Landscape history and heritage revaluation in Olzinelles valley (Montnegre, NE Spain): a socioecological approach (1851-2006)

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Abstract

One of the features of the new scientific framework that is emerging as a response to global environmental crises is the attempt to dissolve classical nature and culture separation and to overcome excessive specialization in unconnected fields. In this context, disciplines as geography, agroecology, landscape ecology and environmental history try to integrate social science and natural science to obtain a better understanding of environmental problems and to find appropriate solutions. Land use and land cover change, one of the most relevant components of global change in terrestrial ecosystems, can be studied at a local and regional level through an environmental history analysis, which is specially useful considering temporal and spatial scale dependency of such phenomena. In this communication we report the first results of an interdisciplinary research on landscape changes and heritage revaluation that is being carried out in Olzinelles valley (Montnegre, NE Spain), considering the period 1851-2006. We use the concept of socioecological heritage to describe a selection of evidences of historical evolution of landscape, and we applied it to the study area, where we have detected 263 elements. We report an important depopulation process with a loss of 85% of the population of 1924 in 2006. Future research will try to correlate demographic evolution of the twentieth century to changes in land use and land cover.

1. Introduction

The need to understand environmental problems and find suitable solutions, one of the biggest challenges that society faces nowadays, has driven science to new methodological and epistemological approaches aimed at overcoming the classical nature/culture separation, integrating parcelled knowledge into interdisciplinary views and taking into account the importance of those forms of knowledge that are not based in scientific method. This new conceptual paradigm has appeared in different moments and in different fields of knowledge, following an opposite trend to contemporary science, which tends to increase specialization in unconnected fields (Toledo, 1998). Nature and culture separation is being criticized by the Colombian philosopher Augusto Ángel, who stands that the deep change in conceptual relation between man and nature that meant platonic split or dualism would be the cultural basis of current environmental crisis (Ángel, 2001). The platonic division between sensitive world (body and nature) and real world (soul) would have been incorporated by Christianity into its dogma, and would have arrived to modernity under the forms of object and subject (Noguera, 2004), separated nature and culture. The critic to the "ontology of split", as it has been named, is the departure point for the construction of a new environmental philosophy whose main objective is to recover the lost unity between these two domains. As Noguera (2004) points out, the construction of this environmental thought can be compared with a rizomatic growth that breaks with linearity and Cartesian order and that integrates unknown actors for anthropocentric modernity.

Nature and culture separation divides clearly the fields of study to undertake by scientific knowledge (Boada & Saurí, 2002), and may lead to a subordination of social sciences to natural sciences (Wynne, 1994) in global change studies. Besides this clear division we see, as pointed out before, a big specialization of knowledge in unconnected fields, which has been named as "Neo-obscurantism" by Naredo (Toledo, 1998). According to Edgar Morin, the main limitation of the predominant style of doing research is the "simplifier paradigm", a way to organize knowledge that eludes the increasing complexity of contemporary reality (Toledo, 2005). In this context, hybrid disciplines are different proposals to integrate knowledge into interdisciplinary views. Among them we find agroecology, environmental history and landscape ecology. Agroecology considers agriculture as a coevolution between social systems and ecological systems, and as information comprised in local cultures. While agronomists develop new technologies based in scientific knowledge to modernize traditional agriculture, agroecologists study traditional technologies of peasants and indigenous people to obtain modern scientific knowledge (Norgaard, 1985). The role played by traditional primary activities in maintaining landscape structure and biodiversity is taken into account by landscape ecology, whose principles can be applied to ecosystem management and conservation practices. Not considering or even forgetting the role of traditional management has been a distinctive feature of the responsible staff in charge of protected areas in the province of Barcelona (Otero & Boada, 2006), as well as in any other protected areas worldwide.

Environmental history, born at the beginning of the seventies when environmental crisis was perceived by scientific international community and when the first ecologist movements appeared (Worster, 1988; González de Molina, 1993), is another hybrid discipline. It provides an appropriate framework to analyse regional consequences of global change (Otero, 2005), specially regional and local land use and land cover changes. Geography, which is recovering the lost environmentalist tradition after a period of dualism strengthening, makes important contributions to the study of these changes through the application of the systemic approach into the international research programme LUCC (Boada & Saurí, 2002). Changes in land use and land cover are the main component of global change in terrestrial ecosystems (Turner, 1990), and its effects may be more important than those associated with potential climate change (IGBP, 2004). So a deeper understanding of this phenomenon is needed to inform society about consequences of its socioeconomic activity and to design adequate mitigation and adaptation strategies.

2. Objectives and methodology

Regional consequences of global change have been demonstrated in some Mediterranean regions of Catalonia by different studies. Peñuelas *et al.* (2002) have provided evidence of altered life cycles for some of the most abundant Mediterranean plants and birds, and one butterfly species for the period 1952-2000 in Cardedéu (Catalonia, NE Spain), as a consequence of an increase in temperature. Because of the different responses of the species, these climate-driven changes may lead to a decoupling of species interactions and alter the structure and functioning of communities (Peñuelas *et al.*, 2002; Peñuelas & Filella, 2001). Peñuelas & Boada (2003) reported a progressive replacement of cold-temperate ecosystems by Mediterranean ecosystems in Montseny mountains (Catalonia, NE Spain), where beech (*Fagus sylvatica*) forest has shifted altitudinally upwards by ca. 70 m at the highest latitudes (1600-1700 m) and is being replaced by holm oak (*Quercus ilex*) forest at medium altitudes (800-1400 m), as a consequence of warmer conditions complemented by the land use changes. A logical hypothesis emerges when analysing global change-induced cover shifts in Mediterranean mountains of Catalonia: forest appropriation, cultivation and farming have strongly decreased in last 50 years and this would lead to an increase in forest area and forest density. The landscape homogenization may have produced a decrease of open habitat and ecotonic species and

may have increased forest vulnerability to severe forest fires, in a complex process where increase in mean temperature affects both causes and consequences of land cover change.

The area under study has an extension of 1.130 hectares and is mainly occupied by Olzinelles valley, located in Montnegre Mountain (province of Barcelona, NE Spain), which is part of the Catalan Coastal mountain range. A 94% of the area is covered by forests, mainly cork oak (*Quercus suber*), holm oak (*Q. ilex*) or mixed forest (holm oak with cork oak or holm oak with *Q. humilis*), while only 3% is covered by active fields. The population, 27 inhabitants, is scattered in *masos*, the traditional cultivation and farming unit of Catalan countryside. Land tenure is private in all the area and 60% of it belongs to properties bigger than 95 hectares (38% of study area belongs to one property). Since 1989, 74% of the area is included in the Montnegre-Corredor Natural Park. Olzinelles used to be an independent municipality since 1927, when it was annexed to Sant Celoni municipality. The ongoing project is being carried out with support from its city council, in an attempt to revalue a rich heritage that is being "buried" by forest. The objectives of the project are to analyse land use and land cover change in an environmental history approach (1851-2006); to compile and revalue the socioecological heritage of traditional activities, to compile traditional agrosilvopastoral knowledge and to use oral sources for the historical analysis. Methodology is based on generating a map of current land use and land cover by means of different cartographic sources; inventorying fauna and flora and studying its relation to different vegetation units; making an analysis of the evolution of population and landscape based on historical documents (1851-2006); combining information from photointerpretation of aerial photographs of 1956 and 2004 using GIS tools; inventorying elements of the socioecological heritage of traditional activities and compiling traditional knowledge by means of personal interviews and the creation of an audio file collection.

3. Results and discussion

3.1. Land use and land cover, flora and fauna

To create a current vegetation map we have used the cartographic information supplied by existing forest management plans of private properties[1], which account for 71% of the study area, and a vegetation map of Montnegre-Corredor Natural Park[2]. The basic cartography is topographic maps and orthophotoimages of 2004 (scale 1:5.000). Field work has been carried out to check source validity and to unify criteria in mapping land covers/uses[3]. Olzinelles valley is mainly occupied by forests: 30% of coppiced cork oak (*Quercus suber*), 22% of coppiced holm oak (*Q. ilex*) and 31% of mixed forests (holm oak with cork oak or holm oak with *Q. humilis*). Another relevant forest cover is European alder (*Alnus glutinosa*) forest along streams (3%). Coniferous cover (*Pinus pinea, P. radiata* and *P. pinaster*) accounts for 5% of the total area, while 3% is occupied by active fields and 2% by plantations of plane trees (*Platanus* sp.). Finally, quarries account for 1% of the area. To inventor the fauna we have conducted a bibliographical review of species cited in the study area and we have used direct or indirect observation in field work. The results, in number of species, are: 9 amphibians and 10 reptiles (31% and 16% of the species in Spain according to

[1] *Plans Tècnics de Gestió i Millora Forestal*. They provide a map with the vegetation and management units of the property (scale 1:5.000). These documents are usually made by forest engineers and approved by Forest Property Centre, a body of the Catalan Government in charge of private forest planning and management. Plans used (8) were drafted between 1998 and 2003.

[2] Supplied by Natural Park technical staff (scale 1.10.000). It was made using fotointerpretation and field work in 1997.

[3] According to Turner *et al.* (1995) land cover "is the biophysical state of the earth's surface and immediate subsurface" and land use "involves both the manner in which biophysical attributes of the land are manipulated and the intent underlying that manipulation", that is the purpose for which the land is used. We realised that, as in other land use and land cover change studies, distinguishing use from cover is not easy and it may not be even fruitful.

Pleguezuelos et al., 2002[4]), 4 fishes, 72 birds (3 of which are considered threatened in Catalonia according to Estrada et al., 2004) and 23 mammals[5] .

3.2. Socioecological heritage: a piece of history

Next step has been to study the heritage, to which it has been given a new conceptualization to overcome the nature/culture division. The separation mentioned in the introduction is also present in heritage conceptions and studies (natural vs. cultural heritage), and socioecological heritage tries to integrate them into a broad category that could be defined as a selection of evidences of historical evolution of landscape, or as environmental legacy. Elements of socioecological heritage have been georeferenced, described in a catalogue, classified in a database and represented in maps. The results show a large number of elements with a positive relation with the sampling effort: the more the researcher walks along the paths, through the forest or along the edge of the fields, the more amount of socioecological heritage he will find. Landscape in Olzinelles is very rich in environmental legacy, it incorporates history in its own structure. Table 1. shows the results and classifies the elements of socioecological heritage into eight categories.

Table 1. Elements and categories of socioecological heritage in Olzinelles valley

Category	Nº of elements	Subcategories
Architectural and archeological elements	190	*Masos** (conserved and in ruins), water management infrastructures, constructions related to agrosilvopastoral activities, rural industries, constructions and ways related to transport and mobility, religious buildings
Ancient and remarkable trees	49	Ancient trees, remarkable trees and singular trees
Disappeared elements	9	*Masos*, others
Habitats of interest	8	European interest, local and regional interest
Legends and stories	7	Legends, stories and anecdotes
Species of interest**	?	European interest, local and regional interest
Genetic varieties of cultivated species***	—	Fruit trees, grapevine, vegetables
Tools[3]	—	Primary industries, domestic, others

Source: Field work, oral sources and review of local studies.
* *Mas* (or *masia*), in the sense used here, is the traditional familiar house of the Catalan countryside.
** The criteria to consider a species of interest (European and local/regional) is still being discussed.
*** Results not available.

Some explanation has to be given to the fact that we consider all categories in Table 1. as "socioecological", that is, having a double nature. The existence of one type of habitat, an active field for example, is the consequence of an interaction between biophysical and socioeconomic factors, and its conservation depends on the maintenance of both driving forces. In the case of species, flora and fauna have also an important cultural and socioeconomic dimension. For example, even though wild boars (*Sus scrofa*) haven't biological adaptations to the night, they have adopted nocturnal habits in order to avoid contact with human beings, the big predator that has hunted them along centuries. The age and the form of an ancient or remarkable tree depend on biological specific factors, but also on forestry practices. Similar arguments could be given for the other categories. Local knowledge can be considered part of socioecological heritage, but it will be treated separately.

[4] This percentages may have changed due to the description of the new endemic species of brook newt *Calotriton arnoldi* in the Montseny mountains (Catalonia, NE Spain) by Carranza & Amat (2005).
[5] new one may be added if the sampling campaign of micromammal *Arvicola sapidus*, which has to be done along the river in recent future, confirms the suspicions about its return to the valley (see 4. *Provisional conclusions and next steps*).

3.3. Changes in landscape and demographic evolution (1851-2006): first results

3.3.1. Changes in landscape between 1851 and 1862

To study the changes in landscape between 1852 and 1862 we have used the *amillaramiento*[6] of Olzinelles municipality of 1862, as well as the interpretation that Nadal & Urteaga (1997[7]) made of the *amillaramientos* of 24 municipalities of the Montnegre-Corredor region, including Olzinelles, from 1852 to 1862[8]. According to these authors, two key factors were influencing changes in landscape of Montnegre-Corredor region from the middle of the nineteenth century. Arrival and expansion of railway from 1848 onwards were going to drive urban and industrial growth in the region, and the expansion of pest *Oidium tuckeri* in 1852 destroyed more than half of the vineyards in ten years, causing a decrease in agrarian area of about 11%. So the increase in agrarian area that took place in Catalonia during the nineteenth century didn't follow a linear trend and was not homogeneously distributed throughout the country. Another distinctive aspect of landscape of Montnegre-Corredor region was the existence of large extension of woods. In 1862 the percentage of agricultural area was the lowest of the Coastal region in Catalonia, but the predominance of cereals and vineyards in the cultivated land was a common feature, reflecting a quite high level of agrarian specialization linked with trading of products as wine (Nadal & Urteaga, op. cit.). According to these authors, the municipality of Olzinelles[9] had the lowest population density in the region in 1860 (13 h/km^2 compared to a mean of 120 h/km^2) and a lower percentage of agricultural area in 1862 (11.8% compared to a mean of 26.7%). In the period 1851-1862 the agricultural area decreased a 6.8% and the relative importance of vineyards decreased (from 64.9% to 56.5% of cultivated land), while cereals gained relative importance (from 33.7% to 41.2% of cultivated land), probably as a consequence of the pest. In 1862 there were 119 ha of vineyards less than in 1851, but with the available data we can't say whether they evolved to forest or they were replanted with new grapevines.

3.3.2. Demographic evolution between 1924 and 2006

Population growth is considered a basic driving force of global change, and increase in population can be associated with changes in land use and land cover (Turner *et al.*, 1995). In the case of the opposite trend, depopulation in rural areas, it has been stated in a polemical article published in *Science*, that it has allowed ecosystem recovery in Latin America, and that conservation policies should focus on preparing rural migrants for an urban environment and should promote ecosystem recovery in the lands that are abandoned (Aide & Grau, 2004). In Mediterranean forest ecosystems, however, it has been pointed out that rural depopulation is causing environmental degradation (Boada & Saurí, 2002) or loss of biodiversity (Boada, 2002), but it also has permitted an important recovery of the forest area and cover.

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[6] The *Amillaramiento* is documentation derived from the fiscal reform of the Spanish government in 1845, which established a tax on the product of properties, cultivations and livestock. It consists of a list of the land owners of the municipality and its properties, specifying the area, the type of use (cereal, vineyard, forest, etc.) and the amount to pay for each parcel. The fact that it is documentation about taxes may lead to the conclusion that they are not reliable due to a potentially high level of property hiding, but in the province of Barcelona and in Montnegre-Corredor region it has been proved to be a reliable historiographical source (Source: see note 8).

[7] Nadal, F., Urteaga, L., 1997. L'evolució del paisatge a les Serres del Montnegre i el Corredor (segles XVIII-XIX). Unpublished. Library of Montnegre-Corredor Natural Park. Municipality of Sant Celoni.

[8] Data for Olzinelles municipality refer to the *Amillaramiento* of 1851.

[9] The area of the municipality of Olzinelles in this period is 2.350 ha, about twice the study area. So the trends reported here don't refer exactly to study area but can be used to understand how landscape was changing and why.

We analysed demographic evolution in study area using administrative registers that range from 1924 to 2006. Figure 1. shows the quantitative evolution of population in Olzinelles valley, where the 179 inhabitants of 1924 have decreased to 27 in year 2006. New data from the seventies may confirm our suspicion that the demographic minimum of the analysed period took place in this decade.

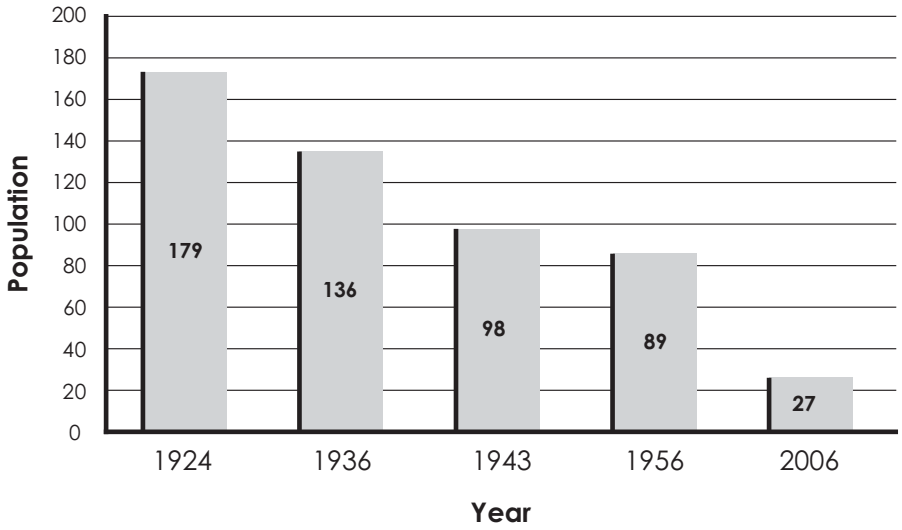

Figure 1. Evolution of population in Olzinelles valley in number of inhabitants (1924-2006).
Source: Census of Olzinelles municipality, 1924; Census of Sant Celoni municipality, 1936; Book of Status *animarum* (Olzinelles parish), 1943-1956; Census of Sant Celoni municipality, 2006, and search in current inhabitants.

We find also a decrease in the number of inhabited houses (31, 29, 20, 18 and 10 for years 1924, 1936, 1943, 1956 and 2006), in a clear process of abandonment of *masos* and its related traditional management practices. In the field work eight *masos* in ruins have been found. In 1924 and 1936 a third of the population older than 10 years had occupations related to primary intervention (peasants, shepherds, etc.), but this is underestimated due to the consideration of all women occupation as "domestic labours", even though they may had an important role in cultivation and farming[10]. Current analysis of the evolution of forest utilization in the second half of the twentieth century and future fotointerpretation exercise (see 4. *Provisional conclusions and next steps*) will try to correlate observed demographic evolution to changes in landscape, in order to demonstrate the initial hypothesis. As pointed out by Ninyerola *et al.* (2004), future distribution of land covers in Montnegre-Corredor Natural Park may be affected by increases in mean temperature and precipitation due to climate change, so scenarios about evolution of land use and land cover will have to take this into account.

3.4. Integrating traditional knowledge and oral sources into the "scientific" study

Traditional knowledge has been compiled by means of personal interviews to a sample of 8 people that is living or used to live in Olzinelles and that used to work on primary activities (timber and firewood felling, charcoal production, cultivation and farming) or on feminine domestic labours on *masos*[11] (taking care of children, cooking, washing clothes), often forgotten in studies about traditional knowledge. Interviews were semi-conducted and interviewer used a simple

[10] In addition, the sources of 1924 and 1936 (see Figure 2.) have allowed us to calculate the level of illiteracy in the population older than 10 years: 26.3% and 19.6% respectively.
[11] See first note in Table 1. for the meaning of this word.

and even mimetic language, without technical terms, in an informal and friendly conversation. Information to be obtained was previously organized in different categories and subcategories, i.e.: 1. Management and utilization of natural resources: 1.1 Charcoal, 1.1.1 Process of production of charcoal, 1.1.2 Transport and trading of charcoal; 1.2 Timber and firewood, 1.2.1 Species used and felling technique, 1.2.2 Number of workers and length of campaign, etc. The interviews have been completed with other visits, conversations and field work with people of the sample, in a participative research that has increased amount and quality of information supplied and enriched researcher's view of socioecological reality.

Interviews have been recorded with a digital recorder that has allowed introducing data to the PC, where the different audio files of the interviews have been organized in folders. The total time recorded is more than 9 hours. First of all the interviews have been listened and the information contrasted and integrated into the socioecological heritage catalogue (see *2. Socioecological heritage: a piece of history*) and into the historical analysis. Secondly, we are starting the literal transcription of the interviews, which will allow the analysis of information from a hermeneutical standpoint and further integration in the study. The collection of interviews, with its transcriptions and data associated, will be placed in a library of Sant Celoni, where it will be able for future research and for citizens and schools interested in using the information for different purposes.

4. Provisional conclusions and next steps

Global environmental crises drives science to reconsider its own bases, in a process of change that is not only a scientific response. Capra (1998) generalises Kuhn's concept of *scientific paradigm* to social paradigm, and stands that we are living a change of *social paradigm*, a transformation similar to the big cultural change that Ángel (2001, 2001b) is asking for from a philosophical standpoint. The challenge for environmental science regards to the application of interdisciplinarity principles into concrete methodologies without falling in a non rigorous or wrong analysis. Analysis of land use and land cover change in agricultural and forest landscapes in Mediterranean areas offers the possibility to apply new methodologies that contribute to global change understanding from a local and regional level study. Environmental history, although it may reflect some of the existing tensions between social and natural science in global change research (Boada & Saurí, 2002), can be fruitful to analyse socioecological land use and land cover changes in an attempt to dissolve nature and culture in history.

The concept of socioecological heritage has been used to apply the conceptual framework into the study and to revaluate the heritage in Olzinelles valley, where a rich environmental legacy has been detected. Even though we need further ontological discussion about what is and what can be considered as socioecological heritage, we are already applying the concept to other studies[12] related to nature conservation. The first historical results for the second half of the nineteenth century show the importance of regional and local studies of land use and land cover change, in so far as these changes are scale dependant. As it has been pointed out by Nadal & Urteaga (1997[13]), agricultural expansion in Catalonia during the nineteenth century needs to be clarified and studied in detail at different spatial and temporal scales. With regard to the twentieth century, the impacts of rural depopulation (a loss of 85% of population since 1924) in land use and land cover distribution will be studied in immediate future.

[12] Badia, A.; Boada, M.; Estany, G.; Maneja, R. i Otero, I., 2006. Diagnosi dels usos del sòl i qualitat ambiental del Tet – Mont-rodon. Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona (unpublished).
[13] See note 8.

Rural depopulation in Olzinelles valley puts an end to traditional knowledge and its related management practices, meaning a loss of information that reduces the management options and decreases conservation possibilities from the landscape ecology point of view. Science hasn't taken into account the "other forms of knowledge" (Funtowicz & Ravetz, 2000), and in the study area these haven't been studied neither from anthropology. In the Fourth Ministerial Conference on the Protection of Forests in Europe, held in Vienna in 2003, the Signatory States and the European Community committed themselves to raise awareness of the contribution of traditional knowledge and practices in sustainable forest management for the protection of landscapes, the conservation of biological diversity as well as for protection against natural hazards (MCPFE, 2003). Although some anthropologists are working on an interesting *symmetric co-production* of knowledge between lay and expert views (Delgado, 2005), we have tested a methodology to compile traditional knowledge and integrate the information supplied by oral sources into the study, in an attempt to gather some of the huge amount of information that is being lost rapidly in the last decades. This methodology is being adapted and improved for the project "Memòries d'una feixa. Matadepera 1931-1983"[14], which is going to make an analysis of the postwar period of dictatorship and the transition to democracy in the town of Matadepera (province of Barcelona), in an environmental history approach based on oral sources. Disappearance of local culture from the ecosystem dynamics is already having negative effects for the system from the sustainable development perspective. Rural culture is substituted by urban culture, which begins a new relation with forest resources, related to leisure time and nature conservation in the new Natural Park framework. The transition from a historical primary land use to a tertiary one would lead most probably land cover to Braun-Blanquet's climax, questioned by some ecologists[15], and would increase vulnerability to severe forest fires as main alteration factor. Other potential changes to be proved with further research are landscape homogenization and loss of ecotonic and open space species.

We are starting the combination of the aerial photograph of 1956 with that of 2004[16], to quantify the changes in land use and land cover that have taken place. As we have seen, from the second half of the nineteenth century Olzinelles valley has been a much forested area, but changes in forests and fields still have to be studied in detail. The evolution of timber and firewood felling is already being studied by means of the administrative registers of the forest authority (1956-2006), a detailed documentation that may be used in future studies. A photographic diachronic analysis will be used to complete the information obtained in the fotointerpretation. Considering that the micromammal *Arvicola sapidus* may have returned to Olzinelles stream after two or three decades of absence, and that it is a potential bioindicator species[17], we will evaluate its role to monitor the socioecological changes reported in the study. It will be done by sampling the potential population with Sherman traps in selected areas along the stream and by reconstructing the evolution of the species with oral sources. Finally, we will study the environmental impacts observed in Olzinelles valley and make a proposal of environmental management of the area. The publication of a book for the general public with the results of the research will contribute to the revaluation of an unknown socioecological heritage and to a better understanding of socioecological changes in Olzinelles.

[14] Ruiz, V. & Otero, I. (coord.): Methodology has been already designed, initial sample of interviewed people has been decided and research team is being formed.

[15] See Bazzaz, F., Sipe, T.W., 1987. Physiological ecology, disturbance and ecosystem recovery. In: Schulze, Wölfer, H. (Ed.) Potentials and Limitations of Ecosystem Analyses. Springer-Verlag, Berlin.

[16] The photograph of 1956 (scale 1:32.000) comes from the flight of the Army and the one of 2004 (scale 1:5.000) has been displayed from ICC (Cartographic Institute of Catalonia).

[17] Personal communication of J. Ventura, from the Department of Animal Biology, Vegetal Biology and Ecology of the Universitat Autònoma de Barcelona (2005).

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