

PROPOSAL OF NATURAL RESOURCES MANAGEMENT FOCUSED ON CONSERVATION AND RESTORATION IN THE LOWER SECTION OF GUADAIRILLA RIVER (SEVILLE, SPAIN)

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The aim of this paper is to show an alternative methodology for the improvement of the management of fluvial corridors focused on its conservation and restoration. This proposal focuses on the detailed knowledge about the natural dynamics (geocodynamics) of these particular landscapes. Thus, our proposal is basically based on two unquestionable premises: the respect of the natural dynamics of the landscape and the “Free Space for River” concept.

Following the premises, and the main objective of this paper, our proposal has been applied to the Guadairilla River using different methods and techniques to inquire about each component that forms the landscape. Therefore, several thematic maps, inventories of plants (by transects) and morphometric basin, drainage network and flow analysis have been carried out. Finally, the assimilated processing into a Geographic Information System has been necessary to design our proposal of natural resources management.

The Guadairilla River is located in the Sevillian countryside and it is the main tributary of Guadaíra River, which is tributary of Guadalquivir River by its left margin. The Guadairilla River basin is characterised by its lengthened shape with a surface of 204.63 square kilometers (km²), 109 km of perimeter and a low slope of 0.0056 m/m.

The vegetation belongs to the domain of Thermo-Mediterranean Zone (Rivas Martínez, 1989). The climatic dataset shows an average temperature of 17 degrees (°C) and an annual cumulative rainfall which average value ranges between 500 and 600 mm. Rainfall mainly occurs between October and May, and during the summer, vegetation suffers a vegetative paralysation caused by dry (humid absence in ground). This paralysation usually lasts three or four months, normally between June and September. The annual potential evapotranspi-

ration reaches 850 mm, while the annual real evapotranspiration is lower than the half of potential value (415 mm). Besides, its “ombrothermic” index shows a value between -25 and -40 and, therefore, its “ombrotype” is clearly dry or sub-humid, which is typical of this Zone in the Mediterranean Region.

The fluvial geomorphology of this section is characterized by the presence of a floodplain over sandy sediments, where “micro-braided” channels are wide spread. A certain number of sandy bars and levees in both margins are also characteristics of this section. The hydrological dynamics, determined by the climate and its interaction with the kind of sediments, enhances the vertical incision of the main channel.

Therefore, these landforms and the channels, particularly narrow and deep, can be explained for a peculiar hydrological behavior based on low energy runoff water with regular rises and less usual extraordinary events with floods and transport of serious quantities of sandy sediment.

The connectivity in the lower section of Guadairilla River (last 3 km) is guaranteed by the runoff water in spite of the dry conditions during the summer season because, even in driest summers, there is usually reserved water in pools along the channel. In addition, the coverage of riparian vegetation in both margins also contributes to this connectivity.

The Guadairilla River has water with low quality and this is not potable because of there are several farms that flow their sewage into the Guadairilla’s runoff water along its itinerary. But, there is another source of pollution along the basin and this is caused by agricultural treatments (pesticides) and chemical fertilizers that flow into the runoff water through sub-surface and groundwater flows like a widespread pollutant.

The mosaic of riparian vegetation of the lower Guadairilla has a surface of 8.24 ha, and it is composed by communities dominated by different species, such as: elms (*Ulmus minor*) with total coverage of 5.43 ha; poplars (*Populus alba*) with 1.83 ha; eucalyptus (*Eucalyptus camaldulensis*) with 0.56 ha and small patches of willows (*Salix atrocinerea x pedicellata*) and ashes (*Fraxinus angustifolia*) with 0.26 and 0.14 ha, respectively.

During the last century, this landscape has suffered important changes. At the beginning of the twentieth century, a matrix of Mediterranean vegetation, mainly open woodland (dehesas) and wasteland, was used as feeding grounds for livestock and animals which worked in farming (mules, donkeys and oxen). Over the middle of the last century, the size of dehesas and other patches of vegetation were progressively reduced or substituted by land for cereal crops and olive trees. These changes were clearly supported on the substitution of animal drawn by the internal combustion engine and the necessity of increasing the area for wheat crops to provide raw material for the bakery industry, which was very famous in Alcalá de Guadaíra.

In the second half of the last century, the surface of cereal crops continued progressively increasing. The accretion of farming lands was at expense of the drainage of the subsurface flow. The consequences were the decreasing of groundwater level, the reduction of the area and numbers of seasonal pools, in addition to augmenting the aeration zone in soils. The drainage of the area was carried out by introducing ditches and eucalyptus plantations (*Eucalyptus camaldulensis*) that covered wide patches, mainly in the floodplain of the main channels of the Guadaíra basin and in the largest swales where most pools were to be found.

The current mosaic of riparian vegetation in the lower Guadairilla River has been also suffered changes. In this paper, the surface of these changes has been studied and it is clearly

evident that the regressive surfaces are located in the boundary, mainly in the middle section of the lower Guadairilla, where the patches have been erased to extend the farming lands. But, these zones are in the floodplain and, thus, they are periodically flooded in seasonal rises and the aeration zone in soil is frequently saturated. Consequently, the crops located in these places have a very poor productivity.

The stable patches are spread along the studied section and the recovered patches of riparian vegetation (progressive surfaces) are specifically located in these zones placed far away from the confluence of Guadairilla and Guadaíra River.

Currently, the progressive dynamics of elms is determined by the affection of grafiosis disease and, as result, these communities present a characteristic ecotype of “disclimacic” or “plesioclimacic” (Clements, 1916; Hugget, 2004) with the appearance of eternal immature structure, where is too difficult to find long-lived specimen.

The stable patches are the most widely represented in the studied mosaic, although the progressive dynamics has a very positive trend. In fact, the progressive surface is higher than the regressive one in the temporary context used in this analysis. Most of the lost patches were located in the boundary, where the edge tension, between natural dynamics of the corridor and the farming procedures, clearly appears in this landscape.

In sum, the balance of coverage has been positive in the lower Guadairilla because the surface of riparian woodland has increased in 21.26 ha in the second half of 20th century.

The proposal of natural resources management has been applied on three primary sub-zones or environmental unities.

- Environmental Unity 1: Stable landforms on ordinary floodplain, where woodland and channels have a seasonal dynamics (bio and hydro-geomorphological). Three main woodland communities are undoubtedly identified.
- Environmental Unity 2: Stable landforms in ordinary and extraordinary floodplain, where recovered patches and landforms in different state of stability interact together. In relation to the surface and the degree of woodland recovery and the fluvial dynamics or stability of woodland, our proposal suggests other three subcategories into this unity.
- Environmental Unity 3: Fluvial terrace and the countryside. Our proposal considers the subdivision in other three subcategories. The first one is focused in the allochthonous woodlands (dominated by eucalyptus). The second one includes the space between the riparian vegetation boundary and the edge of the extraordinary floodplain. And the last one is applied to the rest of the mosaic (matrix) that includes the fluvial terrace and the countryside.

The proposal of natural resources management focuses on the conservation and restoration of the lower section of Guadairilla River is summarized as follows:

1) Conservation and Comprehensive Protection Areas (A). These patches require the maximum degree of protection as the most sensitive and fragile in the mosaic. It is necessary to avoid whatever action such as: change of land use, clearing, burning, farming or livestock feeding inside them. The subcategories proposed for this category are related to the type of dominant woodland and these specific subcategories of reserve are for Elms (A1), Poplars (A2), Ashes (A3) and Willows (A4).

2) Ecological Conservation Areas (B). These patches require a specific regime of land use, generally less restrictive than in the previous category. Thus, livestock feeding is regulated in the patches included into this category, as you can see below:

B1- Regeneration Patches: The patches included in these zones are forbidden for any use related to livestock, as: feeding, breeding, livestock barn, etc. The main reason is because these patches are formed by communities in stage of progression with most palatable specimens in shrubby strata. Therefore, these communities are very fragile.

B2- Patches for the Restoration of Vegetation and Landforms: The human intervention is the key to recover the natural dynamics in these patches because, during the second half of 20th century, these woodlands were erased. Therefore, it is necessary to enhance the repopulation of these zones included in the “Free Space for River” to reach a new natural dynamics.

B3- Fluvial Landforms of Special Interest: These patches are formed by fluvial landforms, such as: sandy bars or sandy islands separated by “micro-braided channels” and generally non-stabilised areas. Consequently, these patches contribute to enrich the mosaic with heterogeneous patches where herbaceous plants are dominants. To maintain this dynamics as meadows, it is necessary the presence of livestock during the end of the spring and the summer.

3) Sustainable Intervention Areas (C). The most important suggestion is about the put into practice of less aggressive techniques in farming procedures to enhance the conservation of natural resources, which is the basis for the maintenance of this economy. This category is also subdivided into three subcategories as you can see below:

C1- Special Intervention Patches: The patches included in this subcategory are all of them dominated by eucalyptus plantations. Most of these woodlands were planted during the second half of 20th century with a double purpose: to obtain wood for the paper industry as a complementary benefit for farmers and to drain the swales, where most of the seasonal pools were widely spread. Nevertheless, these patches have occupied the ecological niche of other natural woodlands, as for example poplars. Thus, the eucalyptus woodlands currently have important roles for the landscape ecology, as habitat for animals (birds and mammals) and plants. Besides, the results of several indexes of biological diversity support the proposal of conservation or mild intervention for these patches.

C2- Ecological Buffer: The recommendation for all the patches included in this category is to restrict farming land use and specifically the temporary livestock stabling. This procedure is characteristic of this zone because there are too many nomadic goat and sheep flocks, which use to spend the spring and the summer seasons stabling in several places along this riparian corridor.

C3- Farming Exploitation Area: The proposal of management shows the evolution of the current farming procedure towards a more biological agriculture, where the knowledge about the ecological interactions in these complex agro-ecosystems constitutes the base of a sustainable economy. Nevertheless, the effects of the current model of farming will take considerable time to submit.

In sum, the studied mosaic has a whole surface of 409.6 ha, which is shared in our proposal categories as follows: Conservation and Comprehensive Protection Areas (A) with 4.56 ha (1%); Ecological Conservation Areas (B) with 13.98 ha (3%) and Sustainable Intervention Areas (C) with 391.06 ha (96%).

In conclusion, this proposal emphasises physical factors of a fluvial system as the key to carry out a planning. Definitively, this is a novel contribution to the land management by itself. In the same way, the objectives are a novel proposal in relation to the most of the rest land management planning applied to this territory.

Another one aspect to underline from our proposal is its capacity of adaptation to those environmental changes that could appear in the studied fluvial corridor because this is a foresighted proposal based on the analysis of temporary dynamics (geocodynamics) of the landscape.

This proposal of management suggests the demarcation of hierarchically zones according to different degrees of protection or recommendation in order to achieve the conservation and/or restoration for the balanced dynamics of the fluvial corridor. Thus, the aim of this proposal is not the stabilisation of floodplains. In contrast to this approach, this paper emphasises the recovery of the “Free Space for River” concept and, of course, in this way, the recovery of the specific vegetation of that “Free Space”.

In addition, this proposal is focused on the perception of the landscape as an inherited historic reality that no suggests land use changes for the use of the citizenry. This proposal emphasises the inherited rural character of this landscape and the conservation of its harmony.

Finally, as whatever proposal of management, we consider that the social participation of citizenry is a necessity in all the process. It is necessary a social agreement between owners, farmers, politicians and the rest of the civil society.

