi-urban areas show the effects of urbanization on soil particles aggregation and consequences of erosion and reduction of water infiltration. The simulations explore how these factors may hamper industrial production and water production from springs and streams. Rural areas are represented in the model as areas that are being deforestated and, as a consequence, problems of soil and nutrient loss, deposit of sediments on water bodies, reduction on agricultural production and loss of biodiversity arise.

Three groups took part in the evaluation events: (a) experts from the Brasilia Water and Sewage Company (CAESB); (b) water resources managers; and (c) secondary school teachers. Nine events of dissemination and evaluation activities were held between July and October 2007, involving in total almost 100 representatives of these groups. Three types of questionnaires were prepared, exploring different aspects of the Riacho Fundo model. The experts were concerned with the conceptual validation of the model on scientific grounds, inspecting the clarity and correctness of concepts expressed by the entities and configurations (the representation of the system structure), the quantities and the simulations. The teachers assessed the concepts represented in model from the educational view point. During the operational validation different aspects of the model were assessed. Both the managers and the teachers evaluated the use of the model in their dedicated activities. Special attention was given to the evaluation of the causal model, and to the use of qualitative models to support the development of cognitive competences and abilities.

The results were very positive. The experts agreed that the concepts could be justified by scientific knowledge or educated commonsense. The managers considered the modeling language easy and accessible to different potential water managers. They also mentioned that the causal models are conceptually correct and clear, and could be useful to support the generation of explanations and predictions about the system behaviour. The teachers considered the models very useful for educational purposes and accessible for secondary school students. They also assessed the generation of explanations and predictions about system behaviour based on causal models alone or in combination with qualitative values of relevant variables. The teachers also recognized the potential of qualitative models for supporting the development of cognitive competences and abilities . Finally, the three types of stakeholders were very positive about the potential use of qualitative models in general and in the Riacho Fundo model in particular, for representing problems and maybe suggesting solutions for real world problems in their activities.

We conclude that the Riacho Fundo model was positively evaluated, that it can be used in different ways and that it has the potential to support learning about sustainability in the basin and in decision making about how to use natural resources in a sustainable way.

Acknowledgements: The authors thank the teachers, experts and managers who participate of the evaluation activities. We are also grateful to the Centro Educacional 6, the Centro Educacional Ave Branca, the Brasilia Water and Sewage Company (CAESB) and the University of Brasilia for their support to the activities of the NaturNet-Redime project.

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Evaluation of QR Models Related to a Sustainable Catchment Management

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Summary

The qualitative simulation models related to the sustainable development of the Kamp valley explore the following aspects (Zitek, 2006; Zitek et al., 2006):

(A) Development and implementation of sustainable actions in a river catchment (stakeholder integration, quality of sustainability plans, development of ecological integrity and human well being, probability of catastrophic events).

(B) Hydropower production (water storage and release, water abstraction) and its effect on fish.

As a part of the training and evaluation activities described in Deliverable 7.2 (Bredeweg et al., 2007) their reliability and potential for usage in education and decision-making was evaluated by experts and students.

Evaluation goals

The evaluation of models is an important step in the model building process. Generally a model evaluation basically covers **"validation and verification"** of the model as well as the **"acceptance of the chosen approach and model"** by the addressed stakeholder groups. **Validation** proves if the scientific and conceptual contents of the model are acceptable for its intended use, **verification** proves that the model is correctly implemented by a demonstration of its use. **Proving the acceptance** of stakeholders typically evaluates the potential of the model and the modelling approach for broader use.

Evaluation methods

To evaluate both models developed by the BOKU (Model A: "Sustainability Management" and Model B: "Water abstraction and Fish") a two phase approach was chosen. **A general evaluation of Model A mainly focusing on the "acceptance of the chosen approach and model"** by students and scientists of different domains and **an expert evaluation of both models focusing on "validation and verification"** of the models were conducted separately. The participants were asked to fill out questionnaires after the presentation, and the collective (interactive) inspection of important scenarios and model fragments with the GARP3 software.

The general evaluation, based on a power point presentation and a collective exploration of parts of the model using GARP3 on personal Lap tops, was done at the 17.10.07 from 16:15 to 18:15. Eleven persons, divided into students and experts of different aquatic resource domains, participated in the event.

The expert evaluation of Model A and B took place at the 30.10.07 between 8:30 and 12:30 each lasting about 2 hours and were run as face to face discussions based on the printed causal maps and a conjoint exploration of important model fragments and simulations using GARP3 using a laptop.

Results and discussion

Both evaluations, the general evaluation of Model A "Sustainability Management" and the expert evaluations of Model A & B "Water abstraction and Fish" yielded a very positive feedback with regard to the QR approach, the GARP3 software used to build models and the models themselves representing important issues related to the sustainable development of the riverine landscape Kamp. For example, using a 5-point scale (fully disagree, largely disagree, somewhat agree/disagree, largely agree, fully agree) **most people "largely or fully agreed" that QR models represent complex knowledge in an understandable manner and that QR and GARP3 can be seen as a valuable learning tool for understanding real world causal relationships related to a sustainable development of riverine landscapes.** Also most people "largely or fully agreed" that the presented QR models might significantly contribute to the understanding of students and stakeholders which entities and processes drive a sustainable development of a riverine landscape and therefore enhances their capability of making decisions.

So the general aim, to produce software and models in QR language that allow people to interact with and learn about sustainable development is clearly supported by the evaluation results.

Generally experts were a bit more conservative in agreeing with the approach than students. That could be because A) that experts are more familiar with the problems of model building and therefore do not agree full with many aspects (they only agree "largely") or B) that students can be more influenced by the opinion of the presenter being ‘on fire’ with QR modelling. On the other hand few students gave sometimes answers like “I fully disagree or largely disagree”, which did not occur that often with the persons considering themselves experts. This means in our opinion, that these students probably have not yet understood the potential of the approach or they simply made a mistake when answering the questions (maybe they misinterpreted the rating scheme).

Parts of the Model A, that were most interesting for the evaluators were:

- To see the causal interrelatedness of the involved entities of the Kamp management system and especially that private interest might negatively influence the sustainability process and that the combined influence of planners, science and local population (stakeholders) defines the quality of sustainability plans and the whole sustainability process. This understanding opens the possibility of different potential intervention options to reach the goal of a sustainable development.
- To see that ecological integrity and human well being are represented in the sustainability model.
- Specific scenarios showing the catastrophic event as trigger for government action for sustainable development.
- The idea that money spent for measures can only be treated as money spent for a community driven development, if the community is involved in the process of developing and implementing measures (otherwise the money spent is not a community driven investment!).

Parts of the Model A, that should be enhanced in the eyes of the evaluators were:

- Private interests should be better represented, as a basis to minimize them and achieve sustainable development
- The government action for sustainable development should be better described, as in reality this is of high complexity, being also driven by the general political structure, difficulties between different organization units with regard to their competences (personal behaviour!) and differences in financial resources; additionally very often policies with complementary aims are existing, as policies often lack behind the social development. That means, a more detailed study and representation of the internal political structures, determining the implementation process, is needed.

Parts of the Model B that were most interesting for the evaluators were:

- That it is easy to change the content of a scenario by using and exchanging different assumptions that simply allows modelling the effects of the same human pressure on different guilds of fish (positive and negative effects of flow velocity and water temperature on different guilds).

Parts of the Model B that should be enhanced in the eyes of the evaluators were:

- A more realistic representation of the natural variability of the river discharge (probably by using the random function in the scenario editor) and the amount of abstracted water related to mean annual flow as this defines the frequency of water overflow events at weirs that are suspected to have a significant effect on fish.
- A more realistic representation of the influence of the length of the water abstraction stretch on the temperature development within the river (at the moment the river stretch is treated as a "container" with the same abiotic factors everywhere) and
- an integration of the effect of morphology on fish and on water temperature.

Important additional statements related to the QR approach, the software and the models were also collected. Most interesting for the attendees was to see the interrelatedness of the system presented and the use of qualitative “stock-flow” dynamics known from the System Dynamics approach. Only some added that they sometimes got a bit lost when confronted with the total view of the causal model describing a sustainable development of the Kamp valley. It was also stated that when showing these models to other user groups, their general ability to deal with complexity should be accounted for; meaning that for each user group the way of presenting the model should be adopted. Probably sometimes these models might be too complicated for certain stakeholder groups (people need to have some education e.g. to deal with complexity and causal relationships – to understand I's and P's for example, in a modelling approach like this). A high potential of an application of QR models in various fields, mainly in education but also in decision making and research was suggested by many participants. The potential of the GARP3 software and the QR approach to sustain collective, interactive social learning was clearly pointed out. Particularly, the identification of dependencies and causal relationships was seen as a prerequisite for understanding a system and therefore also for learning and decision making. With regard to a broader use of QR models in society especially for decision making it was stated, that it might take some time and engagement to establish approaches like that in society. (University) education using and teaching such approaches can be seen as an important basis for a further application.

With regard to the presented simulation scenarios some further interesting statements were collected. For example, that some behaviors of simulations might not be true in real world systems (e.g. that they stay within an interval for a certain time steps before they change; this should be avoided, when not explicitly defined as model target).

That means on the one hand that the simulation behaviors of final models to be presented should be restricted as much as needed to avoid outcomes that are not intended (although one also might also significantly learn from unwanted outcomes of a simulation) and on the other hand that there are still QR domain specific ingredients, semantics and behaviors (e.g. the quantity spaces as points and intervals), that might conflict with the intuitive way of stakeholders to express things. Therefore, it is suggested, that the end user should A) only be confronted with simulations & scenarios that exactly show the intended behaviour and B) be as less as possible confronted with QR domain specific features not to irritate an intuitive modelling building practice by domain specific restrictions.

Finally, there were also some suggestions specific to the development of the GARP3 software:

- With regard to the software packages available for building QR models prior to the project, GARP3 can now be used very intuitively to build QR models representing a prerequisite for the target, to motivate stakeholders and students to use the software and put their conceptual knowledge in causal models.
- To further enhance the modelling process itself it could be helpful to always see the consequences of the modelling actions and newly implemented model fragments (configurations, proportionalities and influences) on the fly.
- It also could be helpful to have the full model shown in a window like the "show entities & configurations" window with the opportunity to select parts of the model by hand to be run in a simulation (running only parts of the model by simply selecting parts of the model by drawing a window).
- To link the outcomes of causal models to a GIS (Geographic Information System) would open a whole new field of promising applications.

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Uniform Resource Management as Tool for Content Awareness of Information and Knowledge Inside Communities

Karel Charvat, Stepan Kafka, Marek Splichal

Uniform Resource Management (URM) provides a framework in which communities can share information and knowledge trough their description, which is easy understandable inside of community. In order to share information and knowledge, there has to be scheme, which will support uniform description of information and knowledge including common scheme and vocabularies. A schema defines the meaning, characteristics, and relationships of a set of properties, and this may include constraints on potential values and the inheritance of properties from other schemas. The schema specification language is a declarative representation language influenced by ideas from knowledge representation (e.g. semantic nets, frames, predicate logic) as well as database schema specification languages and graph data models.

Objectives

The main objective of URM will be easy description, discovery and validation of relevant information sources. URM will ensure that any user can easily discover, evaluate and use relevant information. The free text engine (eg. Google) can't be used due to the fact in many cases user obtains thousands of irrelevant links. This happens because the free text engines don't fully recognise the context of researched information. The context characterise any information, knowledge and observation. Context strongly influences the way how the information will be used. There are existing different definitions of context. The important issues for the context are:

- to identity of an entity;
- to profile of an entity;
- spatial information
- temporal information
- environmental information
- social relation
- resources that are nearby
- availability of resources;

Many context attributes characterize the environmental information or knowledge. From the point of view of context, the information or knowledge could be divided into different parties:

- Information or knowledge provider i.e. a party supplying the resource;
- Custodian, accepts accountability and responsibility for the resources and ensures appropriate care and maintenance of the resource;
- Owner of the resource;
- User, who uses the resource;
- Distributor who distributes the resource;
- Originator who created the resource;
- Point of Contact to be contacted for acquiring knowledge about or acquisition of the resource;
- Principal investigator responsible for gathering information and conducting research;
- Processor who has processed the data in a manner such that the resource has been modified;
- Publisher, i.e. party who published the resource;
- Author, i.e. party who authored the resource.

Any information could be characterised by identification of information which uniquely identify the resource such as:

- Title, abstract, reference dates, version, purpose, responsible parties
- Data extent,
- Browse graphics (overview, thumbnail, etc.),
- Possible usage;
- Legal and security constraints;

- Content Description, i.e. information identifying the feature catalogue(s) used and/or information about the coverage content;
- Spatial Representation, i.e. information concerning the mechanisms used to represent spatially the resource data;
- Quality and validity information, i.e. a general assessment of the quality of the resource data including:
- Quality measures related to the geometric, temporal and semantic accuracy, the completeness or the logical consistency of the data;
- Lineage information including the description of the sources and processes applied to the sources;
- Validity information

Methodology

The possibility, how to solve the problem with context is to use metadata for standardised description of any information, knowledge, data sources, sensors, etc. In the combination with standardised lists of terms (controlled vocabularies or thesaurus, standardised way of geometric location, gazetteers and controlled list of categories), it will increase efficiency of discovery of requested knowledge, information or data sources.

Metadata is descriptive information about an object or a resource whether it is physical or electronic. While metadata itself is relatively new, the underlying concepts behind metadata have been used for as long as collections of information have been organized. Library card catalogues represent a well-established type of metadata that has served as collection management and resource discovery tools for decades. Metadata can be generated either "by hand" or derived automatically using software. Metadata, then, can be thought of as data about other data. It is the Internet-age term for information that librarians traditionally have put into catalogues, and it most commonly refers to descriptive information about Web resources. A metadata record consists of a set of attributes, or elements, necessary to describe the resource in question. Although the concept of metadata predates the Internet and the Web, worldwide interest in metadata standards and practices has exploded with the increase in electronic publishing and digital content, but now also in relation with information resources like sensors, and the concomitant "information overload" resulting from vast quantities of undifferentiated digital data available online. The need to overcome problem of overloading of data has to be solved on the base standardized descriptive metadata with networked objects has the potential for substantially improving resource discovery capabilities by enabling field-based searches, permitting indexing of non-textual objects, and allowing access to the surrogate content that is distinct from access to the content of the resource itself."

Technology Description

The basic components, of URM could be divided into followings topics:

- Metadata scheme, which define structure, which could be used for description of information
- Thesaurus - These are well known examples of hierarchical systems for representing subject taxonomies in terms of the relationships between named concepts.
- Geospatial thesaurus - Geospatial thesaurus supported search about geospatial object (for example gazetteers, GeoParcers, Geocoders)
- Catalogue service. Service that provides discovery and management services on a store of metadata about instances. The metadata may be for dataset instances, e.g., dataset catalogue, or may contain service metadata, e.g., service catalogue. ISO 19115 is relevant to catalogue service for dataset metadata.

Metadata profile

For the purpose of NaturNet Redime and c@r project, the following profiles are used:

- Dublin Core
- ISO19115
- ISO19119
- ISO19139

Dublin Core - ISO 15836

The Dublin Core metadata element set is a standard for cross-domain information resource description. It provides a simple and standardised set of conventions for describing things online in ways that make them easier to find. Dublin Core is widely used to describe digital materials such as video, sound, image, text, and composite media like web pages. Implementations of Dublin Core typically make use of XML and are Resource Description Framework based. Dublin Core is defined by NISO Standard Z39.85-2007. It could be used for description of any non spatial information.

The Dublin Core standard includes two levels: Simple and Qualified. Simple Dublin Core comprises fifteen elements; The Simple Dublin Core Metadata Element Set (DCMES) consists of 15 metadata elements:

- Title
- Creator
- Subject
- Description
- Publisher
- Contributor
- Date
- Type
- Format
- Identifier
- Source
- Language
- Relation
- Coverage
- Rights

DCMI also maintains a small, general vocabulary recommended for use within the element Type. This vocabulary currently consists of 12 terms:

- Collection
- Dataset
- Event
- Image
- InteractiveResource
- MovingImage
- PhysicalObject
- Service
- Software
- Sound
- StillImage
- Text

The Dublin Core concepts and semantics are designed to be syntax independent, are equally applicable in a variety of contexts, as long as the metadata is in a form suitable for interpretation both by machines and by human beings.

ISO19115:2003

ISO 19115:2003 defines the schema required for describing geographic information and services. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data.

ISO 19115:2003 is applicable to:

- the cataloguing of datasets, clearinghouse activities, and the full description of datasets;
- geographic datasets, dataset series, and individual geographic features and feature properties.

ISO 19115:2003 defines:

- mandatory and conditional metadata sections, metadata entities, and metadata elements;
- the minimum set of metadata required to serve the full range of metadata applications (data discovery, determining data fitness for use, data access, data transfer, and use of digital data);
- optional metadata elements - to allow for a more extensive standard description of geographic data, if required;
- a method for extending metadata to fit specialized needs.

Though ISO 19115:2003 is applicable to digital data, its principles can be extended to many other forms of geographic data such as maps, charts, and textual documents as well as non-geographic data.

ISO19119

ISO 19119 provides a framework for developers to create software that enables users to access and process geographic data from a variety of sources across a generic computinginterface within an open information technology environment.

The geographic services architecture specified in ISO 19119 has been developed to meet the following purposes:

- Provide an abstract framework to allow coordinated development of specific services,
- Enable interoperable services through interface standardization,
- Support development of a service catalogue through the definition of service metadata,
- Allow separation of data instances & service instances,

- Enable use of one provider's service on another provider's data, and
- Define an abstract framework which can be implemented in multiple ways.

ISO19119

ISO 19119 was developed by first considering the functionality provided by “monolithic” image processing and GIS packages. The ISO 19119 architecture provides those samefunctionalities and more in a distributed environment, e.g., the Internet.

ISO19139

ISO 19139 defines a spatial metadata XML schema (smXML) for the carrying out ISO 19115/19119 Standard to facilitates standardisation of implementation and interoperability by providing a common specification for describing, validating and exchanging metadata

Thesaurus

The technological repercussions of the digital environment has affected artefacts, tools and user behaviours alike in relation to information representation and retrieval. This effect opens up new possibilities in terms of design and elaboration, management and use of tools used for information representation and retrieval. The digital environments to thesauruses, and these can be summarised in the following elements:

The first element to be considered is the enriching of the thesaurus structure functionality based on hypertexting. This leads to the establishing of hyperlinks among all the structural elements (descriptors, no descriptors, scope notes, etc.), and also among the different parts of the thesaurus.

The second element is the reduction of updating and maintenance costs. Due to the growing digitalisation of thesaurus-construction processes and the gradual abandoning of paper formats in publishing these tools, cost-reduction is perfectly viable.

The third element is user-integration into the process of creating, managing and optimising thesauruses, through usability tests, the use of user-modelling techniques, etc. This makes it possible to create tools that take user requirements into account and rules out their creation as simple theoretical structures.

The fourth element is the possibility of applying methods of reuse and interoperability at the time of planning and creating the thesauruses. This makes it possible to use and make the most of the conceptual and linguistic information already generated for other artefacts.

From our point of view, this last element is a key factor in the new generation of digital thesauruses. The use of conceptual and linguistic information stored in other types of artefacts (e.g., in an ontology) enables advantage to be taken of the thesaurus structural elements and makes enables the friendly nature of these tools to be increased for non-specialist, end-users.

AGROVOC Thesaurus

The AGROVOC Thesaurus has been developed by FAO and the Commission of the European Communities in the early 1980s and is used by AGRIS and CARIS information systems of FAO for indexing (associating the descriptors appropriate to the content of the documents referred) and retrieval since 1986.

- It is a multilingual structured and controlled vocabulary designed to cover the terminology of all subject fields of agriculture, forestry, fisheries, food and related domains (e.g. environment) in order to describe the documents in a controlled system language.
- The last edition of AGROVOC (Third Edition, Version 1997) contains over 46000 terms (key words), of which 16105 base descriptors (English), 9480 English synonyms, 8693 French synonyms and 12086 Spanish synonyms. Supplements to AGROVOC are produced yearly.
- Different hierarchical and associative relations (broader/narrower terms, related terms, equivalent terms, combination use) are established between the terms of AGROVOC.

Geospatial Thesauruses

Gazetteer Service

A Gazetteer Service is here defined as a network-accessible service that retrieves one or more features (after the ISO feature model), given a query (filter) request. This filter request must support selection by well-known feature attribute values, and especially by published or context-unique identifiers. The query able feature attributes are any properties that describe the features, including but not limited to feature type, feature name, authority, or identification code. Each instance of a Gazetteer Service has an associated vocabulary of identifiers. Thus, a Gazetteer Service may apply to a given region, such as a country, or some other specialized grouping of features. The returned features will include one or more geometries expressed in an OGC Spatial Reference System.

Geocoder

A Geocoder Service is a network-accessible service that transforms a description of a feature location, such as a place name, street address or postal code, into a normalized description of the location, which includes a coordinate geometry. In other words, the Geocoder Service receives the description of a feature location as input and provides a normalized address with geometry as output. The feature location descriptions are any words, codes or terms that describe the features, and that are well-known to the Geocoder Service, such as street addressing or postal coding scheme. This service will determine the geometries for one or more features, given their associated well-known feature location descriptions, which are specified to the service at run-time, through a query.

Geoparser

A Geoparser Service is a network-accessible service that focuses on the geoparsing and marking of free text messages using a vocabulary, such as place names for Canada, which is possibly specified by the user. Output from a Geoparser Service is a collection of features that identifies words and phrases in the original text resource. The returned collection of features is suitable for subsequent processing, such as user-controlled geocoding. It is anticipated that this Geoparser Service will have a significant impact on the ability of applications to share multiple distributed interoperable Geoparser Services and offer a useful service to the geospatial community.

Catalogue

Catalogue services are the key technology for locating, managing and maintaining distributed resources. With catalogue services, client applications are capable of searching for resources in a standardised way (i.e. through standardised interfaces and operations) and, ideally, they re based on a well-known information model, which includes spatial references and further descriptive (thematic) information that enables client applications to search for geo-resources in very efficient ways. Whereas interfaces and operations of catalogue services are well defined, it is left up to the developer of the system to define a specific information model which a catalogue service instance provides. This includes, but is not limited to, supported query languages, available search terms, response/result sets, etc. This point is of major importance with respect to interoperability between different catalogue service instances.

CSW2.0

OGC's catalogue revision working group (CS-RWG) has revised and integrated the current catalogue implementation specifications that have resulted in CSW 2.0. One part of this OGC specification comprises the definition of application profiles according to ISO 19106 (Geographic information – Profiles). The overall goal of these profiles is to improve interoperability between systems conforming to a specific profile. Experience has shown that the need for application profiles results from the fact that in practice, there is no single solution for catalogue services that fits every user's needs. As stated in CSW 2.0, a base profile that provides a basic set of information objects has to be supported by each catalogue instance; in addition, application profiles for different information communities should be specified.

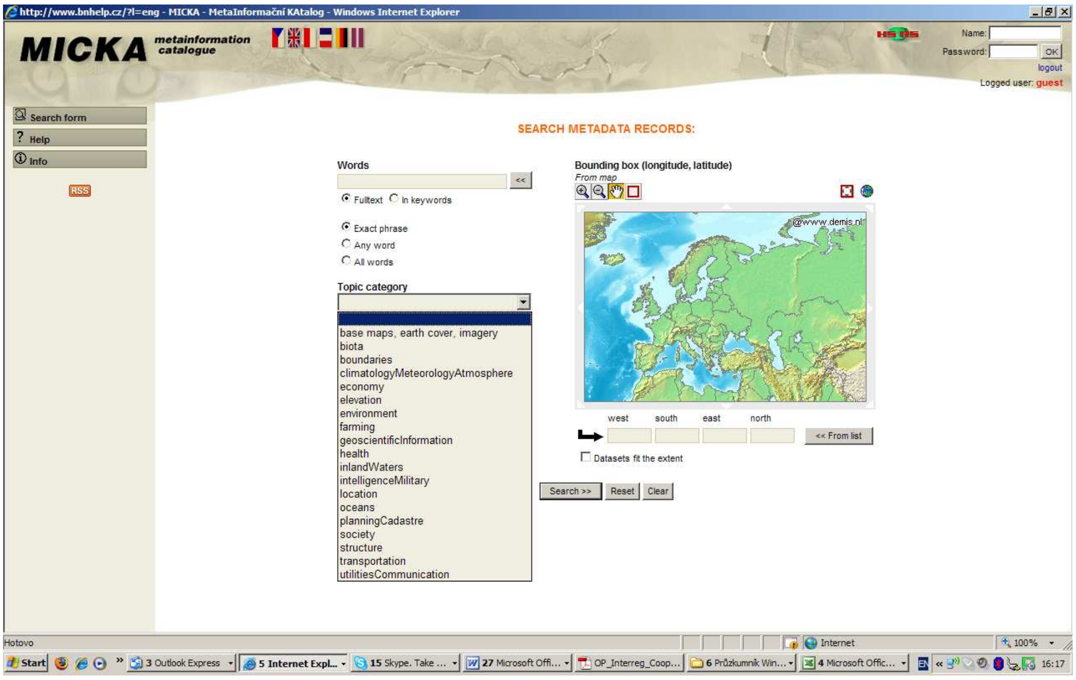
Developments

Metadata and catalogue for URM

Core element of implementation of URM is **Metadata Catalogue service Micka**. Micka is spatial metadata catalogue, which supported standards:

- Any XML based standard may be stored in the system. There is special module for standard tree maintenance.
- In current version these standards are supported:
- Spatial data metadata (ISO 19115) - full standard
- Service metadata (ISO 19119) - reasonable core
- Feature catalogue (ISO 19110) - reasonable core
- Dublin Core Metadata (ISO 15836)
- There are some predefined profiles in the system:
- ISO 19115 mandatory elements
- ISO 19115 core elements
- INSPIRE
- MICKA (INSPIRE elements with added ones for common use.)
- ISO/DC (ISO 19115 elements covering the DC core profile)
- Full ISO19115 standard

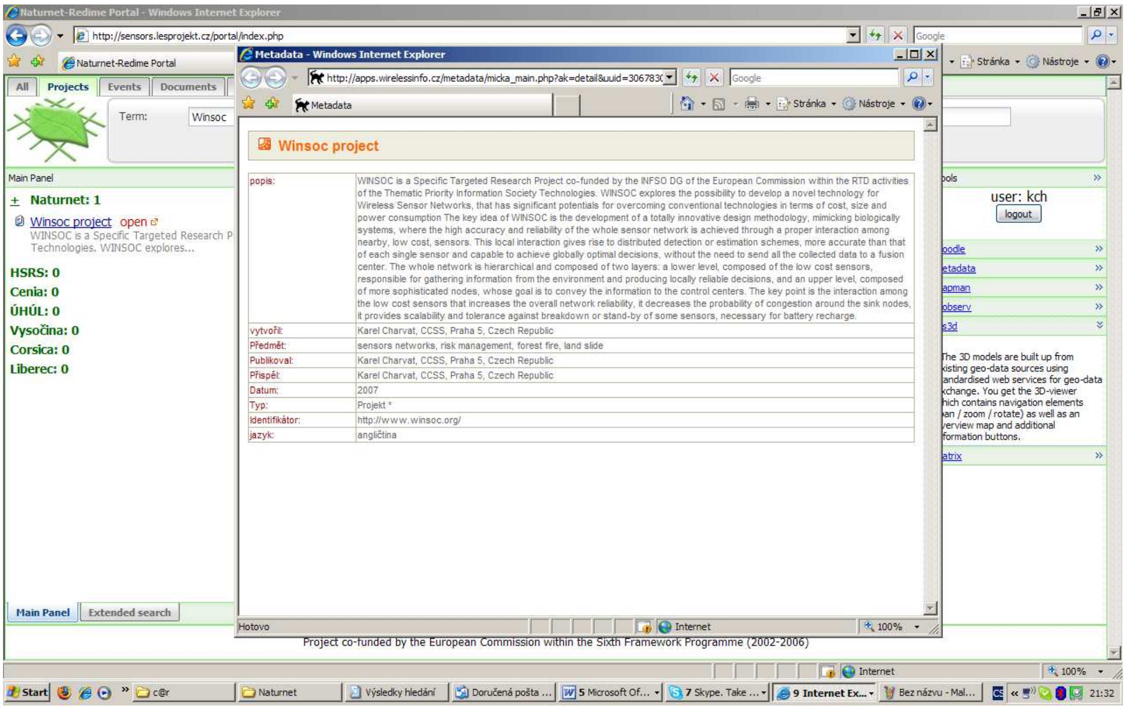
User interface is multilingual. English, Czech, German, French, and partially Polish are currently supported. (New language may be added by filling the corresponding database table.) User may switch language clicking corresponding flag on the top bar of the program. The Micka use AgroVoc thesaurus and supported WFS gazetteers.



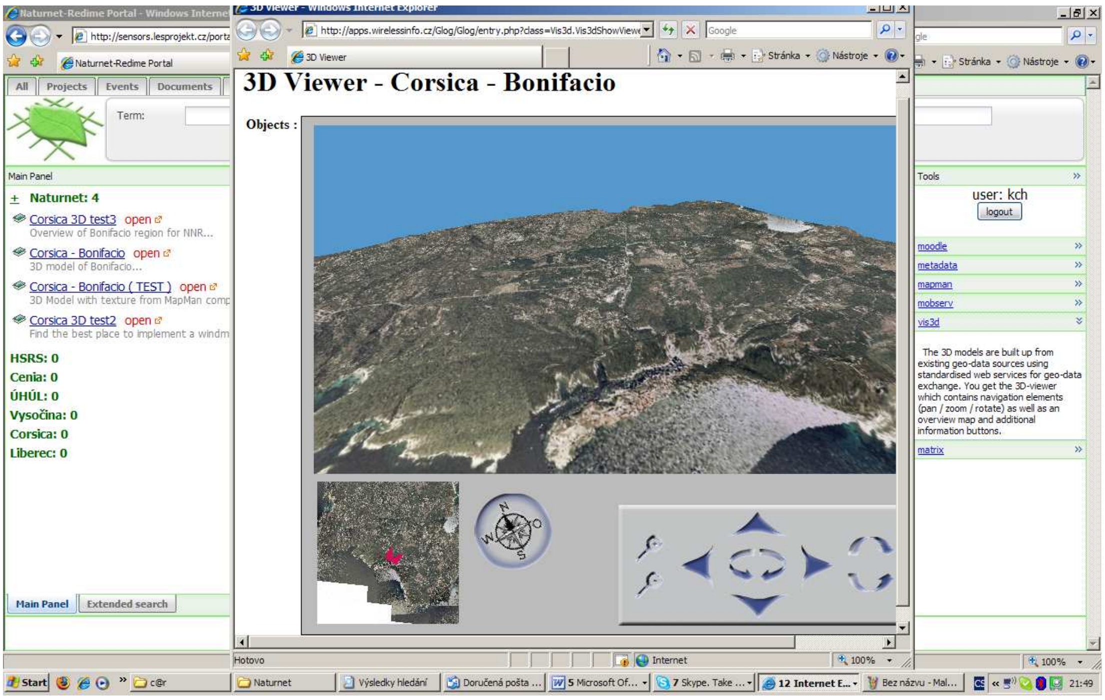
Metadata system Micka

URM implementation

The first existing implementation of URM are NaturNet-Redime Portal for awareness, training, presentation and sharing of knowledge and tools about European sustainability which is built as an interoperable network, with effective exchange of information, knowledge, services. Other existing implementation is Czech version of c-rural portal for sharing information inside of Czech Living labs. Both portals are implemented using AJAX technology (WEB 2) and support on one side easy management of information inside of portal and on other side easy context awareness knowledge discovery using new concept of Uniform Resource Management (URM). This URM concept is one from research results introduced by NaturNet Redime project and today deeply elaborated by c@r and support sharing of knowledge inside of community using metadata and catalogue standards for their description and discovery.



URM metadata search



URM application selection

Results

NaturNet Redime and Czech c-rural portals currently support

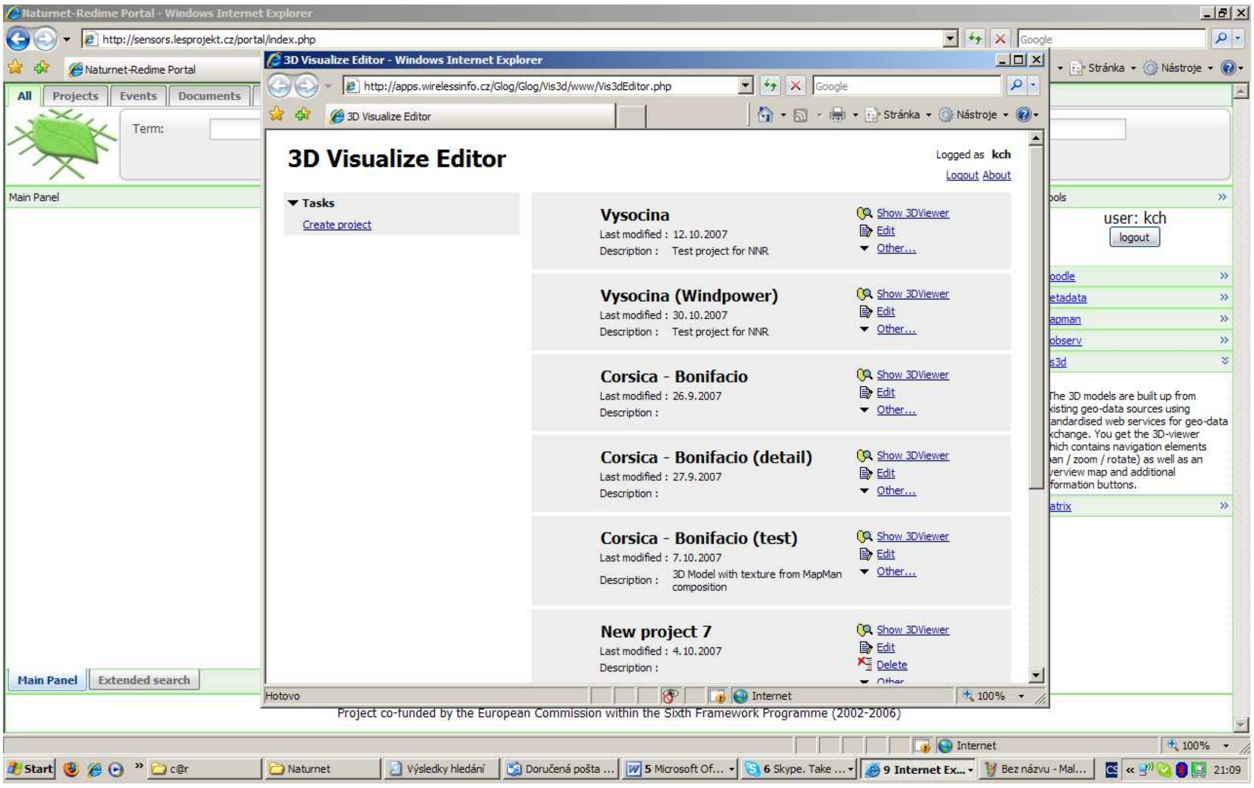
- Management of knowledge related to sustainable development
- Discovery of heterogeneous knowledge in distributed environment using URM concept

Portals could be used by:

- registered users with access to knowledge management and knowledge discovery
- non registered user could only discover and access information in heterogeneous environment

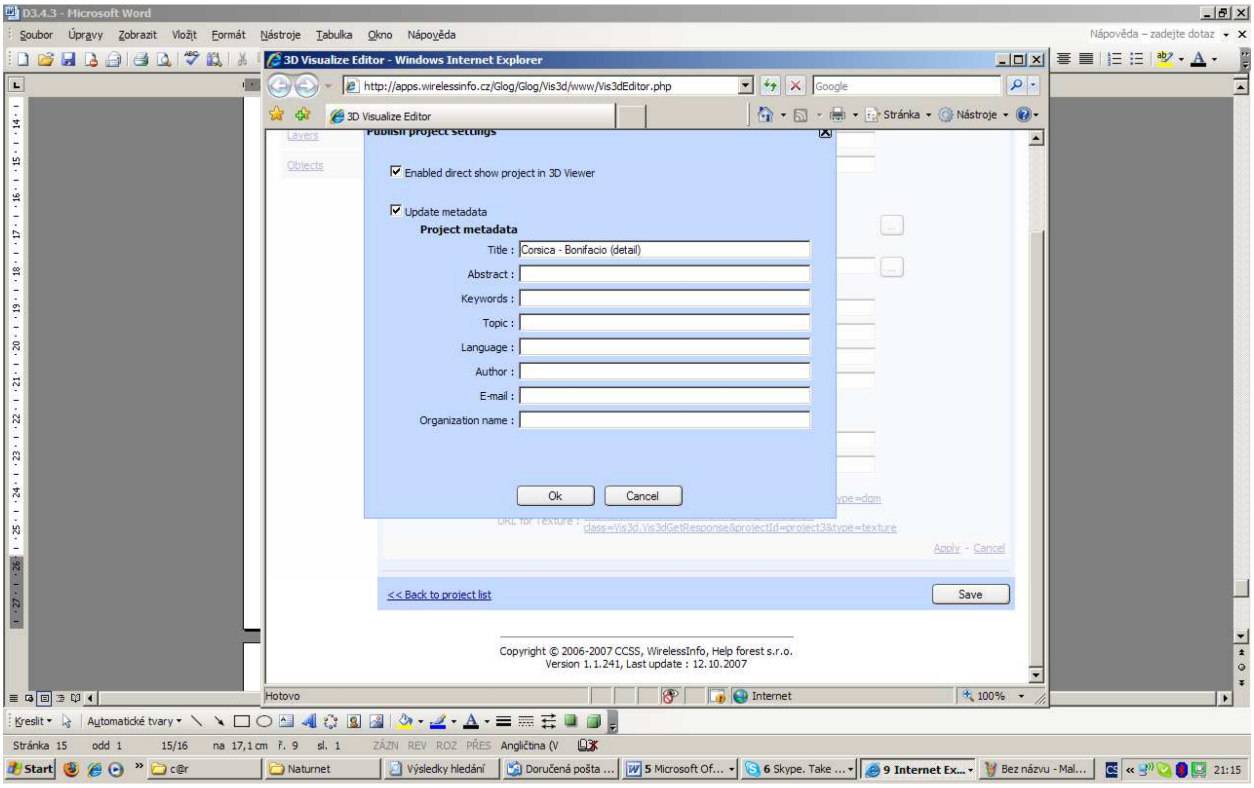
Authorisation is realised using authorisation system, which support sharing of authorisation information trough all application on portal. After login into the system

Is on portal open list of all available tools and for every tool is also available short description. After selection of concrete tools, this tool is open in new window.



Using URM tools

The user is automatically logged with his user name into this application. Every from implanted application supported automatically storing of metadata, when are published any outputs into portal metadata system.

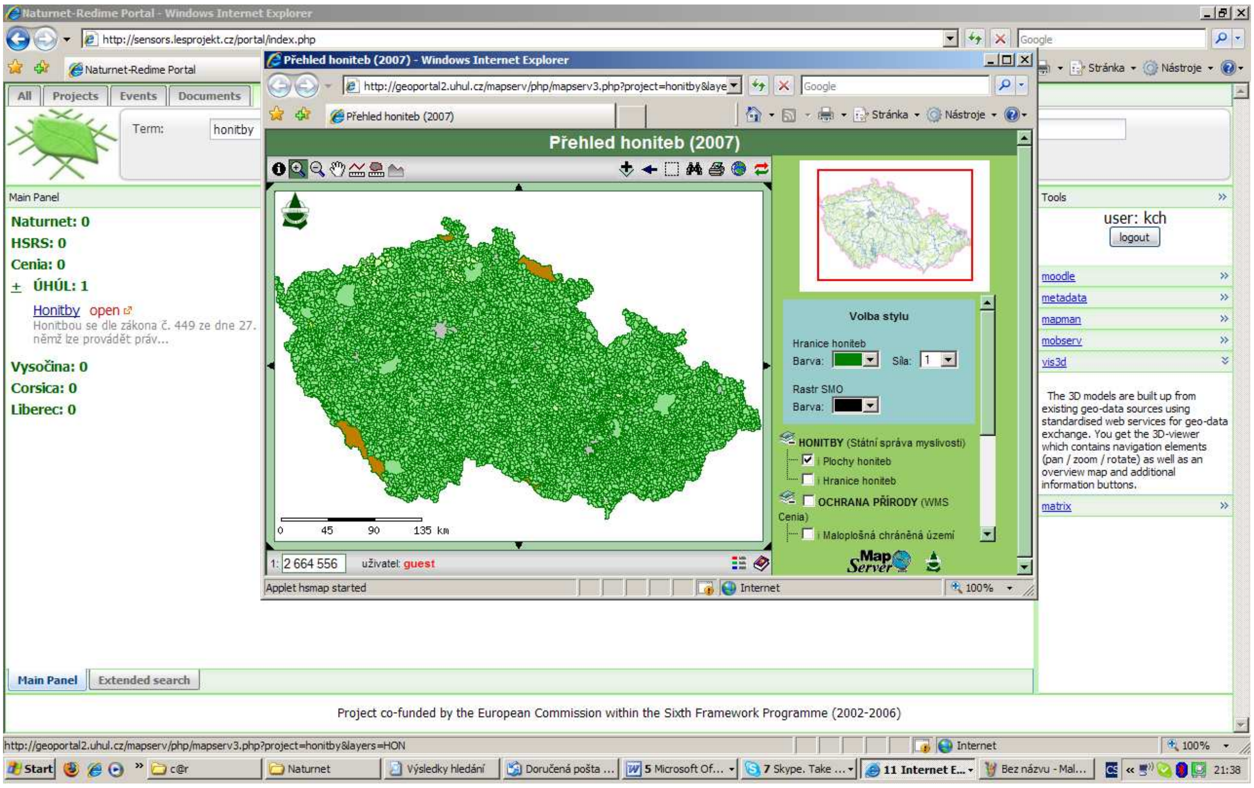


Direct metadata uploading

The knowledge discovery could be provided on the base of context awareness methods and knowledge is possible discover not only on the URM server, but on all registered servers, which belongs to certain communities. Discovery of knowledge could be provided or using simple search or using methods of extended search. The simple search is defined by to attributes:

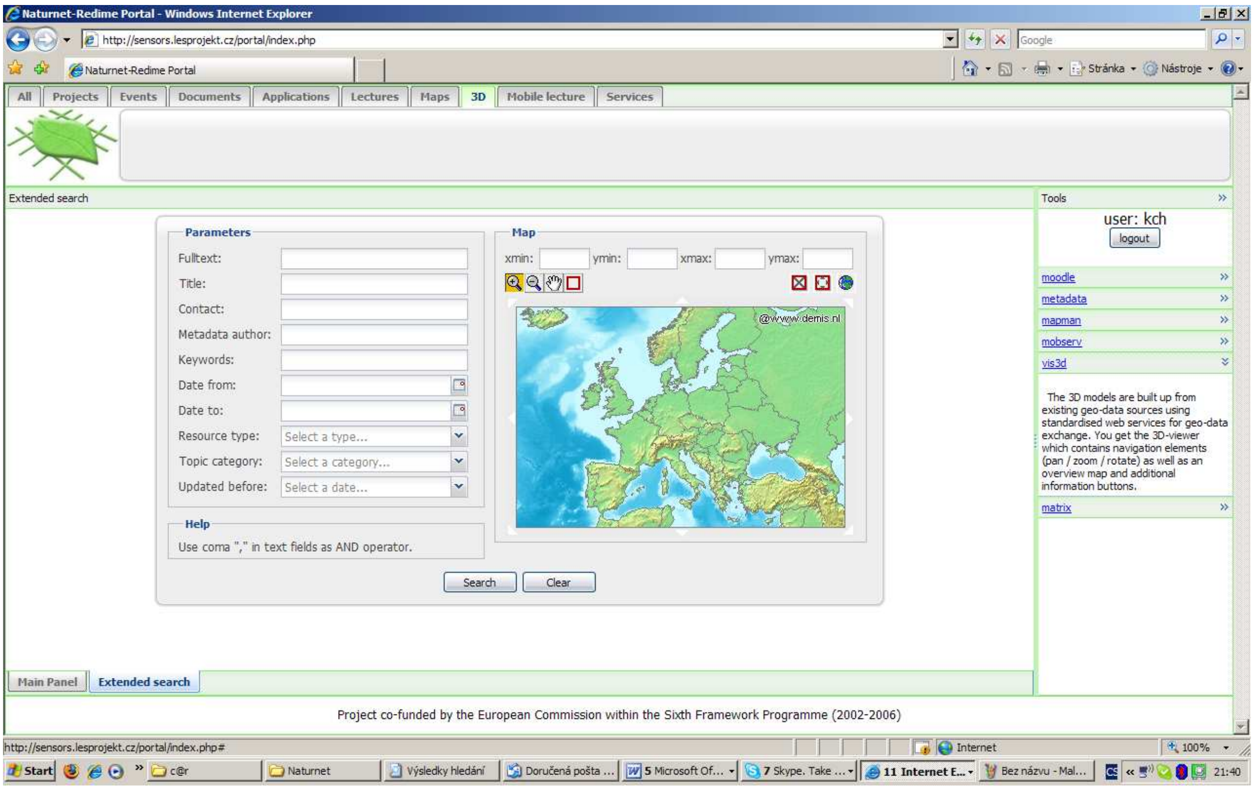
- Term – this term is used for full text search in or connected catalogues
- Category – there is discovered only selected category trough all contacted catalogues

and return short info about discovered knowledge (abstract and information about online accessibility). The some could be done for other categories, for example application, which could discover application descried on other servers. Also for remote servers are possible see full metadata profile and after also this application could run:



Work with external applications

Extended search supported discovery knowledge on the base of more parameters



Extended URM search

As in previous case, there could be selected category, but this parameters for discovery could be combined with other parameters like

- Geographical extension
- Fulltext
- Title
- Contact
- Metadata author
- Keywords
- Time extension
- Topic category
- Date of update

The discovery of knowledge is provided on combination of all these parameters

Business Benefits

The URM opens new possibilities, how to share knowledge and information inside of communities. The current version of URM is based on Metadata and catalogue system Micka, but there were already tested possibilities with other interoperable platforms like Geonetwork. This new method of sharing of knowledge could increase collaboration inside of communities, but also could be useful tools for training and education. The kind of application could e easy extended and modify.

Conclusions

The NaturNet portal demonstrates unique methods for training and awareness in are of sustainable development. Main innovations are mainly:

- Using URM model, which is research result of NaturNet Redime project
- Implementation of AJAX technology which support easy and user friendly interface
- New authorisation model
- Easy integration of new tools
- Easy discovery of information
- Sharing of knowledge inside of community
- Integration of QR results

The URM model could be easy adopted for other topics and represent new way of sharing of knowledge. This concept is now extended inside of c@r project. There are studied such methods like direct automatic derivation of metadata from information sources.

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European Living Labs

Sarka Horakova, Petr Horak, Wirelessinfo

Information technologies are in a process of the rapid development. In the whole Europe were established centres with the ability to provide alternative solution of mobile applications and technologies more quickly and effectively. These centres were the base stones for unites called **Living Labs (LL).**

Living Lab is an open flexible environment which works on principles of collaboration between companies, regional administrations, universities, researches, institutions a citizens to develop, model and test new technologies, services and products.

Openness of Living Lab means that users

- define their requirements
- are actively involved into research, development and testing
- are encouraged to cooperate closely with researches, developers and designers
- have better possibilities how to solve concrete tasks
- can test ideas and prototypes from the earlier stage of the innovation process
- can actively contribute to innovation process
- can validate research results.

This active connection is a base of modern partnership between research, test centre of LL and end-user. Living labs move research out of laboratories into real-life contexts to stimulate innovation. Involving end-users makes the initial stages of product or service development more challenging, as users communicate their wishes and researchers explain what is technically or logistically possible. This early involvement of end users saves time later on in the process as the researchers have a better understanding of what the user wants and expects.

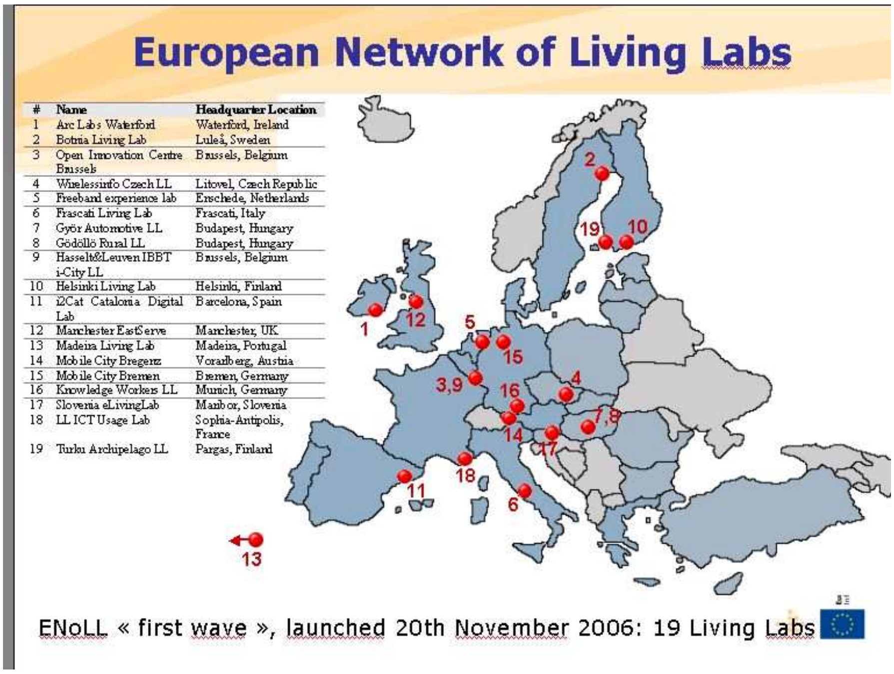
Living Labs in the whole Europe create **the European Network of Living Labs (ENoLL)**. This activity enables concrete steps to introduction of the Lisbon strategy for jobs and growth in Europe into real life, brings common methodologies and tools developed across Europe that support, stimulate and accelerate the **Innovation Process**.

The aim of **the European Network of Living Labs** is to link the separate Living Labs innovations and innovators around Europe to a common European network. The network enables the development of innovation services, methods, testing environments and Europe-wide provision of those for local and international companies and public administration. This helps to achieve globally competitive European innovations and to create products and services facilitating the everyday life of people and businesses.

The network also provides an opportunity to test products and services produced in one country in different cultural environments and create easily-copied solutions from the very beginning.

A **first wave of the European Network of Living Labs (ENoLL)** was launched on the 20th of November 2006 by the Finnish EU Presidency (fig.1).

19 Living Labs from 15 European countries started creation of this European network. At this time there was established a first Living Lab in the Czech Republic **- the Czech Living Lab – Wirelessinfo.**



#	Name	Headquarter Location
1	Arc Labs Waterford	Waterford, Ireland
2	Botnia Living Lab	Luleå, Sweden
3	Open Innovation Centre Brussels	Brussels, Belgium
4	Wirelessinfo Czech LL	Litovel, Czech Republic
5	Freeband experience lab	Enschede, Netherlands
6	Frascati Living Lab	Frascati, Italy
7	Györ Automotive LL	Budapest, Hungary
8	Gödöllö Rural LL	Budapest, Hungary
9	Hasselt&Leuven IBBT i-City LL	Brussels, Belgium
10	Helsinki Living Lab	Helsinki, Finland
11	i2Cat Catalonia Digital Lab	Barcelona, Spain
12	Manchester EastServe	Manchester, UK
13	Madeira Living Lab	Madeira, Portugal
14	Mobile City Bregenz	Vorarlberg, Austria
15	Mobile City Bremen	Bremen, Germany
16	Knowledge Workers LL	Munich, Germany
17	Slovenia eLivingLab	Maribor, Slovenia
18	LL ICT Usage Lab	Sophia-Antipolis, France
19	Turku Archipelago LL	Pargas, Finland

Fig.1 Living Labs Europe – 1st wave of ENoLL

The **second wave of the European Network of Living Labs (ENoLL)** has been launched at a Portuguese Presidency event in Brussels (October 2007), bringing the total number of **ENoLL members to 51** (fig.2)**.**

Third wave of Living Labs will be expecting in this year 2008 by Slovenian Presidency of EU).

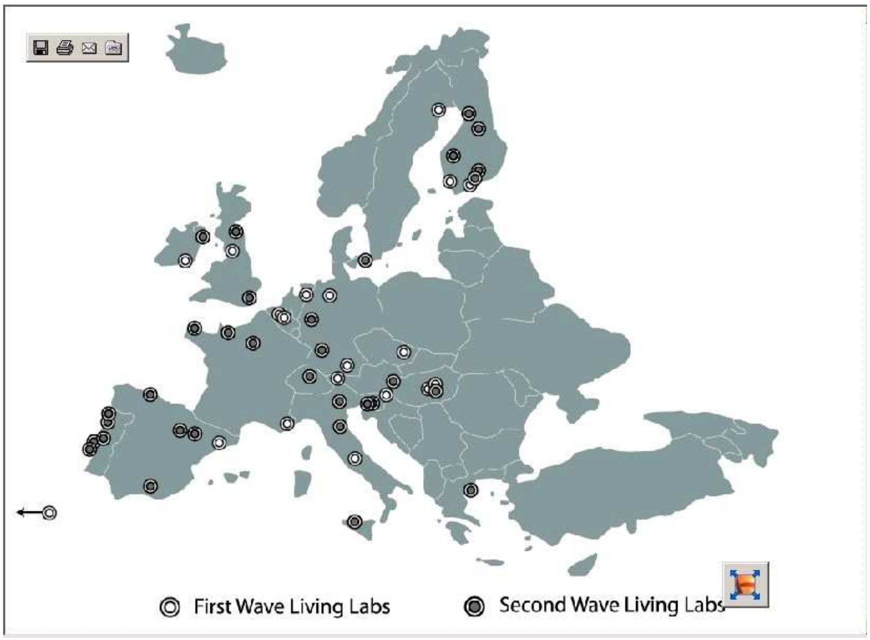


Fig.2 Living Labs Europe – 2nd wave of ENoLL

The Living Lab problematic, coordination of activities and common methodology is solving in several European projects (e.g. Collaboration @ Rural, CoreLabs, CLOCK , eCoSpace) (fig.3).

The overall objectives of the EU projects are to achieve a coordination of activities towards the establishment of co-creative Living Labs as the foundation of a Common European Innovation System on several levels and develop a roadmap and policy recommendations for the widespread adoption of the Living Lab concept.

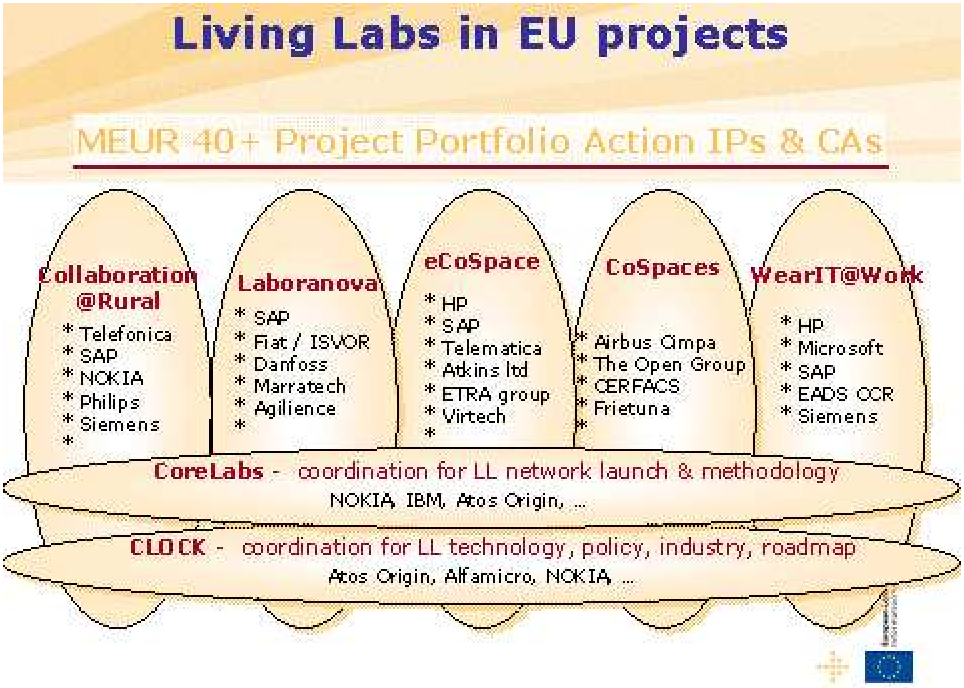


Fig. 3 Living Labs related EU project

The Czech Living Lab - WIRELESSINFO is the first Living Lab in Czech Republic, which was established in the first wave of launch European Network of Living Labs (ENoLL). The concept of the **Czech Living Lab WIRELESSINFO** is involved in the framework of Collaboration@Rural project (integrated project of 6th Framework Programme EU). **CLL - WIRELESSINFO** is an open flexible environment mainly focused on development of mobile applications and technologies, on the development of eGovernment and eParticipation services, their implementation and testing. On this account, state institutes, regional authorities and municipalities are involved into the living lab – being both partly researchers and partly users.

Living Labs bring a new possibility for modern partnership between researchers and users, where users are encouraged to define their requirements and bring their own ideas. On the basis of the requirements, the model scenarios are defined and LL can search the applications and the tools to cover specified users' needs.

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Events of Interest

24th – 27th June 2008, Lyon, France

OpeniWorld:Europe2008

For its first European event, to be hosted in France by the Lyon 2 University (member of the Lyon University Consortium) in collaboration with MIT's Open Knowledge Initiative, OpeniWorld will focus its attention on resource federation, one of today's key educational technology challenges. Federation offers much promise for inter-institutional collaboration towards more effective learning as well as significant market opportunities for providers and consumers of educational content, software and services.

http://www.openiworld.org/Europe2008

6th – 10th July 2008, Barcelona, Catalonia

iEMSs 2008

International Congress on Environmental Modelling and Software. Call for abstracts and participation for WORKSHOP on QUALITATIVE MODELS FOR SUSTAINABILITY (W5)

In this workshop will be invited the partners from the project NaturNet-Redime to present their latest developments on the main themes within the approach taken: software, models and model library, curriculum, and evaluative case studies with stakeholders.

In addition, the workshop will be opened for contributions of researchers and practitioners outside the NaturNet-Redime project who are working with or developing materials along similar dimensions. The main goals of the workshop are to share results, identify problems and opportunities, and to support the development of a user-group on qualitative approaches to environmental management.

Organisers: Bert Bredeweg, University of Amsterdam, The Netherlands (contact: bredeweg@science.uva.nl)

Paulo Salles. University of Brasilia, Brazil

Deadline: Workshop participants should submit their abstracts (three pages at most) by January 27, 2008.

http://www.iemss.org/iemss2008/

SIXTH FRAMEWORK PROGRAMME
Educational programmes on social, economic, and environmental tools for the implementation of the EU Strategy on Sustainable Development at both EU and international levels

NATURNET-REDIME

New Education and Decision Support Model for Active Behaviour in Sustainable Development Based on Innovative Web Services and Qualitative Reasoning

Project no.	004074		
Instrument:	SPECIFIC TARGETED RESEARCH PROJECT		
Thematic Priority:	SUSTDEV-2004-3.VIII.2.e		
Start date of project:	1st March 2005	Duration:	30 months
Web:	http://www.naturnet.org		
Project officer	Patrizia Poggi Patrizia.POGGI@ec.europa.eu		

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)

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