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TOWARDS A GLOBAL STRATEGY FOR THE ENVIRONMENTAL SUSTAINABILITY OF THE PROVINCE OF CUENCA (SPAIN)

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This article reflects on whether to raise an overall strategy for conservation of nature that goes beyond the preservation of the areas that already enjoy a form of protection. It argues the need to expand the existing network of protected areas, buffer zones and incorporating biological corridors that function as connectors of the core areas. Also, it points out the obligation to regulate land use to ensure sustainability and conservation of biodiversity. Using GIS spatial analysis techniques and the use of satellite imagery, are designed buffer zones that protect the ten areas of the Natura 2000 network present in the northwestern province of Cuenca, and river corridors. This ecological network has expanded occupies 337,298 ha, or 55% of the total area of study.

I. OBJECTIVE

The main objective of this paper is to propose an operational methodology to design a network of natural areas, geographically interconnected with each other and complementary to those already protected by the regional networks, national and European level. The purpose of this network is to extend the conservation of nature, by adding two additional figures to the areas already covered. On the one hand, the buffer zones that surround and protect the most valuable natural areas, absorbing the environmental impacts that eventually could affect them. Furthermore, adding the corridors, river type, which provide connectivity between areas of greater value. The aim, in other words, regulate and manage, with less intensity, land use in these areas of influence, pursuing sustainability.

II. STUDY AREA

This work has been tested in three districts of northwestern province of Cuenca. This province is committed to sustainable development and the implementation of Local Agenda 21 since 2002. The Diputación de Cuenca and municipalities of the province are part of the Network of Sustainable Cities and Towns of Castilla-La Mancha, a regional network that aims to help local authorities in the design and implementation of Local Agenda 21. Cuenca province covers an area of 17,140 km^2 and it is constituted by 238 municipalities. According to data from Census 2009, has a population of 217,363 inhabitants. 70% of its municipalities have fewer than 500 inhabitants and an aging population. The population density of the province is 12.68 inhabitants/km^2. The three regions mentioned are: La Mancha Alta Conquense, west of the province, covers an area of 1,775 km^2 distributed in 28 municipalities. In 2009 had a population of 30,408 inhabitants. The Alcarria Conquense in the northwest of the province, made up of 42 municipalities and an area of 2,514 km^2. In 2009 had a population of 11,487 inhabitants. The Sierra Media Conquense in the center of the province, made up of 28 municipalities and covers an area of 1,798 km^2. In 2009 had a population of 12,205 inhabitants. In summary, the three regions with a population of 54,100 inhabitants, distributed over an area of 6,087 km^2, with an average density of less than 8 inhabitants per km^2. Our research group is collaborating on the design and implementation of Local Agenda 21 in each of the three regions.

III. MATERIAL AND METHODS

The data used as sources of this work have been the coverage of Protected Natural Areas EUROPARC-SPAIN and Special Protection Areas for birds and Sites of Community Importance of the Database of Biodiversity, Ministry of Environment and Rural and Marine Affairs, in order to locate the core areas or Natura 2000 network areas.

From surveying the digital cartographic base of scale 1:50,000, from the geographic center of the Army, have been extracted permanent rivers and water bodies in order to generate the fluvial corridors. In order to examine the sustainability of current land uses in the areas of Natura 2000 and the buffer zones proposed in this paper we have used a land use map, a map of agroforestry land capability and slope map. It has also used the map of visual quality of the landscape, in order to know what proportion of the landscape of visual quality is high or very high content in natural areas of interest proposed in this paper (Natura 2000 areas, buffer areas and fluvial corridors) and wilderness areas that eventually could form forest corridors. The methodology is based on the approach made by Bennett and Mulongoy (2006), in the context of the review of experiences with ecological networks, corridors and buffer zones in order to provide ideas for integrating protected areas into wider networks that maintain ecological structure and function and relations with neighboring protected areas.

We used the basic functions of spatial analysis in a GIS to delineate areas of influence of the areas of Natura 2000 and the permanent courses and water bodies, as a buffer. By design tool buffers, has drawn a protective perimeter of 5,000 m. around the areas of the Natura 2000 network as a buffer zone. Also, around perennial streams and water bodies have

been delimited river corridors. Depending on its geographical context, are given unequal treatment. When the bodies or streams crossing wild and semi-natural vegetation zones or when these areas are less than 10 m. away from those, the river corridor has a width of 1,000 m. on each side of the hydrographic entity. However, when the waters pass through farm land, these biological corridors have been narrowed to 200 meters on each side. Complementary methods are being tested for the forest connectors design using visual analysis of land use map and satellite imagery and aerial orthophotos. Besides the analysis of the morphology of the patches, also consider the visual quality of the landscape to select, within such corridors, those portions of the territorial matrix of higher landscape value.

To ensure that river corridors type perform their mission to link the core areas, we calculated an index of connectivity, at the landscape level, defined by the number of functional connections between all the patches of the same type of land use. Previously, it has been reclassified land use map by grouping the thirty-six original categories into three main classes: artificial areas, agricultural areas and the areas occupied by natural and semi-natural vegetation. These include grassland, shrub and tree stands occupied by monospecific formations or mixed formations. The results indicate where they are connected each pair of patches, according to a circular analysis window of 1,000 m. side. His range of values moves between 0 (is a single union or any of the patches are connected) and 100, when all the patches in the analysis window are connected. Conversely, we calculated an index of fragmentation, at the landscape level, considering a moving window of 1 km^2 on land use map, reclassified into three categories mentioned above.

IV. RESULTS

The expanded network of protected areas proposed, comprising the areas of Natura 2000, the buffer zones and river corridors, occupies an area of 337,298 ha., which means 55% of global territory of the three regions studied.

The areas of the Natura 2000 network, also called core areas, are formed by the Special Protection Areas for Birds (SPAs) and Sites of Community Importance (SCI). One of these spaces, the «*laguna de El Hito*», part of the network of Protected Natural Areas of the Spanish state, being also a Nature Reserve. Ten spaces are in the area of study that are part of Natura 2000. These are two areas mountain —«*Sierra de Altomira*» and «*Serranía de Cuenca*»—, two steppe areas —«*Estepas yesosas de La Alcarria Conquense*» and «*Área esteparia de La Mancha Norte*»—, two lagoon areas —«*laguna de El Hito*» and «*Complejo lagunar de Arcas*»—, three river ecosystems —«*río Júcar sobre Alarcón*», «*Yesares del valle del Tajo*» and «*Hoz del río Gritos y páramos de Las Valeras*»— and a cave —«*Cueva de la Judía*»—.

Buffer zones protects the whole ecological network of external influences potentially harmful and are essentially transitional areas, characterized by compatible uses. In the proposed expanded network of protected areas, these zones surrounding the areas of Natura 2000. In them, in areas of the Natura 2000 network and ecological corridors, land managers should pay particular attention to the regulation of land use to eliminate those who may be considered unsustainable.

Moreover, one can say that much of these areas contain landscapes of high and very high visual quality. It is rugged terrain, the presence of water bodies and trees or forests are varied and diverse in its composition stage. Additionally, they can be landscapes that contain rare or land use and vegetation very representative near the climax. Moreover, there are important external factors that take the visual quality of the landscape. These areas coincide mainly with areas of forest in mountain areas (*Altomira, Almenara, Cuenca* mountains and hills *Vindel* area averages SE), with areas around the reservoir *Buendía*, with the cliffs of Alcarria and some steppe areas where the ecological value of landscape components increases their visual quality. Only the central-northern «*Sierra de Altomira*» is an exception. The low visual quality of the landscape because the landscape degradation imposed by a great forest fire that destroyed 3,241 hectares in 2003.

The corridors, in the sense of functional connections between sites of ecological interest, are devices that maintain a degree of consistency between these ecosystems, to alleviate fragmentation. Also, spaces are said to have usually an elongated shape and facilitate the mobility of organisms between different habitats that are linked together through these corridors.

In the study area, the fluvial corridors occupy an area of 51,095 ha., equivalent to 8.4% of the entire territory. Geographically, the core areas connected through the main permanent rivers. To the north, the «*Serranía de Cuenca*» and «*Sierra de Altomira*» are linked through the corridor of rivers *Guadiela*, *Escabas* and Lake *Buendía*. These trout streams have biological indicators that show the high quality of its waters. The «*Estepas yesosas de La Alcarria Conquense*», in the center, link to the previous areas of Natura 2000 through the *Mayor* and *Guadamajud* rivers that drain into the reservoir *Buendía*. Another fragment of this Site of Community Importance connects with another steppe zone, «*La Mancha Norte*», across the *Gigüela* river. Likewise, the SPA binds to the *Sierra de Altomira* along the *Riansares* river. The «*Yesares del valle del Tajo*» have connectivity with similar habitats ranging from the west, outside the study area, along the Tagus river and its neighboring cliffs.

In the SE, the core areas are interconnected across the *Júcar* river and *Alarcón* reservoir and its tributaries. Finally, the «*laguna de El Hito*», in south central, not terrestrial connectivity to other core areas through the fluvial network, as it is a character entity endorheic water. However, in our opinion, has no more importance. The mobility of their populations of cranes and other bird species less dependent on the conditions provided by terrestrial ecosystems.

In general, the function of these corridors is essential as they facilitate the mobility of mammals such as otters, amphibians, reptiles and fish. Globally, much of the fluvial corridors and forest connectors have high values of connectivity. The results of the analysis of fragmentation, at the landscape level, correspond with those expected. Core areas, buffer zones and river corridors are the spaces that recorded the lowest values of fragmentation. Moreover, one can say that, overall, just over 43% of biological corridors, river type, the study area are occupied by landscapes of high and very high visual quality. Despite the purpose of buffer zones and areas of Natura 2000 are examples of sustainability still remain unsustainable uses in these areas of the northwestern province of Cuenca. Remain small scattered parcels of non-irrigated arable land on slopes greater than 15%. These practices are unsustainable especially when taking into account that part of the

agricultural year these plots remain devoid of vegetation that protects the soil, considering tillage practices that favor the plow to the maximum longitudinal slope, due to the limitation of agricultural machinery to lateral bending. These bad agricultural practices promote soil loss and increase the risk of erosion.

Also, it is found that there are areas where there are disagreements between the current land use and potential use. A proportion of 3.56% of the surface areas of the Natura 2000 network, present in the study area, is occupied by crops on marginal land capacity. In the buffer zone surrounding Natura 2000 areas, this percentage increased to 5.76%. In short, it is clearly necessary to insist on removing these uses unsustainable, especially in the core areas of Natura 2000 and its buffer zones, if they are to preserve biodiversity and manage natural resources properly. The managers are a major challenge and should pay attention to these issues.

V. CONCLUSIONS, DISCUSSION AND FUTURE DEVELOPMENTS

In this work, has demonstrated the potential of geographic information technologies (Remote Sensing and GIS) for the delimitation of biological corridors. This is a simple and feasible methodological approach to apply to other territories. To achieve effective management of biodiversity conservation, it must be active and must identify the corridors linking the habitats of interest. In this sense, buffer zones and fluvial corridors proposed in this work are new geographical entities can play a strategic role to consolidate the conservation of biodiversity in the northwestern province of Cuenca, at landscape level, and to ensure adequate connectivity between habitats of high ecological value. These two figures should be part of an expanded network of protected areas and, also explicitly, of the priority areas of landscape management.

Finally, we should note the importance of participatory planning in environmental management, especially in protected areas where private ownership predominates. Involving local people in environmental management, although it is a task that involves difficulties, is a guarantee of success. In the study area, following the implementation of the Local Agenda 21, is demonstrating the interest of social and economic agents to participate, actively, to achieve the ultimate goal of conserving natural resources and biodiversity. Nevertheless, the discussion can focus on knowing whether the declaration of protected areas in the Iberian Peninsula ensures the conservation of natural resources in order to better design future protected areas.

Another aspect discussed is the width of buffer zones and biological corridors. Depending on the resources to protect —flora and/or fauna—, and the characteristics and habits of the animal species to be protected, there are a variety of widths used in previous work on biological corridors. So this is a subject on which further work is needed to study the biological and socioeconomic effects of considering different sizes of width of the corridors.

From the methodological point of view, in future work will use a visual analysis on the land use map, on the SPOT image and aerial orthophotos available, so the operator to select new forest connectors, so link, linear or irregularly, the core areas. Be taken into account criteria of linearity and contiguity or adjacency of forest patches and criteria of friction and transversality which determine the mobility of fauna between patches of the landscape. They

tested the calculation of two indices of Landscape Ecology: the index of connectivity, at the class level, and the index of transversality of the patches. Both will help in making decisions about the layout of these wildlife corridors that will help to link, with the fluvial corridors, areas of greatest ecological value.

Finally, we will consider the visual quality of the landscape. An exploratory analysis show that 38% of these forest corridors proposed contains landscapes with very high visual quality and a further 47% has landscapes of high visual quality. Both subsets are wildlife corridors that contain high quality landscapes that are complementary to fluvial corridors and provide connectivity between different core areas. In summary, further work is needed on this line to make a definitive proposal for a comprehensive system of protected areas.