

The SCATOL8™: an innovation for shifting from Environmental and Landscape Management System (ELMS) to the Eco-Land-Web-Scape Management System (ELWSMS)

Riccardo Beltramo, University of Torino, Department of Commodity Science.

beltramo@econ.unito.it, <http://web.econ.unito.it/cresta>

Abstract

The perception of the territory translates into landscape a complex combination of culture and sensorial stimuli. The importance of landscape has been highlighted in the European contest by the European Landscape Convention which has been imported in the structure of the EMAS regulation by a group of researchers lead by the author, in order to identify, detect, control and improve environmental and landscape significant aspects. A review of the management model, called ELMS, has been conducted to identify critical aspects, in order to find solutions able to broaden the application of the model. The innovation presented in the paper is a combination of technologies, software and management systems, organized in a new scheme called Eco-Land-Web-Scape-Management System.

Key words: Remote sensing, Environmental quality, Landscape, Innovation, Simulation models.

Introduction

In 2005, the Department of Commodity Science (DCS) launched a research project, to develop the Guidelines for environmental and landscape management systems (ELMS). This project, funded by Regione Piemonte, Assessorato all'Ambiente, ended in 2009 and it saw the DCS engaging a multidisciplinary team and working with 14 municipalities, in the wellknown territory of Langhe hills. As final result, Guidelines for designing and implementing an ELMS has been published: the methodology integrates the environmental management systems (EMS) by ISO14001 and EMAS¹ standards, and the European Landscape Convention (ELC)². It is useful to identify, keep under control and improve environmental and landscape aspects related to the activities of municipalities or group of municipalities.³; it has broadened the scope of EMS, creating new opportunities for certification bodies. In this sense, it is possible to intergate some other famous tool to promote territories, such as UNESCO's World Heritage Sites. The analysis of the results and of the processes used to elaborate the Guidelines has driven the reseachers to define an improvement path, to overcome the weak points and, above all, to efficiently solve the problem of data gathering. The evolution of ELMS, has been called Eco-Land-Web-Scape Management System (ELWSMS) and it is described in Fig. 1.

¹ The EMAS (Eco-Management and Audit Scheme) was established by Regulation (EEC) n. 1836/93; revised in 2001, with Regulation (EC) n. 761/2001, and a second time in 2009, is now ruled by Regulation n. 1221/09.

² The European Landscape Convention is a document adopted by the Committee of Ministers of Culture and Environment of the Council of Europe on July 19, 2000 and signed in Florence on October 20, 2000. In force since 1 September 2006, at the international level, the Convention has been ratified by Italy by Law of January 9, 2006, n. 14

³ R. BELTRAMO, M. QUARTA, SGAP – Sistema di Gestione Ambientale-Paesaggistico: aspetti introduttivi e impostazione metodologica, in Valutazione Ambientale, n 12, Luglio Dicembre 2007, 19-27 and, english version, ENVIRONMENTAL EVALUATION on line, Riccardo Beltramo, Maria Quarta, The environmental and landscape management system, http://www.enver.eu/vol_12/index_vol_12.html

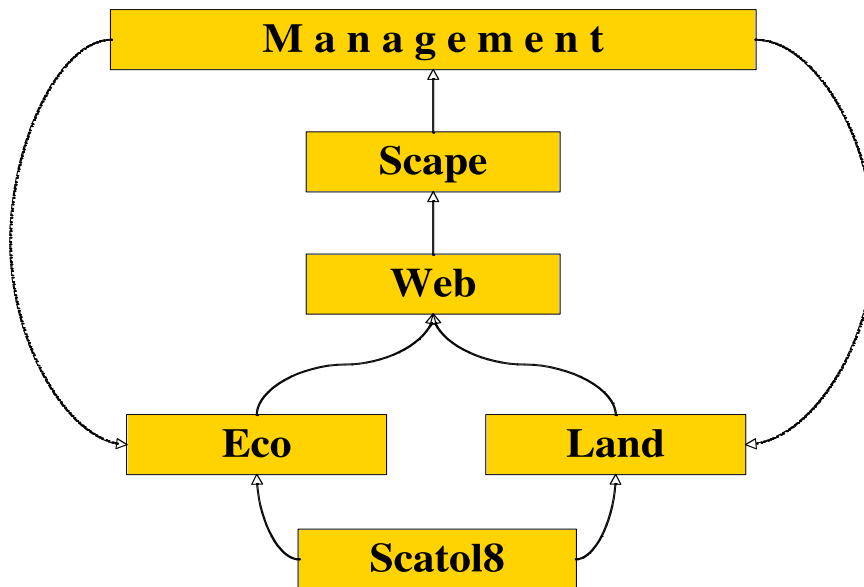


Fig. 1: The evolution from ELMS to ELWSMS, thanks to SCATOL8®

Breafly, the ongoing activities are focused on:

- **SCATOL8™** is the basis of this evolution, a complete kit, consisting of detection tools, which will feed, via web, softwares for dynamic modeling and management. The prototype of **SCATOL8™**, integrates Arduino⁴, an *open-source* electronics platform, with sensors, displays, interactive devices and PC;
- **Eco**: application of remote sensing technics, through **SCATOL8™**, to monitor resource consumption and pollution.
- **Land**: Studying environmental and landscape evolutions by means of Intelligent Geographic Information Systems, Artificial Neural Networks, Fractals, Artificial Agents on the basis of information provided or managed by **SCATOL8™**.
- **Web**: The Web is the platform that lets you create Scapes, view maps of landscape-environmental quality, store data allowing the study of complex dynamics, to share results with stakeholders, to raise awareness, to simulate and manage changes through an organized communication.
- **Scape**: Real landscape and the perception of territorial transformations, create a landscape on the internet, where quantitative, qualitative, perceptual aspects are assembled and kept in communication, encouraging a shared path for continuous improvement, made possible through the use of dynamic models which, starting from the real, lead to the development of future scenarios.
- **Management**: Encourage a shared decision process, using Stella modelling system and making easier the implementation of management software system, introducing user-friendly interfaces.

Developing the new scheme, two new research projects have been proposed and approved by national and regional bodies:

- a National Research Project, PRIN 2008, entitled "Natural extracts from medicinal plants and textile-dyeing: characterization and innovative uses of nettle, daphne, lavender and chestnut tannin";
- a transboundary regions cooperation project Italy-Swiss 2007-2013, called "V.E.T.T.A. - Enhancement of Best practices and transboundary touristic products in mountain areas".

⁴ <http://www.arduino.cc>

Both of them cover macroeconomics aspects (local government) and microeconomics ones (interesting for companies or touristic organizations involved in project). The two researches are focused on real cases, on which economists, architects, engineers, naturalists, biologists, landowners and managers, are working together, aimed at improving environmental and landscape quality.

The components of the ELWSMS

SCATOL8™

Availability of relevant, accurate and up to date information is one of the most important issue for creating an environmental and landscape management system; by definition, it seeks to identify and control significant environmental and landscape variables, related to the organizations' management operating in connection with the territory and with stakeholders. In carrying out the environmental and landscape system design in different situations, we found that a common element is the lack of data, and an uncertain data quality: a data set must be completed, often through long and tortuous relationships with various entities, each of which has a piece of information. Moreover we recorded asymmetric information: information is kept by bodies which provide services but it is not known by those who manage the purchased resources. This is the case of energy or water supply and of waste management.

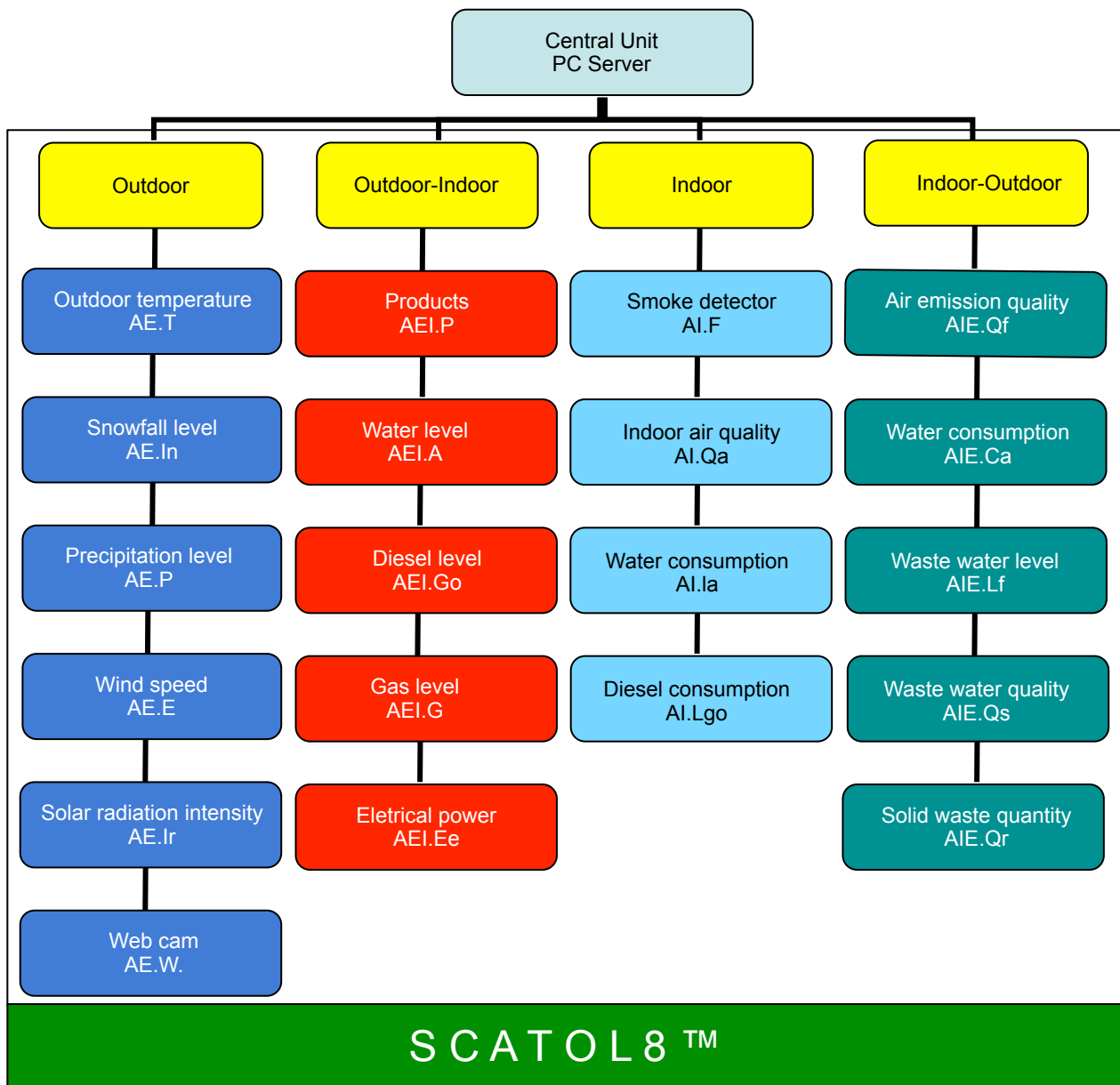
This critic situation has to be resolved in order to avoid the risk of building a management system based on imperfect information. For this reason, the first task addressed is the development of a remote sensing system for environmental and landscape variables under local authorities control. This action is aimed at creating a device to be installed in buildings, directly managed by the local servants, able to detect variables related to managerial and environmental aspects, to store data, to view them on the internet and send alarm if an abnormal event occurs. A similar system, equipped with proper sensors and automatically managed, could also be installed in arduous places, to provide periodical information in relation to the territorial changes that may affect the perception of the landscape.

We are working, in particular, on environmental quality, through the creation of a hardware and open source software, as shown in the diagram. **SCATOL8™** includes a central unit and peripherals connected to a set of digital and analogic sensors, to detect environmental significant variables. The system is managed by an Arduino development environment, called IDE⁵. In this way it is possible to supply a real-time archive of environmental data. The system, currently in prototype phase, involves the detection of environmental variables of municipal buildings. The foreseen benefits are, in the short range, a most efficient use of energy resources and, in the medium to long range, improvements for managing and renewing structural building elements, in order to influence landscape preception, thanks to statistical elaboration of time series.

Variables have been divided considering Outdoor, Outddor-Indoor, Indoor, Indoor-Outdoor i.e. the environment where the activities generating them are undertaken. Thus, four Arduino's have been included in **SCATOL8™** to monitor process that transform material and energy in environmental aspects, as reported in Figure 2:

⁵ <http://www.arduino.cc/en/Main/software>

Variables kept under control by the SCATOL8™



We are working on two prototypes, based wired or wireless the connection between sensors, Arduino's and central unit, as displayed in the following Figures 3 and 4:

Architecture of the SCATOL8 - Wired

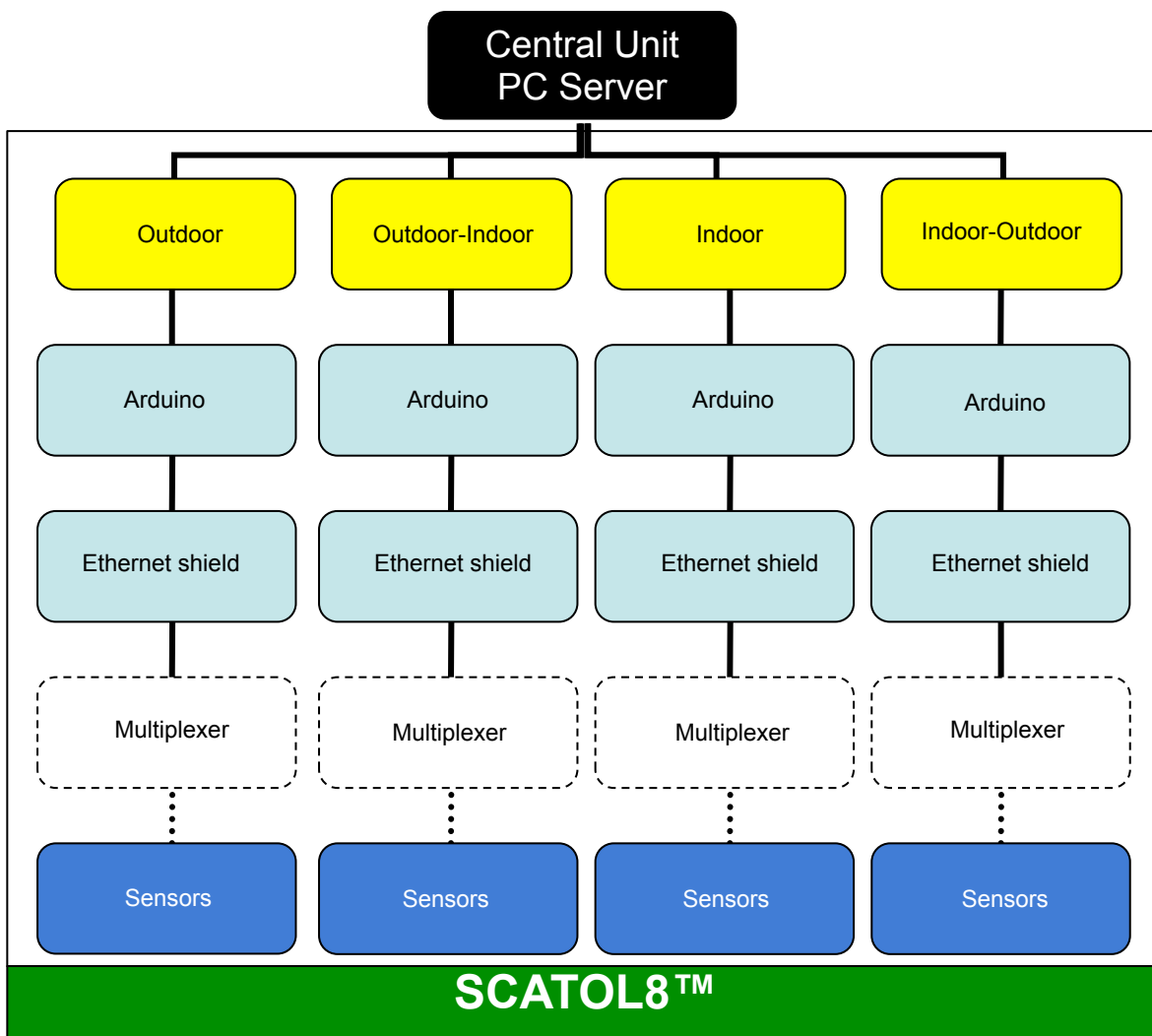


Figure 3: Architecture of SCATOL8™ - wired version.

Wireless version will allow a less invasive installation. Drawbacks are represented:

- by an increase of complication, due to the adding components to transmit and receive information;
- by the potential vulnerability to interferences, and
- by an higher demand of energy supply.

Architecture of the SCATOL8 - Wireless

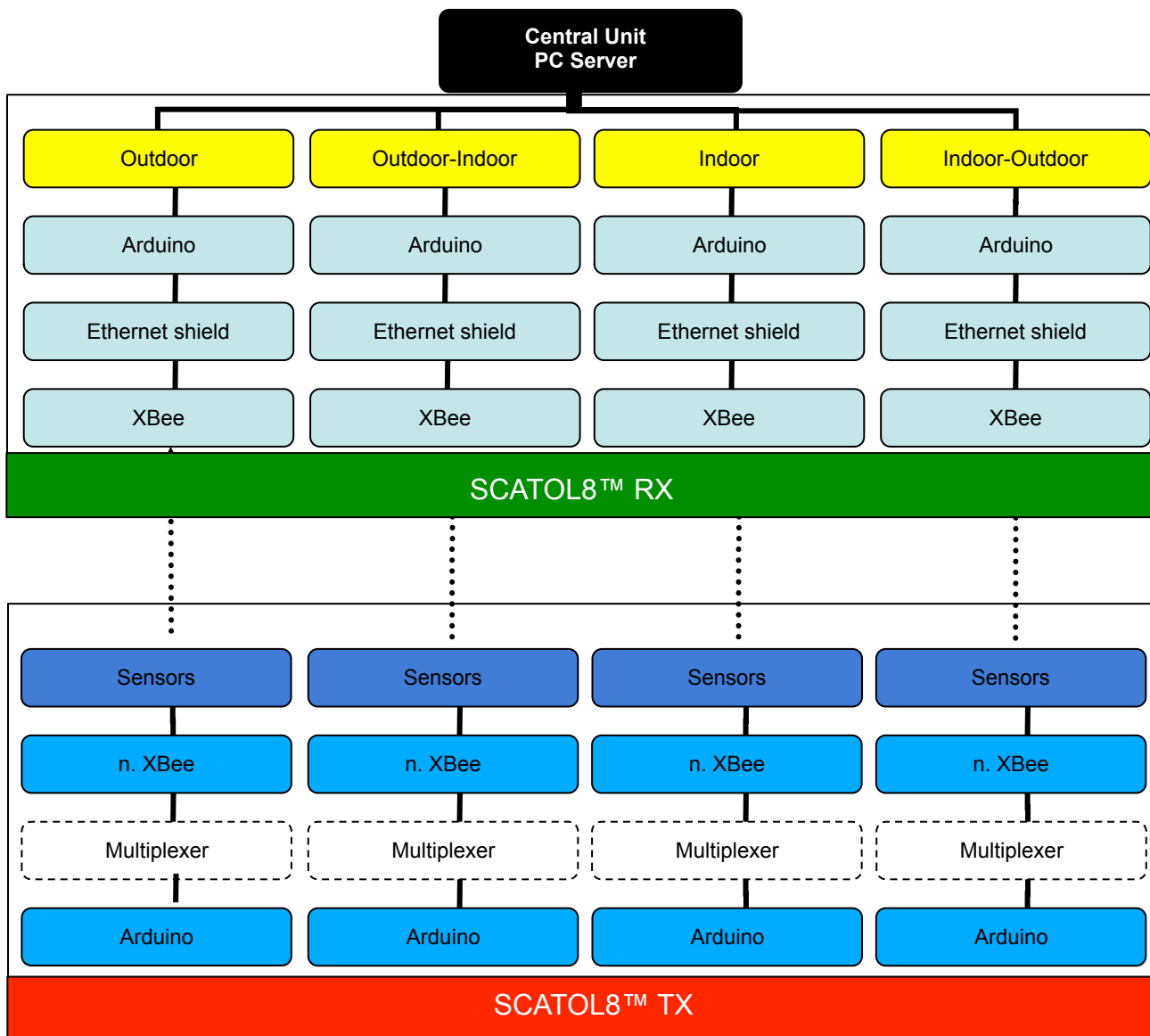


Figure 4: Architecture of SCATOL8™ - wireless version

Both of the versions, wired and wireless, will be produced, accordingly to customers' desires.

Eco-

As previously stated, the retrieval of environmental data was critical due to the pulverization of the institutions and lack of coordinated and systematic accountability, both within and outside local authorities or companies responsible for undertaking services on behalf of the City. We focused, therefore, on the possibility to more easily acquire data on environmental quality.

List of variables monitored thanks to SCATOL8™ is included in Table 1, where unit of measurement and the reference of the related undergiong subprojects are specified:

Variables	u.m.	Subproject Ref.
Outdoor temperature	°C	AE.T

Snowfall level	<i>mm</i>	AE.In
Precipitation level	<i>mm</i>	AE.P
Wind speed	<i>m/s</i>	AE.E
Solar radiation intensity	<i>W/m</i>	AE.Ir
Webcam		AE.W
Products	<i>n</i>	AEI.P
Water level	<i>mc</i>	AEI.A
Diesel level	<i>mc</i>	AEI.Go
Gas level	<i>mc</i>	AEI.G
Electrical power	<i>KWh</i>	AEI.Ee
Smoke detector		AI.F
Indoor air quality		AI.Qa
Water consumption	<i>mm</i>	AI.La
Diesel consumption	<i>mm</i>	AI.Lgo
Air emission quality		AIE.Qf
Water consumption	<i>mc</i>	AIE.Ca
Waste water level	<i>BOD</i>	AIE.Lf
Waste water quality	<i>pH</i>	AIE.Qs
Solid waste quantity	<i>Kg</i>	AIE.Qr

While the **SCATOL8™** project is developing, some initiatives have been introduced in order to improve communication, such as special procedure to coordinate the skills and methods of communication between the subjects who collect and preserve the environmental data.

Land-

A set of improving actions has been studied, through actions on Operating Procedures and methodologies, and in relation to support provided by **SCATOL8™**.

At first, without **SCATOL8™**, improvements are related to the use of the opportunities arising from information systems: Geographic Information Systems (GIS) programs and their evolutions such as Integrated GIS and Intelligent GIS; programs for data analysis and simulation (complex systems, agent-based models, neural networks, etc...).

When **SCATOL8™** will be in complete running order, its contribution to landscape evaluation and management is foreseen in these areas:

- At the stage of photography, providing geographic coordinates, altitude, orientation of the camera and all the informations necessary to build and view maps of visual perception;
- At the stage of land monitoring, periodically extracting maps of the area under control from Google Earth or surfing in an easier way using interfaces such as joysticks;

- At the stage of implementation of the Operating Instructions, in particular concerning construction sites monitoring, through a digital camera remote control.

Web-

Image processing and playback through graphic representations are just some of the aspects that can be dealt with the help of PC. Data obtained with the **SCATOL8™** can "feed" appropriate programs, to elaborate selections of images for different audiences, ranging from technical to local tourists. Other experiments show that even linguistic landscapes, cultural landscapes, sound landscapes ⁶, olfactory landscapes, etc. ... can be mapped and shared over the Internet. Therefore, the Web enables the creation of spatial patterns at different scales, arising from one variable to a combination of them: this offers numberless opportunities for displaying and analysis.

Scape-

In fact, "There can be as many scapes as there are senses, and with technological enhancement, maybe even more. The scape is spatially relating to particular way of the observer, or the actant to space and time. Thus, a scape is a way to focus on particular aspects of the dynamic relationship between an actant and the environment. Landscapes concerns vision, hearing concerns soundscape, odor concerns smellscape. Scapes can be understood as the spatial configuration of an environment related to an isolated sense of an actant. Since, initially, this scaping is anthropocentric, scapes is a way of considering relationships in the dynamic networking between humans and non-humans "⁷

Management

Knowledge sharing, implementation, system monitoring, target evaluation, decisions to improve performance are all part of the concept of management, so they are reflected in planning, implementation, monitoring and review phases, within a formalized management system. The relationship with the ELC also reinforces the importance of awareness-raising activities to be carried out even outside the organization by involving stakeholders, landscape and environmental aspects.

Simulation and knowledge sharing

In the case of public administrations, a lot of subjects are involved and only some of them (policy makers and civil servants) are included in the organizational structure, within hierarchical relationships. The most numerous, citizens are organized into formal or informal groups and they express their needs with different intensity and to different directions over time. However, the optimal outcome of an organization, in terms of facing the expressed needs, is influenced by endogenous and exogenous variables and by the ability to tune the services and the level at which they are provided with the request expressed by the citizens.

To achieve a true understanding of the complex dynamics which follow non-linear logics, determining the quality of environment and landscape, has been demonstrated the effectiveness of participatory modeling, which involves building a simulation model through working-group of non experts under the guidance of an expert, explaining and facilitating the translation of instances of stakeholders in the language of the model. The tool we have chosen is the software Stella ⁸ that showed good quality in the construction of understanding in all kinds of dynamic systems, from the

⁶ I. Gelsomini, F. Pedrazzi, The silence of the lands: applicazioni per la creazione e la condivisione di paesaggi sonori in rete

⁷ Morten Rømer Jespersen (2001) Soundtrekking Soundscapes (draft), in [http:// interact.uoregon.edu/ mediaLit/.../jespersen%20_%20soundtrekkingpdf.pdf](http://interact.uoregon.edu/mediaLit/.../jespersen%20_%20soundtrekkingpdf.pdf)

⁸ <http://www.iseesystems.com/>

wild to group dynamics and economic markets.⁹ The construction of models has been used for years to help scientists and policy makers to identify solutions to complex problems and is, therefore, a more valid and useful applications of mathematics. While most of the models are difficult to understand and require extensive mathematical knowledge to interpret them, the software STELLA Systems Thinking offers the opportunity to create visual models that actively engage participants to study a wide variety of problems. The construction of a model allows to perform real-time analysis and offers the possibility to act in a more stimulating environment in order to reach conclusions.¹⁰ According to Greenberger et al., "Most models exploring insights of policy effectiveness are gained during the model building process, not after."¹¹

Therefore, it becomes more and more important to have a methodology to:

- Settle the goals of participatory modeling;
- Conceptualizing a system or problem;
- Facilitate knowledge sharing among different stakeholders;
- Increase the understanding of environment and landscape dynamics;
- Display the trade-off between conservation and development;
- Create a shared vision to achieve changes in the desired direction

bearing in mind that you work for exploring scenarios, not to predict the future.¹²

Robert Costanza, in commenting on the use of the software STELLA, shows three complementary and synergistic ways to promote public participation in the construction of integrated models:

- as "stakeholders" and active participants in the conceptualization, development, manufacture, test model, the development of scenarios and in the process of implementation;
- as "actors" of the model, the model is used as decision support and as a research tool to improve understanding of human behavior in complex evaluations and decision-making
- as "agents" in the model, built through a better understanding of their goals and behaviors, by carrying out steps 1 and 2.¹³

In conclusion, the approach based on simulation models is useful to guide participants facing the challenges set by bio-physical limitations, time and relationships (in other words, all sustainability aspects).¹⁴

The possibility of collecting data in real time, through **SCATOL8™**, and organize them in strings, together with the possibility to import such a data format from Stella, allows to feed a database to perform simulations related to scenarios, in order to define and discuss them with the participants.

Implementation of the system

⁹ Sandker, M., B. M. Campbell, M. Ruiz-Pérez, J. A. Sayer, R. Cowling, H. Kassa, and A. T. Knight. 2010. The role of participatory modeling in landscape approaches to reconcile conservation and development. *Ecology and Society* 15(2): 13. [online] URL: <http://www.ecologyandsociety.org/vol15/iss2/art13/>

¹⁰ By Diana M. Fisher, *Modeling Dynamic Systems: Lessons for a First Course*, 2nd Edition, 2007

¹¹ Greenberger, M., M.A. Crensen & B.L. Crissy (1976). *Models in the Policy Process*. New York: Russell Sage Foundation.

¹² Sandker, M, Spatial Projections of Participatory System Dynamics Modeling - Exploring Oil Palm and Carbon Payment Scenarios in Papua, Indonesia, in www.umn-lisah.fr/rtra-projects/.../Marieke_SANDKER.pdf

¹³ Robert Costanza, Applications to Landscape Modeling, 2008 ISEE User conference "Making Connections", Burlington, Vermont (USA)

¹⁴ Federico M. Pulselli, Simone Bastianoni, Nadia MArchettini, Enzo Tiezzi, *La soglia della sostenibilità ovvero quello che il PIL non dice*, Donzelli Editore, Roma, 2007

Following the logic of SCADA systems - Supervisory Control And Data Acquisition System, (which uses information and communication technologies to automate the monitoring and control of industrial processes, making available to operators the most important data in an intuitive manner), data are collected, processed and made available

As the SCADA systems do, the ELWSMS would run on procedures and on operative instructions related to the ELMS, transformed into "recipes" (set of instructions) aimed at achieving the desired outputs. To do this, we examine the procedures and instructions that make up the document management system, organizing them into primary instructions to a single program. The concatenation of elementary instructions is established with a flow-chart. The system connects with **SCATOL8™**, user interfaces and the Internet. The connection between the communication protocols regulating the flow of information between sensors, transmission and reception unit, receiving unit and between the PC and then between the PC and the Web is a complicated issue to address.

The system does not operate with the logic of expert systems (except when an event is seen as an alert related to environmental emergencies), expecting to replace humans, but as a tool for data processing and representation, to enable a shared decision-making approaching the different categories of staff.

Furthermore, applications' versatility coupled with the Internet websites leads to a wide range of modalities of internal and external communication.

The accessibility to the system via Web follows a hierarchical order, regulated by basis of the availability of information. The documents related to the system are made available to those who apply themselves; checklists (useful for documenting the enhancement of activities under the procedures and operating instructions) could be accessible to stakeholders.

The incorporation within ELWSM of data collected from the government then will optimize the management and disseminate awareness of individual actions' impact on the environmental and landscape variables controlled.

Conclusion

SCATOL8™ is the core of the evolution from ELMS to ELWSMS. It makes easy to acquire and organize data, thanks to a friendly approach to physical computing and to the experience poured day by day in Arduino's open newsgroups. Decisions are taken on the basis of data set, in order to manage an organization matching environmental and economic needs. Benefits of a quantitative approach are reflected both in the daily optimization of gathering, processing and disseminating information, and in the review stage of the system, with the possibility to analyze and develop scenarios, through dynamic simulation of the effects of decisions. Nowadays **SCATOL8™**'s quick progress are achieved thanks to the contribution of a multidisciplinary team of professionals, joined to integrate knowledge through mathematical tools and software writing. In this apparently artificial system, the human and their will are the key-factors for the evolution of ELMS.