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URBAN SENSIBILITY OF LANDSCAPE STRUCTURES IN ITALY GENERAL CHARACTERISTICS AND LOCAL DETAILS

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ABSTRACT

Recently the conservation policies in Europe are considering the problem of the urban increasing in terms of soil destroyed and ecosystem fragmentation effects.
In Italy this phenomenon is becoming particularly important if we consider it at national level, but also at regional level. The paper has the goal to show some data relative to the distribution and the impact of urban surfaces on the large landscape national units, comparing the values among the units kind.
Moreover will be implemented the data relative to some regional situation (Lazio, Veneto, Umbria) of the Italian peninsula for having the indication about different environmental conditions as, for example, coastal areas, mountain areas or hill areas or also flat areas and different morphological structures.
These data will be compared with other territorial characteristics, as the protected areas distribution and the biopermeability areas distribution.
The knowledge of this information is very important for the planning action because it is possible to obtain, by means of particular GIS models, indications about the urban sensibility of the different land parts in the future.

REFERENCE FRAMEWORK

The environmental planning, since some years, has a main goal that is the mitigation of fragmentation impacts by means the integrate researches between territorial and environmental sciences and an action on control instruments of territorial transformations (Romano 2000).
To obtain these results it's necessary to implement methods and criteria for identifying the relation among the parameters which describe status and evolutions conditions of the biological components and the settlement transformation phenomena.
The clear goal of these researches, now in progress, is that to establish the links between the rules of urban planning – relative to the civic quality of the cities and territories – and the effects on the ecosystem structure due to urban evolution. Is particularly important to know and draw the environmental condition before and after the anthropic transformations.
Since some years is in progress the proofs to realize a conceptual and experimental union between two thematic sets of indices (Battisti 2003, Biondi *et alii* 2003), but we cannot say now to have reach the efficient results, because we have again methodological and instrumental difficulties.
The present paper to show the characteristic data and indices on urban spaces structure and configuration. These indices has been implemented on the bases of the Landscape Units for linking it with biodiversity analytical data to highlight causa-effect relation.
These territorial units are obtained from overlay processes on climatic, morphological and geo-litological layers and have an important influence on vegetation landscape and, consequently, on total biodiversity. But these units are determinant for the urban landscape also and so can assume a significance role of analysis and interpretation units of urban settlement phenomenon.
Different italian regions have today the maps of Landscape Units, but it is today available just one national layer: Physiographic Units implemented by Environmental National Agency (APAT) as reference base for implementing the National Natural Map (APAT 2004).

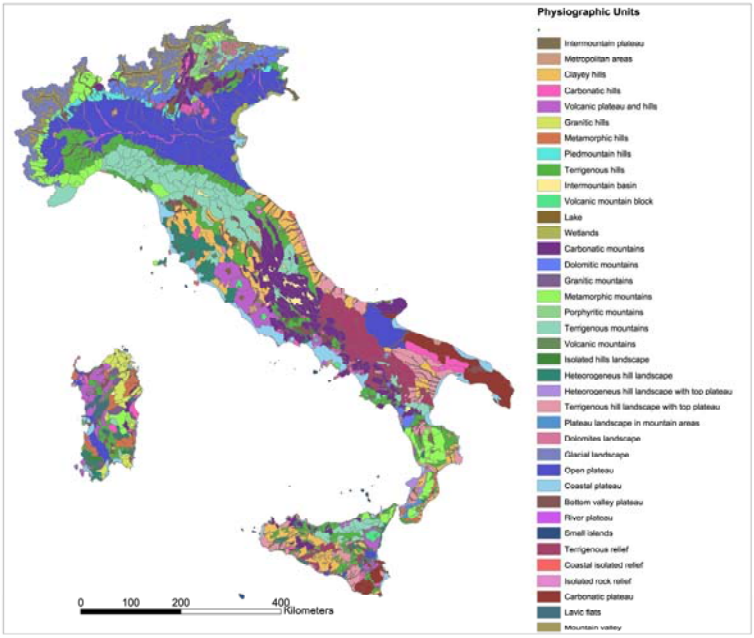

Figure 1 – Physiografphic units in Italy implemented from Environmental National Agency (APAT)

In order to the environmental characteristics one significance product that it is possible to show is the "biopermeability" map based on physiographic units.

Biopermeability condition is related to the territories that are not interested by urbanisation phenomena, comprised some very intensive agricultural forms (Romano 2000).

The key information to read biopermeability at the territorial scale is the land-use map and particularly suitable is the "Corine Land Cover" that has also some information on vegetational characteristics (Commission of the European Communities 1991).

Corine Land Cover categories (Level 3) linked to the biopermeability condition:

Land principally occupied by agriculture, with significant areas of natural vegetation;
Broad-leaved forest;
Coniferous forest;
Mixed forest;
Natural grasslands;
Moors and heathland;
Sclerophyllous vegetation;
Transitional woodland-scrub;
Bare rocks;
Burnt areas;
Glaciers and permanent snow;
Inland marshes;
Coastal lagoons;
Salt marshes;
Water courses;
Water bodies.

The situation in areas of intensified or specialised farming on the other hand is completely different.

The presence of buildings, even if isolated, means movement of people, night lighting and noises. Barriers delimiting property borders are solider and more difficult to cross (wooden or metallic fencing, stone walls) but even without these barriers, the daily activity of man creates a continuous disturbance. The road network, even in these rural areas, is always dense and widespread. The level of bio permeability in this type of area was considered too low to be inserted into ecological corridors.

These conclusions are confirmed by the Map of Natural Habitat which uses the Corine Biotopes Manual (CEC 1991) classification and considers meadows and grazing lands the minimum natural level.

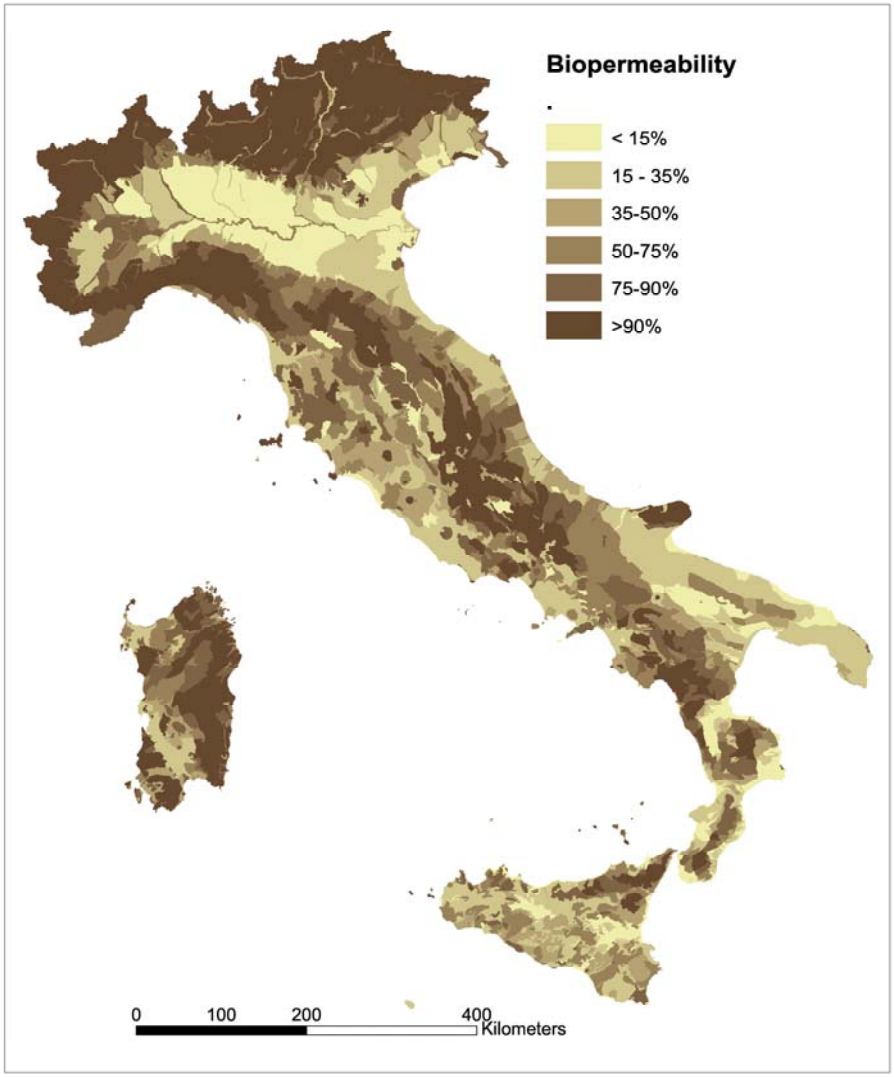

Figure 2 – Biopermeability index on physiographic units

URBAN AND ENVIRONMENT SETTLEMENT PARAMETERS

Urban density (UD): this index can be implemented in different ways in relation with the GIS data which are available on study area. In its easier form the index represent the surface percent covered by builds in relation with the entire surface of the considered spatial unit (mq/ha).

The significance of the UD index is directly linked to the urban sprawl and it is possible to have further information if exist data on builds destination (residential, productive, utilities, and so on), on the builds volume and inhabitants number (in this case could be highlighted the extensive and intensive urban conditions).

The use of the UD index is particularly interesting on landscape units because there are important relations between landscape kinds and settlement kinds in qualitative and quantitative terms.

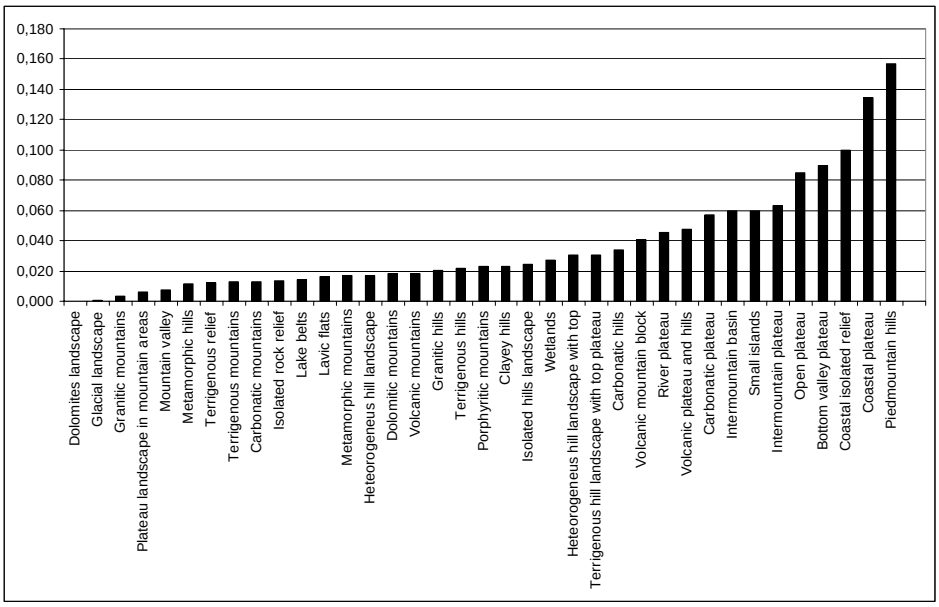

Figure 3 - Percentage of urban areas for each different kind of national landscape units

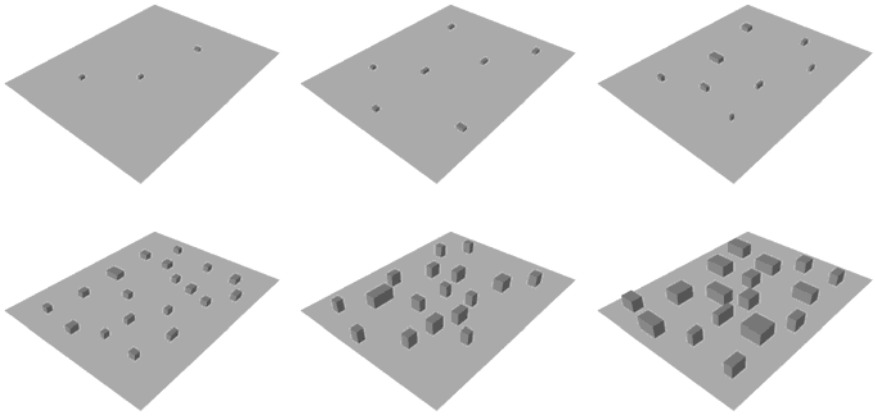

Figure 4 – Tri-dimensional models of increasing territorial urban density from UD=15 mq/ha (high to left) to UD=1000 mq/ha (down to right).

Urban dispersion (URD)

this parameter regards the distribution of urban nucleus (obtained as centroids of the different urban areas polygons) within the considered spatial units. It is possible to have the simple formulation of URD (e.g number of nucleus/units area), or other formulation that could consider the distances among the nucleus. The URD data have to be interpreted together the UD because to give the settlement structural characteristics and could be linked directly to the disturbance typologies on the natural matrix.

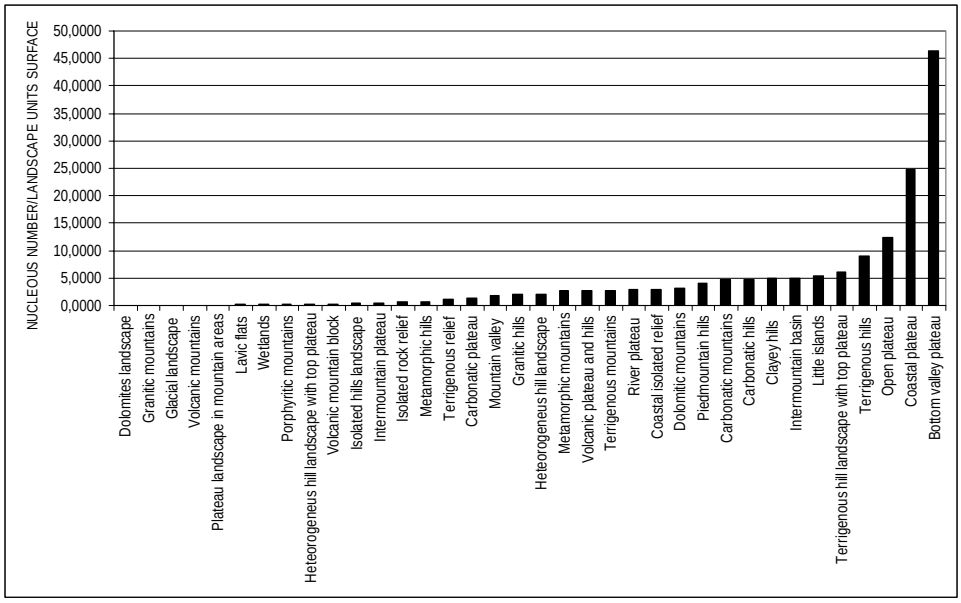

Figure 5 – Urban Dispersion histogram relative to Italian landscape kinds, obtained as ratio between urban nucleus number (font: Corine Land Cover Level 3) and the surface in hectares of the Physiographic Unites designed by APAT on 2004.

Infrastructural Fragmentation Index

The fragmentation caused by road infrastructure may be assessed by means of separate indices according to the type of infrastructure (motorways, railways, main roadways, local roadways, and overall standardised index) depending on the different features of environmental obstruction that each category entails for wildlife (Romano 2002).
Infrastructural fragmentation may be measured using the Infrastructural Fragmentation Index (IFI):

$$IFI = \sum (L_i * o_i) * li/A_u \quad (1)$$

where:

L_i = Length of the infrastructure (excluding tunnels and viaducts);
o_i = Obstruction coefficient of the infrastructure, depending on the type of infrastructure and traffic flow;
li = Road width ;
A_u = Area of the reference territorial unit;
In relation to obstruction coefficient, o_i=1 in the case of motorways and railways (total obstruction due to side fencing), while, in the case of roads with a high volume of traffic (with significant obstruction due to noise and permanent movement), the obstruction coefficient o_i is expressed as a function of the traffic flow on the section of the road considered.
In a given road section, with a traffic flow equal to n vehicles per hour, the time during which the same section is free from transit is equal to:

$$\Delta t = 1/n \quad (2)$$

If Δt are equal, then the probability that wildlife will successfully cross the road depends mainly on the theoretical speed of movement of the species, the width of the road and the length and width of transiting vehicles.

These considerations clearly show that it is possible to develop a very detailed coefficient of biological obstruction caused by roads, at scales where numerous variables can be used.

If one remains at a territorial level of indicator processing, the latter may be simplified by attributing an obstruction coefficient equal to the one of side-fenced infrastructure (100%) when the traffic flow is equal to or greater than 60 vehicles/h. This value tells us that the section of the road is free from transiting vehicles for one minute on average.

Therefore, the obstruction coefficient may be related to the average daily traffic flow per hour through the following relation:

$$o_i = n/60 \quad (3)$$

where **n** is the traffic flow expressed as the number of transiting vehicles per hour.

In general, the same road sections have very different traffic flows depending on the season and times of the day and night. In this respect, the fragmentation effect of a road varies undoubtedly and may be further assessed once relative data are collected.

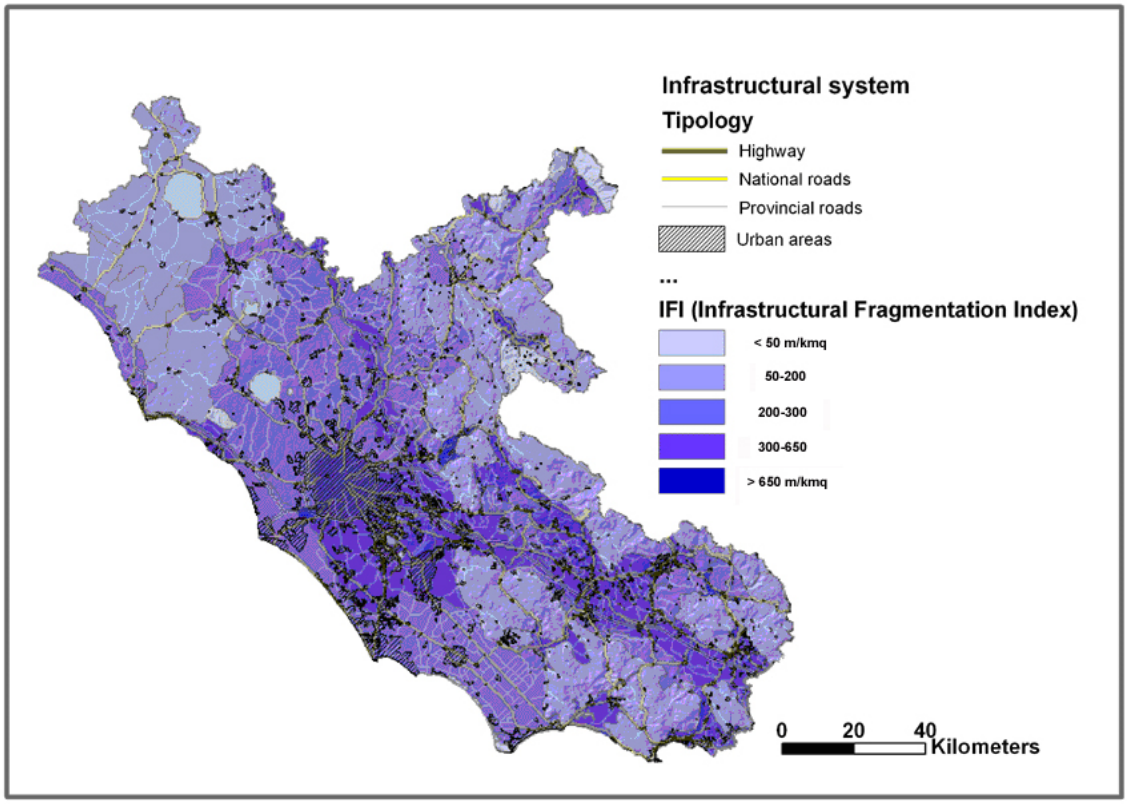

Figure 6 – IFI index calculated for Lazio Region (Central Italy) on the Physiographic Unites (APAT 2004).

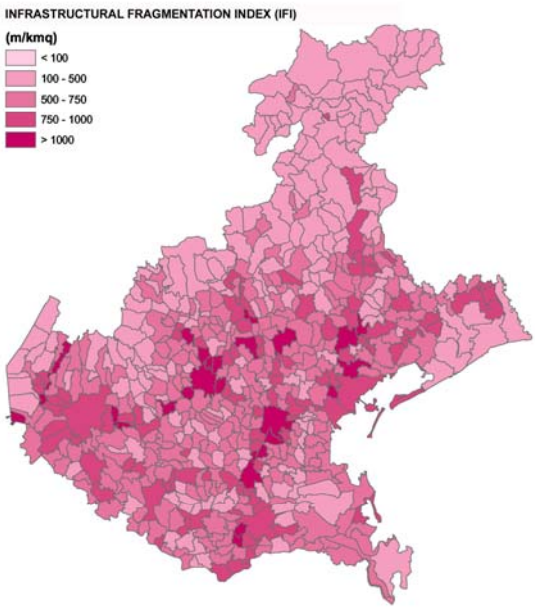

Figure 7 – IFI index calculated for Veneto Region (Northern Italy) on the Municipal Unites.

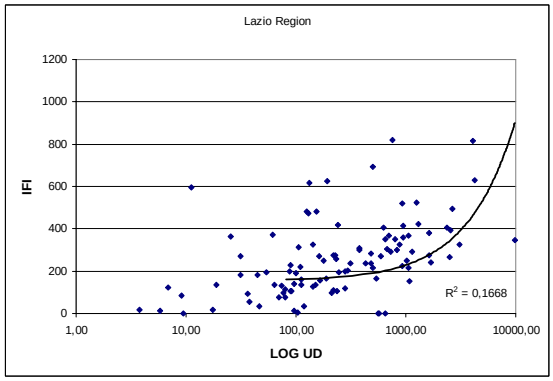

Figure 8 - Relation between Urban density (UD) and IFI index on Lazio region landscape units

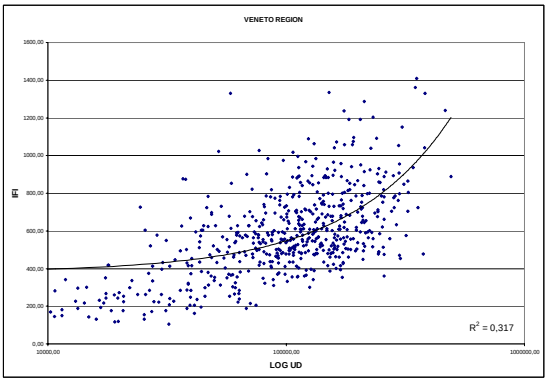

Figure 9 - Relation between Urban density (UD) and IFI index on Veneto Region municipal areas

Urban Fragmentation Index

On the basis of the consideration that, if the size of settlements is the same, then the circular, polarised shape is the one that minimises environmental fragmentation, linear urban fragmentation can be measured using the Urban Fragmentation Index (Romano 2002):

$$UFI = \frac{\sum L_i * \sqrt{\sum S_i}}{A_u} \quad (4)$$

where:

L_i = Maximum size of the linear urban barrier of the i type;

S_i = Surface of the urbanised area of the i type;

A_u = Area of the reference territorial unit;

o_i = Coefficient expressing the level of obstruction that is characteristic of the various types of urbanised areas for the species considered. By using a simplified rationale, to obtain an indication at territorial level, the following values may be viewed as significant:

a) Industrial areas and the like: o_i =100%

Presence of concentrated pollution, heavy traffic, noise, lights and disturbance even at night, presence of large paved areas, general lack of green areas.

b) Business districts and the like: o_i =80%

Presence of large paved areas, night lighting, significant daytime traffic flows, greater general presence of green areas and vegetation compared to case a).

c) Intensive residential areas : o_i =60%

Presence of concentrated pollution, noise, daytime disturbance, general presence of green areas and vegetation that is more distributed and widespread than in case b).

d) Extensive residential areas: o_i =40%

Scattered housing, greater spreading of disturbance, presence of vegetation and green areas, both within private plots and in public areas, generally greater compared to case c).

Sensitiveness towards the use of land for widespread urbanisation can provide a significant indication for the development of environment-friendly planning tools. This involves understanding how an area will respond to the use of land due to the gradual expansion of urbanised areas, following the creation of some favourable conditions related to the geographical and social structure, as well as local and external economic factors.

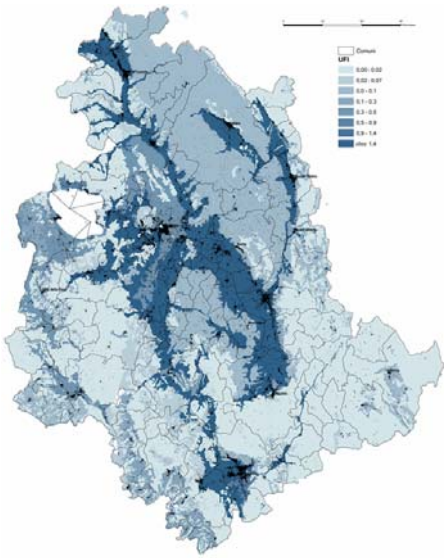

Figure 10 – UFI index implemented on landscape units of Umbria region

Total settlement fragmentation index

$$SFI = IFI + UFI = \frac{\sum L_i o_i l_i + \sum L * \sqrt{\sum S}}{A_u} \quad (5)$$

The index gives the indication about the total fragmentation in the spatial unit due to the combined effects of the infrastructures and linear urbanisation.

SFI values	Environmental fragmentation landscapes
SFI< 0.04 UD<15 mq/ha	Urban settlement very scattered, with some small dense parts, mainly formed by rural and isolated builds within hilly morphological context with extensive agricultural typologies.
0.04 < SFI < 0.15 15 <UD <40 mq/ha	Urban settlement very scattered, with some small dense parts, but with uniform density distribution. Country houses and rural builds are the main typologies.
0.15 < SFI < 0.31 40 <UD < 100 mq/ha	Urban settlement scattered again, but with frequent build small aggregations, often located along morphological or infrastructural lines.
0.31 < SFI < 1.90 100 <UD < 300 mq/ha	Urban settlement mainly aggregated, with urban areas of middle dimension and with linear shape, located on flat or low-hilly morphology and large intensive agriculture places.
SFI > 1.90 UD > 300 mq/ha	Urban settlement formed by different kinds of builded places, with middle and high density, linear urban concentration along bottom valley and infrastructural belts, with road systems surrounded by factories and residential areas.

Figure 11 – Sample of the total settlement fragmentation index (SFI) and its relation with Urban density (UD) for Umbria region

Conclusion

As we said the presented data should represent a profile on urban landscape condition that have to communicate with eco-biogeographical data implemented on the same spatial units. This step can permit to obtain relation functions between the settlement indices and biodiversity indices.

With regards to the cited indices it is necessary to make some considerations: first of all it is important to define level and dimension of the "minimal analysis units" (MAU) in which are realized the observation and the interpretation of the phenomena explain from the different indices.

Normally, in fact, these MAU are very small when are relative to eco-biogeographical data, and are instead larger when are relative to urban and territorial data. At this aspect are link the major problems for implementing the correlation functions.

The “ecoregional approach”, already consolidated in the Landscape Ecology and recently improved by WWF International for establishing the conservation policies (Bulgarini *et alii* 2004), could be a solution. In this case, at different levels of scientific knowledge, the landscape system, subsystem or units could become the standard for developing the ecological, biological and urban researches.

On the other hand we can find a further difficulties on methods and criteria to produce the data and, consequently, on the necessary time: the eco-biogeographical analysis needs of long time, many operators, large financial needs and have seasonal problems. If we make the comparison of this last analysis with the urban settlement analysis (generally ex-situ, with standard map layers and homogeneous instruments) will have two speed for producing the information and an inevitable negative effect on the comparison and relation procedures.

Realize the correlation models will be not easy until are not solved problems and knowledge gaps on the elements that needs of direct data production in way not deducible from different fonts.

We can say that certainly, to start from a present ecosystem balance condition, the modification due to the urban transformation to create undoubtedly the variations on the species richness-isolation characteristics, and these variations will be re-measurable in the next time.

Coherent data give the possibility to find and apply relation diagrams among different phenomena and, consequently, to arrive at the control models by means statistical functions.

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