ARTEMISIA: ACTIVE AND INTERACTIVE MONITORING OF THE FORESTS IN PROTECTED AREAS AIMED AT THE SUSTAINABLE MANAGEMENT OF NATURE

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Abstract

To pursue the usage of forests resources in the processes of economic and social development it is determining that the principles of natural heritage protection join in a concept of progress, based on evolution and technological innovation; the realization of innovative investigation and representation tools turns out to be useful to ease the integration of forests' resources in shared development processes aimed at enhancing the cooperation of local actors, and to ease the territory's sustainable growth and the development of the natural heritage. The integrated management of the actions aimed at protecting and easing the ecologic and recreative functioning of forests, which are increasingly exposed to pressures caused by several catastrophic factors, requires the tuning of modelling and active monitoring systems of the forests based on social networks and volunteering for the processes of data updating.

Keywords: *Open StreetMap , Eddy Covariance, carbon balance, isotopic analysis.*

Introduction

The new knowledge acquired in the field of forestry, adjustment and forestal economy bring to analyse a forest system as an overall system; this type of system involves an orientational management which tends to preservation or to the increase of biodiversity. Management is made more complex by the structural sophistication of forestal systems, and it results to be strongly decentralized. The several interests which are part of the forestal systems make it capable of satisfying society's exigencies and to enhance the local communities' experience (Ciancio, 2007). To support the sustainable management of forestal systems in protected areas in order to ensure bio-ecologic, environmental, productive and recreational results for the collectivity it is important to use the right tools of continuous and interactive monitoring. The idea is to create a modelling system of the forest environments and an active monitoring system based on social networks and on volunteering systems for data upgrade, in order to have the integrated management of all of those actions aimed at preserving and enhancing the ecologic and recreative functioning of protected areas, which are increasingly exposed to anthropic pressure and other pressure caused by several catastrophe factors. An examples of cooperative databases is

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Open StreetMap. Its update can be done by the users themselves, such as guides, excursion groups, simply interested citizens and so on. To pursue the usage of agro-forest resources in social and economic development processes is fundamental that the principles of protection of the natural heritage flow in a notion of progress based on technological evolution and innovation; the building of innovative survey and representation tools turns out to be useful without a doubt in order to have the integration of the forest resources in the processes of shared development intended to allow cooperation of local actors, and to accomplish the sustainable growth of the territory and the valorisation of the natural heritage. The tuning of data built by environmental markers and the usage of advanced diagnostics for the ecologic maintenance and restoration is intended to be, by the project's idea, a fundamental resource in the processes of knowledge and fruition.

Materials and methods

To make sure that the methods of environmental monitoring could effectively represent a support activity to the decisions, connected to the sustainable management of the forest heritage in protected areas, ARTEMISIA is proposed, which is the open active and interactive environmental monitoring system, capable of integrating considerations coming from several sources. The institutional disposition, the approach suggested by the european addresses and strategies in means of environment and sustainable development and the organisational modes adopted for the implementation of the regional developing plans, push towards the elaboration of an unitarian picture, of an unique strategy for the promotion of sustainable development also on a regional level. The development of monitoring instruments and methods of environmental monitoring and evaluation allows to build from below a common picture of the environmental sustainability achievements that are capable of easing the planning and evaluation processes and to promote vertical and horizontal integration in the phases of interventions' execution. In order to supply a cognitive picture that could be useful for environmental estimation during the phases of the program's actuation, it is suggested to define and adopt an "unitarian" environmental monitoring plan, capable of integrating surveys that are common to each regional territory development plan and program. The open source approach suggested for the environmental monitoring, other than allowing an integrated management, has the objective of contributing to the rationalisation of the information gathering systems giving its contribution to the systematisation of contextual environmental information and to the ones relative to the actuation of all the programs which act over the territory.

For the purposes of sustainable management of nature, the ARTEMISIA monitoring has the aim of setting an unitarian method for environmental monitoring in protected areas.

The diffusion of collaborative cartography softwares such as Open StreetMap has increased the public interest for the policies of nature's protection, as they allow to non-experts and outsiders to use open tools and techniques without having the

competences which have traditionally been associated with the discipline of geography.
It is possible, in fact, to download the Italian data of Open StreetMap in several formats, based on their usage. For example the GARMIN file for the whole Italy can be found in two versions, one for the vehicular routes and the other for executioners. There are also several vector formats which allow to analyse data through GIS.
The experimenting of the cooperative monitoring will be using some results, reached for the Campania region by the PON I-AMICA started in January 2012 in the field of the Programma Operativo Nazionale "Ricerca e Competitività 2007-2013", aimed at creating an integrated climatic-environmental observational infrastructure, which can be useful to raise the operative standards of the system of public regional research and to promote the development of entrepreneurial activities, but can be even more useful to support decisions in the field of environmental policies and territory's managements.
The interested study areas are the Naples' Bosco di Capodimonte (Figure 1) and the Oasi Variconi near Caserta (Figure 2). For what regards the Bosco di Capodimonte, the micrometeorology station will allow the complete monitoring of the concentrations of the main greenhouse gasses and will allow to define the role of vegetation on the deletion or creation of secondary polluting agents such as ozone and particulates. Near the mouth of the Volturno river, through the analysis of the stable isotopes of C and O, we have been investigating to check if the saline wedge phenomena (Sea Water Intrusion) was taking place in the aquifer.

Figure 1. *Capodimonte's site*

Capodimonte's park

The atmophere contains turbolent motions that transport trace gasses. The Eddy Covariance Technique samples these turbolent motions to determine the net difference of gasses moving across the canopy-atmosphere (Baldocchi 2003). The Eddy

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Covariance station at the Capodimonte site is under construction. To date, an important range of analysers has been collected, in detail: Irga analyser for CO2 and H2O Li – 7200 (LI-COR), CH4 Li – 770 (LI-COR) analyser, O3 Fast ozone analyser (Sextanttechnologyltd), Li – 7550 (LI-COR) interface, CNR4 radiometer (Campbell scientific), CR1000 acquisition system (Campbell scientific).

Figure 2. *Sampling transect from the mouth of the river to the inner part of Castel Volturno municipality*

In the near future, the equipment will be upgraded with an N2O, NOx and particulate analyser. The usage of specific software such as EdduPro and SmartFlux will allow to analyse the average values of gas concentration and meteorologic parameters during the days, the seasons and the years in order to keep track of the possible environmental-climatic changes. For the analysis of the particulate settle on leaves a SEM PhenomProX (Phenom-world) microscope will be used, which will allow to micro-analyse all the deposited elements. At last, the usage of softwares to quantify the positive effects of vegetation on the environment and on economy would be desirable, such as, for instance, the American UFORE (Urban Forest Effect) calculation model, developed in the 90's by the Forest Service of the U.S. Department of Agriculture.

The calculation is executed combining the structural data of vegetation with the ones on local pollution and on meteo conditions. This model is more and more used in Italy and worldwide thanks to the application of the iTree ECO that allows an easier and more immediate usage of the calculation system.

Variconi's Oasis in Castel Volturno

The study area includes the Oasi dei Variconi, which is part since 1993 of the Riserva Naturale Foce Volturno e Costa di Licola (www.agraria.org/parchi/campania/castelvolturno), and it goes for about 5 km along the SP16 road. The isotopic analyses concerned different sample types: well-exposed leaves, small portions of woody twigs of the two main species growing along this transect (U. minor and R. ulmifolius), water table and soil samples (Esposito et al, 2014). To reach the objectives we'll be referring to the isotopic composition of oxygen ($\delta^{18}O$) in water samples extracted from the shafts, xylem and from the ground, which will allow us to investigate on the water sources used. In addition, we'll be calculating the isotopic composition of carbon (^{13}C) of dry substances and of the solubles extracted from leaves, which will allow to examine the hydric usage of C3 (WUE) plants. Fully expanded leaves representing all the exposures around the crown, were taken from each tree. Leaves were labeled, freezed and finely powdered. From the same leaves, soluble compounds were extracted (Brugnoli et al, 1988). After the extraction, samples were freeze-dried. Subsamples of about 1 mg were used for isotopic determinations by means of a continuous flow isotope ratio mass spectrometer IRMS (Alessio et al. 2004). Samples were quantitatively combusted into an elemental analyzer (NA 1500; Carlo Erba). Carbon dioxide obtained was admitted in the helium stream to the IRMS (Isoprime Ltd, Isoprime). Isotope ratios (R=13C/12C) were measured in order to calculate ^{13}C, referring to the VPDB standard. Xylem and soil water was extracted from small lignified stems and soil samples using a cryogenic vacuum line. Analyses of $\delta^{18}O$ of water samples, soil and xylem water (about 1 ml), were performed by isotopic ratio mass spectrometer (Isoprime, Isoprime Ltd) coupled with multiflow (BIO; Isoprime) and autosampler (222XL; Gilson). $\delta^{18}O$ was calculated referring to the international VSMOW standard (Table 1).

Element	*Stable Isotopes*	*% Average abundance*	*Standard*
Carbon	^{12}C	*98.892*	*V-PDB (Vienna-Pee Dee Belemnite)*
	^{13}C	*1.108*	
Oxygen	^{16}O	*99.759*	*V-SMOW (Vienna–Standard Mean Ocean Water)*
	^{18}O	*0.2039*	

Table 1 *Isotope ratios refer to the international standard*

Results

While in Capodimonte's project we're still in a preliminary phase, the first results of the Castel Volturno area have already been published, which show a wide variation in of leaves sampled in October 2013. In particular, delta ranged from 18,7 ‰ to 22,8 ‰ for U. minor and from 19,4 ‰ to 24,2 ‰ for R. ulmifolius. The mean value of leaf delta for U. minor was lower than that observed for R. ulmifolius. Moreover, R. ulmifolius plants showed an increasing trend of leaf along the transect, from the coast close to the mouth of the river to the inner region (Esposito et al, 2014). $\delta^{18}O$ of the xylem water sampled in October ranged from - 3,8‰ to -6,1 ‰ for U. minor and from 0,1‰ to -5,1‰ for R. ulmifolius, respectively. These

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values matched those detected in water samples of wells collected in the same seasonal period and of soil samples taken in July 2012 at different depth (Esposito et al, 2014).

Discussion and conclusions

Open StreetMap is a project which aims at creating and publishing cartographic data for free; it is a collaborative project finalised at creating free-content maps. The aim is a world-wide collection of geographic data, with the main purpose of creating maps and cartographies. For this purpose, the two mentioned studies within the PON I-AMICA can be an integrating part of the Open StreetMap system (Fig 3).

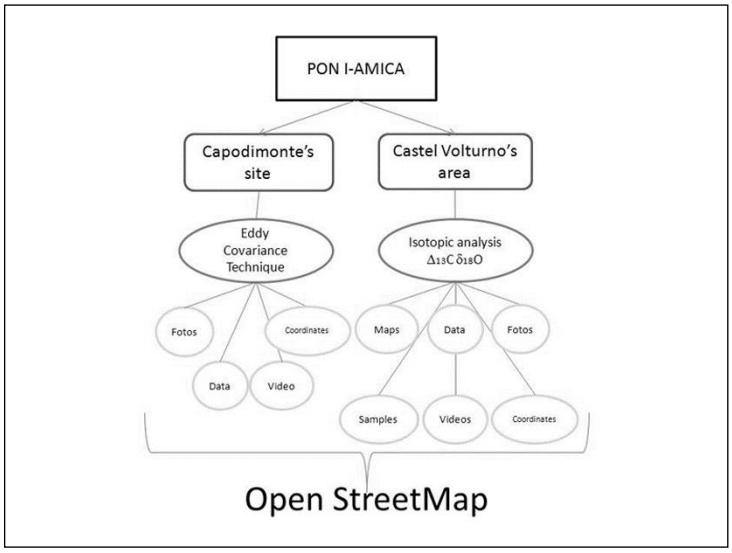

Figure 3
An example of Open StreetMap system

All the available information (coordinates, pictures, historical sets of data, new data) gained in the course of the project, can be uploaded in the system. Anyone can contribute enhancing or correcting data. The maps are created using as reference the data recorded by GPS devices, aerial photographs and other free sources. The data for the realisation of maps are gained by the observations made by volunteers whom systematically survey with GPS and record routes, using smartphones, laptops or vocal recorders, and the gathered information are introduced in the database, in vector format.

The territory survey are made by foot, on bicycles, in car, train or any other transportation means using a GPS unit. Other than the database with meteorology, it is possible to bring several modifications to the database which are made by contributors whom control data, add characteristics and correct mistakes.

The community is the fundamental element of this monitoring as it is the entity charged to upload and control data; the community has another innovation, which is the one of social media, apps and new technologies which allow remote monitoring.

The social Networks represent an huge and useful database to monitor spatial relations; it creates a networks of information, which if correctly exported and elaborated, get the shape of something real; each data becomes a source of information, after being extracted and visualised.
The social network have proved to be faster, and the contents created by the fritters represent the footprint of the community in the description of the territory.
For environmental communication, several software have been developed aimed at supplying knowledge, tools and methods necessary to achieve an Open Source environmental monitoring. Open source software allow the free study and the provision of modification by other independent developers.
And this allows to have an active and interactive environmental monitoring which integrates geographically separated programmers' contribution, giving them the chance to coordinate and work on projects of environmental protection.

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ARTEMISIA: MONITORAGE ACTIF ET INTERACTIF DU PATRIMOINE AGRO-FORESTIER DANS DES AIRES PROTÉGÉES, QUI À COMMEBUT CELUI D'ATTEINDRE UNE GESTION DURABLE DE LA NATURE

Résumé

Pour atteindre l'exploitation des ressources agro-forestières dans des processus de developpement économique et social, il faut absolument que les principes de protection du patrimoine naturel s'unissent à la notion de progress fondée sur l'évolution et innovation technologique; la realization d'outils qui permettent des études innovateurs, favorise l'intégration des ressources agro-forestières dans desprocessus de developpement, avec le but de favoriser la coopération des acteurs sociaux , de réaliser la croissance durable des territoires et finalement de mettre en valeur le patrimoine naturel. La gestion durable unie aux actions destinées à protéger et à favoriser un fonctionnement écologique et récréatif des forêts, constamment exposées à differents facteurs catastrophiques, exige la mise au point d'un système de monitorage actif fondé sur les réseaux sociaux et sur les systems volontaires qui permettent la mise à jour des données.

Mots-clés: *Open Street Map, Eddy covariance, bilan carbone, analise isotopique.*

ARTEMISIA: MONITORAGGIO ATTIVO ED INTERATTIVO DEL PATRIMONIO AGRO-FORESTALE IN AREE PROTETTE FINALIZZATO ALLA GESTIONE SOSTENIBILE DELLA NATURA

Riassunto

Per perseguire l'utilizzo delle risorse agro-forestali nei processi di sviluppo economico e sociale è determinante che i principi di tutela del patrimonio naturalistico confluiscano in una nozione di progresso basata sull'evoluzione e l'innovazione tecnologica; la realizzazione di strumenti di indagine e di rappresentazione innovativi risultano essere sicuramente utili per realizzare l'integrazione delle risorse agro-forestali in processi di sviluppo condivisi e partecipati intesi a favorire la cooperazione degli attori locali, e realizzare la crescita sostenibile dei territorio e la valorizzazione del patrimonio naturalistico. La gestione integrata di tutte quelle azioni volte a proteggere e a favorire il funzionamento ecologico e ricreativo delle foreste, sempre più esposte a pressioni causate da fattori catastrofici di varia natura, richiede la messa a punto di un sistema di modellazione dei sistemi agro-forestali e di un sistema di monitoraggio attivo basato su social network e sistemi volontari per l'aggiornamento dei dati.

Parole chiave: *Open StreetMap, Eddy Covariance, bilancio del carbonio, analisi isotopica.*