

Planning the urban sprawl through a territorial approach Methodological problems and contributions of new ICT technologies to face the critical urban sprawl

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Abstract. The phenomenon known as urban sprawl today is very present in both the academic debate in both urban policies of governments, but its complex nature requires a multiscale and interdisciplinary treatment so as not to fall into the trap of reducing it to a mere quantitative or statistical fact. Too often the lack of clear reference coordinates and shared assumptions produces erroneous interpretation which adversely affect the entire planning process. The research, with particular reference to the Veneto case but with the problems shared throughout the country, explores the issue through 4 keys of lecture integrated with each other that allow to return to a first reference framework to affront the problem from a Urban and Regional planning point of view, first of all by setting a clear basic knowledge framework and an operational experimental method that should avoid the problem sectorialisation, enabling them to share an operational base for the development of specific data within cognitive frameworks in order to provide a complete knowledge of the phenomenon supporting the plan's choices.

Keywords: Consumption of Soil, Landscape, Sprawl, Change Detection, Remote Sensing.

1. The loss of Landscapes, Identity and Urbanity: studying the long-term processes to planning the sprawl

The meaning of the term territory may be declined in different forms, depending on the discipline that it occupies. By virtue of its polysemic nature the term itself suggests that its physical size does not correspond at all to a broad surface, on which it is possible to operate any form of transformation, but it represent visible synthesis of long-term processes that have integrated natural forces and human hands. On it have been settled no written rules of dynamic relations, hierarchies, functions and uses which have given a character to the territory which would be recognized as a place¹. The processes that led to these rules are not characterized by unique and immutable forms of construction and transformation but are introduced in a temporal process in which time has allowed the gradual interaction and sedimentation of settlement process which are always compared

¹ The term place, we mean a physical space and connoted by unique elements and not reproducible in other parts

with the territorial dimension that allows a balance between human factors and natural forces. The phenomenon of sprawl and diffusion / dispersion of settlements, is the result of an acceleration of transformation processes that did not take into account the relations and hierarchies of long duration, which by virtue of a process of economic development considers the territory as the most important resource, has homologated a simple cement block to that what was a system of places of beauty and witnesses of civilizations. The result has been increase of the quantitative welfare but a loss of quality in places of life. The phenomenon known as sprawl has lasted at least fifty years, in Italy, and was the subject of several important studies of well-known urban planners in Italy². The most famous and comprehensive research on the project is It.Urb 80 coordinated by Giovanni Astengo around the mid-80s, through the involvement of 12 universities. It was investigated the evolution of urbanization in the period 1951-1981 on a sample of 25 selected areas in all regions of Italy³. The predictions with which have envolved phenomena come true, one wonders why it is not been caught critical attention to that put into the study of equation high consumption = wastage. This reading of the phenomenon was seen by many as too simplistic and unnecessarily moralistic⁴. The phenomenon is still present and essentially continues to be ignored by the sectorial management. Such underestimation is not before strong reasons, it is not distraction, is consistency. It is consistent with a conception of the economy that sees the indicator of progress in the quantitative growth of any produced entity [...] and is consistent with a specific connotation in our country, which makes Italy different from most other European countries: the huge importance on our economy and our society has the real estate income⁵. Under the terms described above, the damage is twofold, on the one hand areas are removed from agricultural use undermine not only what for centuries has been a source of power for the city but eroded the landscape as the collective good. On the other hand slow transformation of what appears to be the fundamental common good of society: the city, in the approved cementitious agglomerates homologate to architectural trends of the moment. Those hierarchies that gave meaning and recognition to the place were invalidated, incorporated in the cement "jam" anything but abuse, but rather planned. Today, the average amount of residential square meters for inhabitant is about 60 square meters in central areas of the Veneto, just think that the 1150/42 national law provided as minimum 30 sqm / inhabitant then increased to 50 square meters by the Veneto Authorities (LR 61 / 80). The area where we live is at the same time hyper constructed and with a high restriction of the city. These areas in the studies and sectorial literature are defined very frequently metropolitan, using and abusing this term which takes a lot of distance from its original meaning. In ancient Greece metropolis meant city - mother, "the mother city" compared to colonies [From gr. metropolis "mother city"], now we use the term metropolitan city to describe reality much closer to those of Megalopolis or more precisely to *Villettropoli*, without taking the project meaning on its term that tends to idea of metropolitan city understood as city of the city. Those who are

² Through the involvement of 12 universities, has been investigated the evolution of urbanization in the period 1951-1981 on a sample of 25 selected areas in all regions of Italy. The results are published in Quaderni di Urbanistica information n.8 and 9 / 1990

³ M. Baioni, *Diffusione, dispersione, anarchia urbanistica in No sprawl* a cura di M.C. Gibelli. E. Salzano, Alinea Firenze 2006

⁴ Ibidem

⁵ E. Salzano introduzione a *No sprawl* a cura di M.C. Gibelli E. Salzano, Alinea Firenze 2006

working with these problems need to start with a necessary consideration which help to develop and test methods of investigation and re-design of the territories. Learning to take the limit as a resource. The challenge is between two opposing tendencies. The first one is to continue to operate as if resources were infinite, but the consequences would be tragic. The campaign that just yesterday, was threatened by expansion of the suburbs, now it is the villas. Metropolis or Villettopoli for the environment not yet built are the same solution, an increase of entropy, degradation, and a waste of resources. The other tendency is to consider resources being exhausted or in phase of exhaustion. As there is a limit for the urban expansion, so the resources can not be unlimited, without making a drama trying to consider the limit as a resource. The land is known as a unrepeatabe good. We have talked and continue to talk about dismissed areas. We do all the best to recover but for whom and for what? Cement? The new building? We are not aware that if we "limit" these areas to what they are in most cases - areas of industrial archeology, at best, or areas that should return what they were – it can be possible to reinsert them to organization of the city. It is true that it is necessary to reuse them, but inserting in a general drawing. The resource is the limit, a great resource that we do not know value. Consider the limit as a resource allows us to re-establish the city and preserve the landscape. It allows us to determine the coordinates of planning⁶.

D. Lowerthal in his book "The past is a foreign country" writes <<you need the time to create the places>>, a phrase that sums up the reason why it is necessary investigate long-term processes. The concept of place expresses the semantic synthesis of urban quality and identity of a physical space, as if we support the phenomenon of sprawl is the cause of the condition of degradation of urban and territorial reality that we live, then it is required to explore with design intent the long-term processes in order to reduce the risk of the study to a mere quantity fact. Understand those actions that characterize a territory for centuries is not just an issue of historical knowledge, is a strategic act of equal importance if not greater than the value of socio – economic analyses. In case of Veneto region it is necessary begin from the age of Roman domination and understand the rules of transformation and infrastructure of the territory that have shaped its polycentric nature and how this base has influenced the subsequent sedimentation maintaining and consolidating those minute but clear hierarchy made of villages , towns, monasteries and villas, relations still recognizable today despite the great changes of the twentieth century and able to affect the way we live and move in this territory. The acquisition of this knowledge would not allow to fall into the frequent trivialization, so the urban spread that connotes the territories of the Venetian plain originates in the nature of places and recognize that it is the result of a series of recent actions desired by those who have occupied up to now the government of the territory. Knowing the long-term processes is necessary to split the historical peculiarities of the outcome of recent trends, many times the result of a generic planning is totally devoid of knowledge, unfortunately a situation recurrent many times in the Venetian plain⁷.

⁶ P.L. Cervellati, *L'arte di curare la città*, Il Mulino, Bologna, 2001

⁷ L.R. of Veneto 1985 n. 24 building in the agricultural area provide as well as criteria for the new building based mc / ha under cultivation in the territories of the farm, art. 4 *for permanent residences inhabited by a minimum of 7 years' extension to the maximum volume, including the existing 800 cubic meters* expandable to 1200 for farm use. The recent L.R. of Veneto 23 April 2004, n. 11 "Rules for the Government of the territory" includes the agricultural areas for art. 44. 4

2. Knowledge as an essential process for the planning: the problem of sources for the interpretation

Cassini of Thury wrote in 1749 "Without the exact knowledge of the extension, the limits, the position of the different places it is difficult to take certain measures for a large number of useful projects to the state and trade"⁸. Today, the same *exact* knowledge useful in planning is often absent. The territory of Veneto is a planned territory. Regional plans, of area, provincial, municipal, detailed. Plans that, unfortunately, do not produce knowledge. Most of the time are not supported by studies on the processes of long-term, the same produced analysis are not consistent with the choices of the plan. In particular they miss the study in the light of planning, the processes that led to the construction of the territory at the time of starting the planning process. The existing territory is a state of fact (general) on which build a state of the project (also generic), without considering the processes of long-term as indicators that predict future trends and create project choices. Sources available for the study of these dynamics are manifold, in a first identification it is possible to divide into two types:

- Statistics Sources
- Cartographic Sources

The first makes reference to the main censuses and studies conducted by ISTAT and constitute a reservoir of very important information, although difficult to return in morphological terms, the only reference unit that find correspondence in the territory are administrative boundaries and cadastral units, for its nature include complex and do not disagreeable territorial realities. Processes that result from this front remain crucial for a general description of the problem (ratio of population / housing, number of dwellings not occupied etc.) but in the geographical deepening have the limitation that it can not be located on the territory. The data and indexes used are, as we have said, manifold, but there is one that recurs frequently in studies and in regional legislative references: the SAU. SAU means the area used for agriculture, including a series of use of land for agricultural intent including greenhouse and vivariums, we must consider that in calculating with this data are added to all urbanized areas those that crop abandonment, the progressive disappearance of the marginal farms, which have become uncultivated or returned to the "wild". Calculating the free portions of territory are excluded categories poplar woodland, arboriculture for wood, forest, conifers etc. excluded from the SAU because they do not fall within the scope of the territories for agricultural use and is counted instead as vivariums fact that physical characteristics are much closer to the

points: a) for the extension of existing dwelling houses, subject as provided in paragraph 5, up to 200 mc. for each family and / or employee [...], but no later than 1200 cubic meters., aa) for farm uses, [...] the expansion of residential up to 1,200 mc., including the existing [...]; b) for new dwelling houses, if not existing on the farm, up to a limit of 600 mc. for each farm, expandable to 100 mc. for each family and / or employee regularly [...] and not later than 1200 cubic meters. 5. [...] I have always allowed the speeches referred to in points a) b) c) of Article 3 of Decree of President of the Republic 6 June 2001, n. 380 "text of laws and regulations on building construction", as amended, and the expansion of residential, up to a maximum of 800 mc. inclusive of the existing, [...]

⁸ Cassini di Thury, C.F.: *Sur la description geometrique de la France*, in *Histoire de l'Academie Royale des Sciences*, Paris, 1745.

urbanized territory. Processes arising from this source are often remote from physical reality, considered, the SAU is a sign of an economic nature and not territorial: therefore it must be used with the consistency of context. The second source is surely favored in our studies, especially for reading and interpretation of long-term processes. The cartographic information (historic) contains not only physical elements representing the area in a given period, but is itself *sinopia*⁹ of a proposed future land use project. Unfortunately the conditions for access and processing of these sources are a problem, the historical maps have not been computerized so that they can extrapolate information quantifiable, are considered as a way of a romantic imagine, a blank white card, for use as memory of a territory that is not there anymore. The same applies to the aerial photos included in the period 1940-1970, access is difficult and rarely subject to the processes of digitization and georeferencing, especially aerial photos of the RAF (1942-45) and G.A.I. (1950-55) who take over the Italian territory before the heavy processes of urbanization and infrastructure of the 70s and 80s. The contemporary situation is not better then. The latest maps of land use produced for the Veneto are the Corine Land Cover¹⁰ and the Land Use Map in the basin of Venice Lagoon¹¹. Both date back to 2001, from that date the information of soil use is negligible. The relief of CORINE do not count the areas that are urbanized by the infrastructure and the establishment dispersed, which continuously occupy surfaces less than 25 hectares, and if we consider that in the central Veneto the average size of urban settlements (estimated by authors) is 2 hectares the CORINE data is rather distorted. The Land Use Map of Basin Venice Lagoon is characterized by a higher quality and exceeds the limits of CORINE and provides reliable data on the consumption of soil, unfortunately the data still remains on 2001 and it has to be updated (Fig. 1). We are still in the absence of a uniform and constant monitoring of territorial processing, where as Farinelli sustains "Between the city and the geographical representation, there is a relationship of mutual interdependence, according to which one requires the other"¹², today we are dealing with a territory the product of a "planning" representation for about ten years ago, and later than that geographical representation which should provide the elements for the design of tomorrow (Fig. 2).

⁹ The *sinopia* is the stage in designing the painting consists of clay with a preparatory sketch for the painting

¹⁰ From 1985 to 1990 the European Commission has developed the program CORINE (Coordination of Information on the Environment) with the primary purpose of obtaining environmental information harmonized and coordinated at European level. The CORINE program, in addition to collect basic geographic data in a harmonized (coastlines, administrative national boundaries, industry, transport networks, etc.), Provides analysis of the most important environmental parameters such as cover and land use (CORINE Land cover) emissions into the atmosphere (Corineair), the definition and extension of the natural environment (CORINE Biotopes), the mapping of risk of soil erosion (Erosion CORINE).

¹¹ The Land Use Map of the Bacino Scolante in the lagoon of Venice is based on an extract from IT2000® orthophotos of CGR Parma, made by video-assisted photo-interpretation. The area of investigation relates to the territory included in the perimeter of the Bacino Scolante approved by the Regional Council of Veneto with measure n° 23, 7 May 2003, plus some outer areas needed to achieve the completion of the territory of several municipalities.

¹² F. Farinelli, *Geografia*, Einaudi, Torino 2003.

The same provinces called from regional law¹³ to the construction of the mosaic of the PRG for the cognitive framework, often provide unreliable data (still in preparation), or not updated. Remains still the current consideration of Cassini mentioned at the beginning, without an *exact* knowledge there is no project and without project can not be a future of urban civilization.

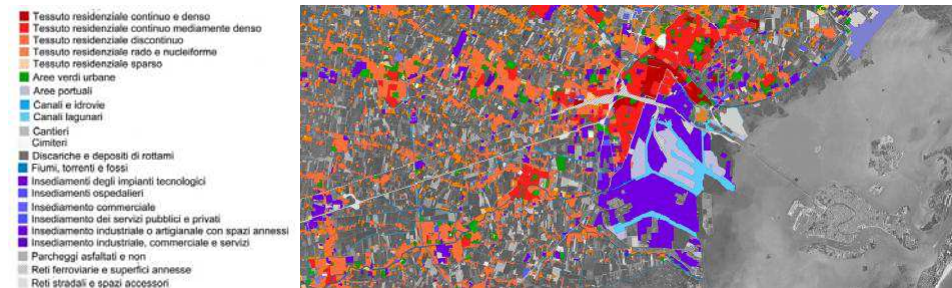


Fig. 1 Urbanized territory to 2001 extract from “*Carta della copertura del suolo del Bacino Scolante nella laguna di Venezia*”.



Fig. 2 Representation of the "planned" territory possible situation of urbanization to 2015 (extract), source Province of Venice, Treviso, Padova [12]. The map was obtained by overlaying the land use of 2001 with the mosaic of the forecast planning at municipal scale. Following this analysis is expected to reach an urbanized area of coverage from 26% in 2001 to 28% in 2015

3. New Technologies for the study and monitoring of spatial transformations: change detection on the Po-Venetian plain

The problem of sources and method described above, once defined needs theoretical paradigm (reading and interpretation of long-term processes and its design declination) and also a complex business model that allows to govern the entire knowledge process.

The analysis *change detection*, described below, is based on multi-temporal comparison of images with *Land Cover* classification and oriented to the quantification of territorial transformations occurred in the referenced period of time. The *change detection* allows to quantify by each class the spoke changes at the expense of all other classes defined by the analysis. The topics treated and subject to monitoring may be the consumption of

¹³ L.R. del 23 aprile 2004 n.1 art. 10

soil, the relationship between sprawl and the matrix of the urban and territorial morphology, as well as the necessity of investigation of both the short and long term processes. The consequent result is the knowledge of the territory in his state of dynamic transformation, thus provide a permanent support to any future action of planning and for building and correct the policies of territorial and environmental regeneration. With the results of the multi timing analysis it is possible to answer for questions such as:

- As agricultural land was urbanized?
- How many forests have been felled to make place for fields?
- How has evolved environmental mosaic as a consequence of the agricultural and wood-pastoral practices
- What are the trend of expanding construction?
- What was the degree of soil sealing in recent decades?
- How and where have modified the natural habitat within a protected area?

Exist established tools for quantitative and qualitative assessment of changes in a given territory. The levels of information available for the study of long-term processes are numerous: the aerial-photogrammetric shooting are available in our country starting from World War II and the satellite images from the seventies, with resolution and increasing quality. The case study presented below is related to the Po-Venetian territory from Lake Garda to the west and the Venice Lagoon to the east, and shows the results of a diachronic analysis on thirty years basis, based on use of Landsat images . The territory in question was characterized by the phenomenon of urban sprawl from the Second World War and examine mainly the areas between the cities of Venice, Treviso, Padua, Vicenza and Verona.

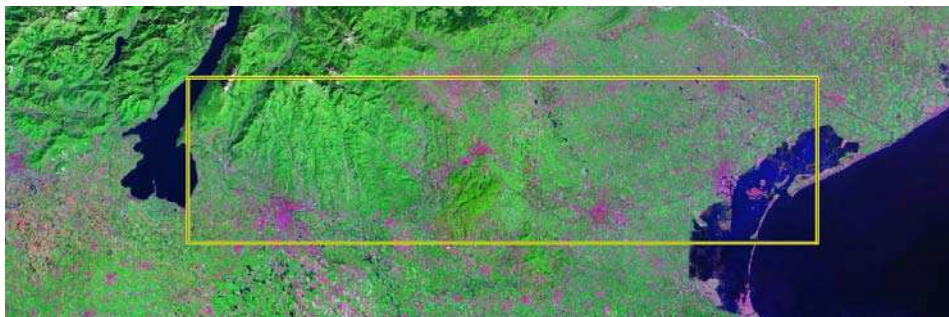


Fig. 3 The study area of the Po-Venetian plain (Landsat 7 ETM+ false color, bands 742)



Fig. 4 A real color image of ETM+ sensor on the study area

The images used in this study are the scene of the Landsat 1 resumed on 12 August 1972 by MSS sensor (Multi-Spectral Scanner System) and the Landsat 7 scene of the shooting on 26 August 2001 by the sensor ETM + (Enhanced Thematic Mapper-plus). Bands available and used to classify the shooting of 1972 are: green (0.5 - 0.6 μm); red (0.6 - 0.7 μm); IR (0.7 - 0.8 μm); IR (0.8 - 1.1 μm) while those available and used to classify the shooting of 2001 are: blue (0.45 - 0.52 μm); green (0.53 - 0.61 μm); red (0.63 - 0.69 μm); NIR (0.75 - 0.9 μm); SWIR (1.55 - 1.75 μm); SWIR (2.1 - 2.35 μm). The images were subjected to a process of guided classification (supervised) by using a maximum likelihood classifier, which produced, respectively, two cards of Land Cover with the following classes:

| | |
|--------------------------------------------|---------------------|
| Continuous urban fabric | Broad-leaved forest |
| Discontinuous urban fabric | Coniferous forest |
| Industrial, commercial and port areas | Arable land |
| Agricultural lands with natural vegetation | Lagoons |
| Beaches, dunes and sands | Salt marshes |
| Inland surface waters | Sea |

Guided classification starts by the definition of discrete classes and the identification of sample areas for each class, subsequently the mean values are calculated and variances in DN for each band used, generating a spectral response curve for each. Maximum likelihood classification proceed then with the statistical analysis in which each image pixel is compared with the different spectral signatures and assigned to the class having the most similar signature. The results for each age is a raster map that shows the themed classes and then it is possible to compute them in terms of areal extent.

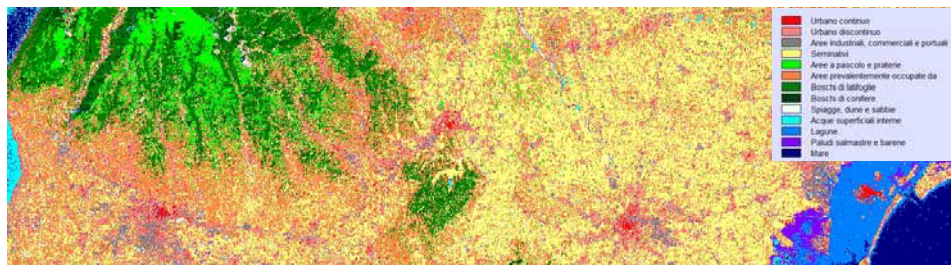


Fig. 5 The image of Landsat 7 classified according to the described classes

4. Results and discussion

Result areas in hectares of the classification of 1972 were: 4431.96 continuous urban fabric; 50690.24 discontinuous urban fabric; 5388.14 industrial, commercial and port areas; 184857.37 arable land; 23170.89 natural grassland; 171579.69 agricultural lands with natural vegetation; 45497.04 broad-leaved forest; 10979.34 coniferous forest; 6835.24 beaches, dunes and sands; 6337.49 inland surface waters; 18250.28 lagoons; 7913.26 salt marshes. While the area in hectares of the classification of 2001 were: 5254.60 continuous urban fabric; 61121.97 discontinuous urban fabric; 22455.62 industrial, commercial and port areas; 191961.23 arable land; 24488.60 natural

grassland; 121771.62 agricultural lands with natural vegetation; 53318.68 broad-leaved forest; 8613.26 coniferous forest; 11537.36 beaches, dunes and sands; 4568.82 inland surface waters; 19169.91 lagoons; 10632.67 salt marshes.

The results of the comparison have shown the increase of the "Discontinuous urban fabric" class which corresponds to more than ten thousand hectares and occurred mainly at the expense of agricultural areas with significant natural areas. Very significant was the increase in industrial, commercial and port areas that took place on land previously occupied by agricultural areas but also semi-nude and arable areas. A significant contribution to identification of the large-scale of the phenomenon of widespread urbanization can be achieved by creating the appropriate maps of the spatial trends of changes occurred between the classes in the examined period of time. In figure 6 it is possible to notice how sprawl has involved the areas between Colli Berici, Verona and Garda Lake as well as the whole band from Padua to Mestre.

Although outside the study area, finally it is observed an important trend relative to urbanization on the piedmont zone between Treviso and Bassano del Grappa.

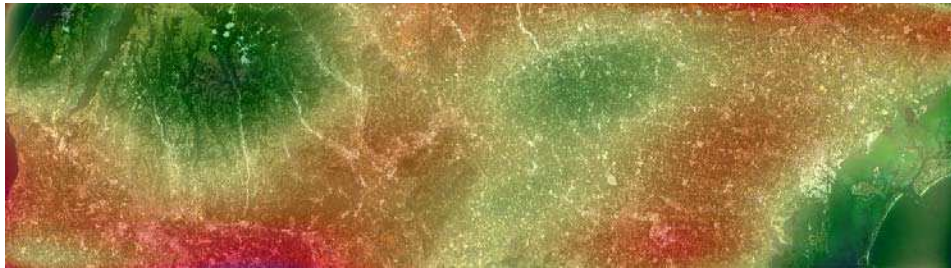


Fig. 6 The map of trends related to the phenomenon of urban sprawl

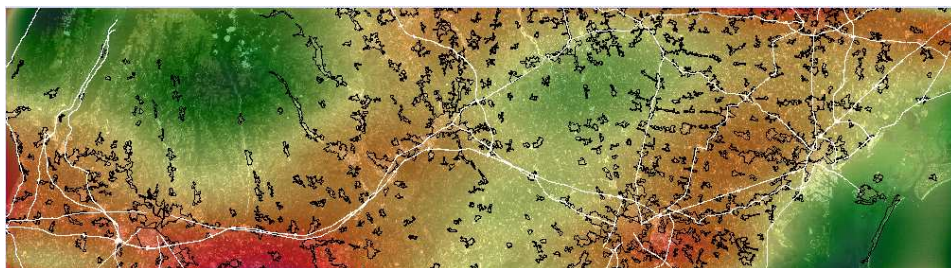


Fig. 7 The map of trends with main roads and urbanized areas

Figure 7 shows how the areas that have suffered greater urbanization is concentrated along the main roads (highways and state roads) especially between Verona and Vicenza, and between Padua and Venice. The phenomenon then moves north along the foothills belt, although there are no roads to great slider.

Finally, an important contribution of New Technologies under consideration was to show the future forecast of the trends development assuming the same trend occurred in the past regarding the policies of government of the Territory. The following matrix shows the percentage of each class to change to another according to a calculated forecast for the next thirty years and, in the main diagonal, it can be read in the rate of persistence of each class.

| Given : | Probability of changing to : | | | | | | | | | | | | |
|------------------------------------------|------------------------------|--------------|---------------|------------|---------------|---------------|------------------|----------------|----------------|--------------|--------|---------------|--------|
| | Urbano cont. | Urbano disc. | Aree Industr. | Seminativi | Aree a pasco. | Aree prevale. | Boschi di latif. | Boschi di col. | Spieagge, dune | Acque super. | Lagune | Paludi salma. | Mare |
| Urbano continuo | 0.2222 | 0.2191 | 0.1423 | 0.0963 | 0.0018 | 0.0622 | 0.0011 | 0.0005 | 0.0149 | 0.0063 | 0.0308 | 0.2025 | 0.0001 |
| Urbano discontinuo | 0.0378 | 0.3533 | 0.0987 | 0.2633 | 0.0077 | 0.1805 | 0.0050 | 0.0012 | 0.0313 | 0.0031 | 0.0005 | 0.0176 | 0.0000 |
| Aree Industriali, commerciali e portuali | 0.0293 | 0.1873 | 0.3578 | 0.0773 | 0.0018 | 0.0849 | 0.0035 | 0.0014 | 0.0663 | 0.0146 | 0.0454 | 0.1304 | 0.0001 |
| Seminativi | 0.0043 | 0.0806 | 0.0304 | 0.5200 | 0.0374 | 0.2508 | 0.0479 | 0.0015 | 0.0236 | 0.0007 | 0.0000 | 0.0027 | 0.0000 |
| Aree a pascolo e praterie | 0.0013 | 0.0249 | 0.0146 | 0.1778 | 0.4050 | 0.1227 | 0.2254 | 0.0074 | 0.0183 | 0.0010 | 0.0000 | 0.0015 | 0.0000 |
| Aree prevalentemente occupate da | 0.0074 | 0.1365 | 0.0386 | 0.4070 | 0.0209 | 0.3138 | 0.0413 | 0.0051 | 0.0202 | 0.0011 | 0.0001 | 0.0081 | 0.0000 |
| Boschi di latifoglie | 0.0003 | 0.0082 | 0.0035 | 0.1043 | 0.0754 | 0.1268 | 0.5889 | 0.0861 | 0.0034 | 0.0006 | 0.0000 | 0.0023 | 0.0000 |
| Boschi di conifere | 0.0008 | 0.0190 | 0.0097 | 0.0700 | 0.0407 | 0.1187 | 0.4253 | 0.2845 | 0.0073 | 0.0155 | 0.0000 | 0.0083 | 0.0000 |
| Spieagge, dune e sabbie | 0.0056 | 0.1534 | 0.1969 | 0.2144 | 0.0446 | 0.1780 | 0.0393 | 0.0168 | 0.1227 | 0.0142 | 0.0006 | 0.0131 | 0.0001 |
| Acque superficiali interne | 0.0028 | 0.0588 | 0.0529 | 0.0622 | 0.0018 | 0.0414 | 0.0069 | 0.0041 | 0.0155 | 0.2175 | 0.1773 | 0.3136 | 0.0452 |
| Lagune | 0.0001 | 0.0005 | 0.0064 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0032 | 0.0680 | 0.8075 | 0.0338 | 0.0805 |
| Paludi salmastre e barene | 0.0033 | 0.0409 | 0.0303 | 0.0414 | 0.0006 | 0.0381 | 0.0128 | 0.0051 | 0.0037 | 0.0899 | 0.2579 | 0.4174 | 0.0186 |
| Mare | 0.0000 | 0.0000 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0216 | 0.0350 | 0.0015 | 0.9416 |

Fig. 8 The matrix of evolution and persistence of each class in a forecast to 2030

The work done to date does not arise as a finished product, but rather as a dissertation of the problem in order to stimulate a debate on which to develop a permanent research project. This is an open and experimental research that, given the complexity of the issues raised and disciplines, is being working on.

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