Land capability, present degree of erosion and potential hazard of erosion in the Valencian Community (Spain)

C. Antolin

Email: m.carmen.antolin@uv.es

Abstract

Human demand for the use of Natural Resources has increased considerably in the last decades. As a result, rational Land Use Planning policies are required with a view to the distribution of resources within the context of optimum utilization, and the prevention of practices that imply their destruction or deterioration. With this purpose in mind, we have studied the Natural Resource Land Use Capability and Water Erosion Degradation Risks of the Valencian Community (Spain), scale 1:50.000, on behalf of the Dirección General de Urbanismo y Ordenación Territorial de la Conselleria de Obras Públicas, Urbanismo y Transportes, Generalitat Valenciana (Valencian Community regional authorities).

As a result of this approach, the 23.000 Km² surface of our territory has been divided into more than 5000 environmental units. Vink’s Physiographic method (in Breimer, 1986) was used for delimiting the established Environmental Units. The characterization of these units as a function of their capability has been carried out according to the Land Capability methodology of Sánchez et al. (1984), modified for the purpose of the present study by Antolin (1997). The main soil degradation risks in the Mediterranean Basin correspond to water erosion-related soil loss. The evaluation in this study of the Present Degree of Erosion and Potential Hazard of Erosion according to the Universal Soil Loss Equation (USLE), adapted to the Mediterranean Basin by Rubio et al. (1984) and modified for the present study by Antolin (1997), affords a perspective of the Erosion Risk resulting from destruction of the vegetation cover. The present study allows the establishment of a first reference level in Land Use Management providing a useful tool in the decision making process in Land Use Planning at Regional level.

1. Introduction

In the course of history, the concept of land has undergone important changes, in accordance with growing scientific knowledge. In the early times of the human species it was probably regarded as little more than a means for displacement, dwelling and the obtaining of useful products. The transition from nomadic activities to sedentary populations (around 9000 B.C.) implied a change in perception and attention towards the environments in which plants...
grew and animals were to be found, both aspects of obvious importance for survival (Malagón et al., 1995). The concept of soil as a static medium persisted until well into the XIX century probably as a result of the difficulty of grasping its true significance, for soil constitutes a complex natural system in which physical, chemical and biological processes converge in a state of continuous dynamism. In natural terms, changes are slow and do not alter the productivity of soils over the short term; however, when change takes place rapidly, marked degradation is often a consequence.

Based on this concept of soil, the European Land Act was established over two decades ago in European Council, regarding soil as a non-renewable Natural Resource. If Development, in accordance to its meaning and amplitude as perceived at the close of the XX century, can be regarded as "a process of potential implementations, of the development of the capacities of the population" (U.N.D.P., 1995), then it must be encompassed within the concept of Environmental Sustainability, which in turn decides the success or failure of development policies. In order to secure environmental sustainability, in view of the growing demand for natural resources on the part of the human population, we must first know, evaluate and guarantee the preservation of such resources for future generations.

Within this context, policies are required for the Planification of Land Use on a rational basis. On the positive side, such policies would facilitate the distribution of resource use with the aim of securing optimum utilization, while on the restrictive side they would imply prevention of uses that cause deterioration or destruction. As the impact caused by man increases, the need grows for measures to control human action upon soils and ecosystems, while allowing for advancement in the study of environmental change.

The Edaphosystem, an integral part of the Ecosystem, is more stable than the biological formations supported by it. Consequently, knowledge of its properties and function, and of the agents or phenomena capable of inducing changes in it constitutes a good indicator and a useful tool for predicting and cataloguing the possible impacts derived from the modification of the natural characteristics of the Edaphosystem. With this purpose in mind, we have studied the Natural Resource Land Use Capability and Water Erosion Degradation Risks of the Valencian Community (Spain), on a scale of 1:50,000, on behalf of the Dirección General de Urbanismo y Ordenación Territorial de la COPUT de la Generalitat Valenciana (Valencian Community regional authorities)(Antolin, 1997). This study allows us to establish a first reference for the taking of decisions in the context of Territorial Planning.

2. Land Use Capability as a Natural Resource

In basic studies of Territorial Planning, a certain knowledge of the properties of soil and its surroundings is considered essential, in order to reflect the capacity and fragility of the cartographic units in the context of different uses. More than in the choice of study parameters, the evaluation systems employed tend to differ in terms of the grading employed (Aguilar, 1995). In order to establish
the Land Use Capability of the Valencian Community, we adopted the methodology proposed by Sánchez et al. (1984), adjusted in certain aspects to the purposes of the present research project (Antolín, 1997). This method has been used by our research unit for many years, and fits the needs and peculiarities of the Mediterranean setting. The method classifies Capability in the range of Very High (Class A) to Very Low (Class E), and reflects from among all the parameters evaluated which two factors are most relevant to Land Use Capability (Table 1).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion (e)</td>
<td>&lt;7 Tm/ha/yr</td>
<td>7–15 Tm/ha/yr</td>
<td>15–40 Tm/ha/yr</td>
<td>40–100 Tm/ha/yr</td>
<td>&gt;100 Tm/ha/yr</td>
</tr>
<tr>
<td>Slope (p)</td>
<td>&lt;8 %</td>
<td>8–15 %</td>
<td>15–25 %</td>
<td>25–45 %</td>
<td>&gt;45 %</td>
</tr>
<tr>
<td>Effective soil depth (x)</td>
<td>&gt;80 cm</td>
<td>40–80 cm</td>
<td>30–40 cm</td>
<td>10–30 cm, discon.</td>
<td>&lt;10 cm, discon.</td>
</tr>
<tr>
<td>Rock outcrops (r)</td>
<td>&lt;2 %</td>
<td>2–10 %</td>
<td>10–25 %</td>
<td>25–50 %</td>
<td>&gt;50 %</td>
</tr>
<tr>
<td>Stoniness (g)</td>
<td>&lt;20 %</td>
<td>20–40 %</td>
<td>40–80%</td>
<td>80–100%</td>
<td>100%</td>
</tr>
<tr>
<td>Salinity (s)</td>
<td>&lt;2 dS/m</td>
<td>2–4 dS/m</td>
<td>4–8 dS/m</td>
<td>8–16 dS/m</td>
<td>&gt;16 dS/m</td>
</tr>
<tr>
<td>Chemical properties (q)</td>
<td>Favourables</td>
<td>Restrictions</td>
<td>Restrictions</td>
<td>Desfav.</td>
<td>————</td>
</tr>
<tr>
<td>Hidromorphy (h)</td>
<td>Without</td>
<td>Seasonal</td>
<td>Seasonal</td>
<td>Permanent</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

Table 1. Characterization of the Classes of Land Use Capability.

The Valencian Community has been subdivided according to Vink's physiographic method (Breimer et al., 1986) into more than 5,000 environmental units. The delimitation of each cartographic unit is the product of the definition of the corresponding Physiographic Units in which, through a synthesizing procedure, the relationships between the characteristics of the soil and its surroundings are reflected, its capacity is catalogued, the water erosion degradation risks are determined, each soil is situated within the context of its scenery, and its corresponding geographical extension is appraised.

In global terms, units with Very High (Class A) and High (Class B) Capabilities are located on the coastal plains and fluvial valleys. In total, they account for almost 400,000 hectares, and in most cases these units are dedicated to intensive agricultural activities. The environmental units with Moderate (Class C) Land Use Capabilities cover over 500,000 hectares and generally constitute transition zones from higher Capability areas. Hence, these units are traditionally found both on the coast and towards the interior of the Community,
and are used in low-intensity agricultural practices. Lastly, the Low (Class D) or Very Low (Class E) Capability units correspond to the least favored zones, with total surfaces of over 800,000 hectares and about 500,000 hectares, respectively. In the interior they generally correspond to the more abrupt topographies, or the plateaus of mountain chains. In contrast, in the littoral regions they constitute areas with high salinity, permanent hydromorhipha or containing mainly sandy textures. These units are respectively salt pans, humid areas and beaches (Figure 1).

The assignation of territorial uses as a function of their Capability guarantees maintenance of the land as a natural resource.

3. Present and potential erosion in the Valencian Community

At present, in the Mediterranean countries there is an important advance in the social awareness of the problems posed by desertification, understood as the loss of biological productivity, with regressive characteristics among the ecosystems, which in turn leads to a diminished biodiversity. One of the main causes of this desertification process in our setting is the intense degradation of our soils due to water erosion.

The Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1965\textsuperscript{8}) for investigating hydric erosion has been routinely applied by the Unit of Research in the Earth Sciences of the University of Valencia. This has in turn generated numerous studies of erosion conditions, and integration with other methods at municipal, county or provincial level both in the Valencian Community and in other Autonomous Communities in Spain.

This equation attempts to quantify the factors involved in superficial hydric erosion: rain erosivity, soil erodibility, topography, vegetation cover and preservation practices. The USLE model adopts the form $A = R \times K \times LS \times C \times P$, expressing $A$ in $\text{Tm/Ha/year}$ of soil loss.

The adaptation of this model to the Mediterranean Basin has been carried out by Rubio et al. (1984\textsuperscript{5}), and adapted by Antolín (1997\textsuperscript{2}) for the purpose of the present study. Specifically, modifications have been made in the method used for obtaining some of the factors, and thus also in the soil loss ranges established for each class of erosion, which are as follows: Class 1 Very Low (0–7 $\text{Tm/Ha/year}$), Class 2 Low (7–15), Class 3 Moderate (15–40), Class 4 High (40–100), Class 5 Very High (>100), and Class 6, which refers to lithic–phase soils where losses have not been quantified.

The joint evaluation of Factors $R$ (Climatic Aggressivity), $K$ (Soil Erodibility), $LS$ (Topography) and $C$ (vegetation cover), according to the USLE, provides an estimation of the amount of soil lost as a result of hydric erosion over time, expressed in $\text{Tm/Ha/years}$. These factors typify Present Erosion corresponding to each environmental unit in the Valencian Community (Figure 2). The prediction of soil loss in the event that the protective vegetation cover were to disappear, in turn constitutes Potential Erosion (Figure 3). The difference between the two parameters constitutes Erosion risk, of greater or lesser severity, depending on the magnitude of the ratio.
Figure 1. Map of Land Capability of Valencian Community (Spain).
Figure 2. Map of Present Erosion of Valencian Community (Spain).
Figure 3. Map of Potential Erosion of Valencian Community (Spain).
In the Valencian Community, the lowest erosion classes (Classes 1 and 2) mainly correspond to the more favorable topographies—plains or rolling land—in the coastal regions or plains and valleys towards the interior. Potential erosion in these cases does not usually exceed a soil loss prediction of more than 40 Tm/Ha/year, beyond which the process begins to be serious.

Minor soil loss from erosion is also observed in certain environmental units located on high-lying plateaus or small hillsides with Low or Very Low Land Use Capabilities, and normally covered to a greater or lesser extent by natural vegetation.

These two classes of present erosion, with tolerable or near-tolerable soil loss figures represent about 40% of the total surface of the Valencian Community. However, this percentage would fall to less than 20% if the protective natural or cultivated vegetation cover were to disappear; in this case, erosion risk would increase particularly in those areas located on greater slopes and in those zones where soil erodibility is highest.

The areas belonging to Class 3 (Moderate) in turn account for almost 25% of the territory, a figure that would fall to less than 15% if the existing vegetation cover were lost.

The sectors with high soil losses (Class 4) present a percentage distribution similar to that of the class 3 areas, though in contrast, potential erosion would be maximum for 90% if the vegetation cover were to disappear.

In turn, the areas with very high soil losses (Class 5) currently account for a relatively small surface. They correspond to burnt areas on steep slopes, where erosion has reached a maximum due to the loss of vegetation cover that has not yet been able to regenerate. Alternatively, they involve sectors without an underlying erosion-accelerating cause that nevertheless possess very little cover and present unfavorable soil conditions, slopes and geological materials vulnerable to the intense activity of erosive processes.

Finally, lithic-phase soils (Class 6) correspond to environmental units for which erosion could not be evaluated because they presently lack soil. These units overly hard rocky substrates and often constitute vertical surfaces on our more abrupt mountains. They account for about 4% of the total surface of the Valencian Community.

4. Discussion

In the Valencian Community, the areas that present tolerable soil loss figures (i.e., Classes 1 and 2) basically coincide with the zones of Very High (Class A) and High (Class B) Land Use Capabilities; alternatively, they involve sectors with Moderate (Class C) Capabilities in which the limitations present are attributable to thickness, presence of stone and gravel, salinity, hydromorphism and/or chemical or physical characteristics and where terracing proves effective against erosion, preventing the topographic sloping effect from potentiating erosion.
The fact that a given zone may present low grade erosion does not necessarily imply that erosion is of no relevance. In effect, laminar erosion morphology implies selective losses, mainly of the fine soil particles, which are directly responsible for soil fertility. When subjected to adequate management, these environmental units – traditionally dedicated to intense agricultural activities – constitute the most productive land areas of the Valencian Community. There are also lesser Capability areas that practically suffer no hydric erosion, namely beaches, dunes, salt pans, more or less flooded areas, and natural zones with little if any slope and a heavy vegetation cover. All these units require the implementation of Land Use Planning to maintain their economic and ecological potentials.

Low or Very Low Capability environmental units located on more accentuated slopes, yet presenting these classes of erosion, are particularly significant. Indeed, in these cases a dense vegetation cover is usually responsible for preventing erosion. These units, with High or Very High potential erosions, constitute the most vulnerable areas of the Valencian Community in the event that the vegetation cover is lost. Consequently, they deserve the adoption of special protection measures.

Depending on the Land Use method employed, areas with moderate soil loss due to hydric erosion (Class 3) in turn correspond to a Moderate (Class C) Land Use Capability zones; Low (Class D) and even Very Low (Class E) Capability areas are also frequent. In the first case, the major limitation involved is precisely the appearance of moderate erosive processes. In the rest of the cases, the erosive processes are less severe than the problems induced by some other limiting factor such as soil thickness, slope or rock outcrops.

In heavily eroded areas, mountains or steep slopes, the presence of moderate soil losses is attributable to the protective effect of the vegetation cover. In turn, if this cover disappears, the unfavorable topography becomes responsible for the very high erosion potentials of these areas. In contrast, present erosion coincides with potential erosion in only a few areas.

The soil losses regarded as severe (Class 4) imply an important decrease in Land Use Capability, the latter being either Low or Very Low. The lack of a vegetation cover is the main cause underlying the development of erosive processes. The physiography and original materials detail and either accentuate or diminish soil loss (based on the existence of a greater or lesser slope and/or on the consolidation of the geological substrate) to a greater degree than in the previous class of erosion.

All those units that currently pertain to Class 5 erosion are practically in their maximum state of degradation. They correspond to the same potential erosion class, and exhibit Very Low Land Use Capabilities. A Very High erosion potential is found in more than 50% of our total territory, comprising areas that are presently protected to a variable degree by the vegetation cover. This important percentage reflects the importance of the associated type of degradation in the Valencian Community.
Finally, Class 6 erosion (lithic-phase) areas tend to be found overlying a hard rock substrate, and often constitute vertical surfaces on our more abrupt mountains. They in turn exhibit the most unfavorable Land Use Capability.

5 Conclusions.

The present situation in the Valencian Community indicates that less than 3% of its total surface presents the characteristics necessary for application to any usage. Soils with small or moderate limitations account for over one-third of the total territory. Finally, half of the Community presents either severe or very severe limitations. In view of the lack of aptitude for different uses, an erroneous utilization may lead to possibly irreversible degradation.

As in the rest of the Mediterranean Basin, the Valencian Community is regarded as an area where erosion is a major cause of desertification. Any approach to the problem must take into account the state of degradation of our territory, the latter being the first matter to be addressed if a solution is to be found.

Proposals are required for a rational Planning of usage in the Valencian Community, taking into account both the characteristics offered by the natural environment and its limitations, with the purpose of avoiding inadequate management policies that may lead to the deterioration or irreversible destruction of the soil as a natural resource.

The evaluation of the Land Use Capabilities of the different environmental units in our Community provides a basis for the scientific cataloguing of the best and poorest soils, and facilitates the identification of those areas in equilibrium with the environment, as well as those whose fragility make them extremely vulnerable to change of any kind. Such studies serve to show that an environmental unit possessing such properties and limitations, with similar degradation risks, is likely to respond in the same way to the implementation of a given activity, a certain perturbation, or to substantial change in its defining characteristics. The findings of such evaluations may thus contribute to the establishment of a Mesoplanning Action Unit.

Applied Edaphology, in the field of Soil Evaluation, is the essential link between economic planification and ecological planification, for in terms of the physical organization of space it introduces a series of characteristics pertaining to the natural environment. In our opinion, the organization of territorial space resulting from the integration of such knowledge constitutes the fundamental guideline for Territorial Planning.
References


