45TH CONGRESS OF THE EUROPEAN REGIONAL SCIENCE ASSOCIATION

APPENNINES SETTLEMENT EVOLUTION AND TRANSFORMATION ANALYSIS WITH GIS INSTRUMENT

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The analysis of the spatial and structural changes of the urban web represents a valid key of reading not only for the study of the landscape evolution of a datum territory but also for the understanding of the social and economic tendencies that will influence the choices in phase of planning and the following managerial politics.
The proposed job illustrates some methodologies, supported from GIS technique, for the analysis of the modifications intervened so far in use and landscape picture, formulating the structure of some evolution entity indexes connected to past and current planning, both to the consequent spontaneous phenomenons to the economic logics.
The result is that to compare the found trends of arrangement in the demografic-social-productive sphere with the changes in progress aspects loaded instead with environmental system through the analysis of the actual settlement structure and urbanistic instrument.

1. INTRODUCTION

1.1 Landscape complexity and environmental analysis

"Landscapes, as well as ecosystems, are characterized by intermediate numbers of diverse natural biotic and abiotic and anthropogenic cultural components with greatly varying dimensions and structural and functional relationships among these components. Because of their emergent organizational systems properties, landscapes are more than the sum of their measurable components." (Naveh, 2002).

This *holistic view* of landscape complexity (Naveh & Lieberman 1994), embedded in the web of life as a micro-hierarchic level in the macro-hierarchy of the self-organizing universe culminates in the recognition that humans are not apart from nature or even above nature. As the highest level of the global ecological hierarchy, above ecosystems, they form together with their total environment an indivisible co-evolutionary geo-bio-anthropological entity (*Total human ecosytem).*

The comprehension of landscape complexity as part of a much broader transdisciplinary systems view is then a fundamental key in order to perform the relationship of all environmental components and their structural tendencies. Landscape and human ecology are interrelationed systems in continuous evolution and the processing of anticipating models is an important instrument for planning analysis, management policy and natural conservation.

Ecological knowledge and such models are translated to conservation and management programs. A landscape-based program should be oriented towards the conservation of cultural components as well as natural components. In particular, indigenous cultures and traditional economies are of special value for conservation, for different reasons: they harbor both ecological values and cultural values, they represent the many faces of the coexistence of nature and culture, product of long history of co-evolution.

Side by side to the analysis of the evolution during time of the natural components is for this meaningful to consider the evolution of the human ecosystem. The chronological analysis of the various sectors can be effected by based and applied ecological disciplines using different typologies of tools, not always however feasible because of the availability of the sources and the data.

Table 1 - Characteristics of the ecosystem approach and the landscape approach with respect to conservation, planning and management (Naveh, 2002)

Ecosystem approach	Landscape approach
Reductionistic	Holistic
Based solely on bio-ecological aspects, dealing with "natural" organisms populations and communities.	Including also human-ecological aspects, dealing with all biotic components, including humans
Vaguely defined borders	Clear borders
Spatially indifferent models	Spatially explicit models
Biodiversity	Ecodiversity (yet to be developed)
'Natural landscape' components only	Ecodiversity

1.2 Complexity in Apenines landscape

Innovative transdisciplinary approaches and methods are required, especially in the case with highly fragmented and heterogeneous human modified, used and managed landscapes like Italian ones. In Apennines landscapes, for example, natural and cultural pattern and processes have been closely interwoven for thousands of years, creating several kinds of phenomenons about population and settlement distribution: social and economic depression and consequent abandonment of smallest mountain villages, uncontrolled urban sprawl in the biggest ones.

Large number of Apennines villages are actually included in the network of national and regional parks even if depopulation problems are still occurring and suitable planning tools are requested.

The search intends to furnish a methodological contribution for the reading of the different environmental components (natural, human, historical-cultural, symbolic and socio-economic) interpreting the mutual interactions of them, with a particular attention to the tendencies in action owed to the choices of planning.

The contribution illustrates particularly the methodological scheme in reference to two (socio-demografic, settlement) of the expected sectors of investigation and to the two areas of study (the Rocche highland in the Abruzzo Apennines and the town territory of Foligno in the Umbria Apennines), and it exposes the results related to the transformations of the settlement morphology, to the demografic and economic trends during the last fifty years, built on

quantitative indicators gotten through elaborations of statistic and map data and through the use of the GIS technologies .

The importance of the GIS application in the definition of the general schemes of the human geography and in the monitoring of the territory is remarkable; it allows to perform the study of the relationships between man and environment and the spatial distribution of innumerable phenomenons, furnishing the identification of the concrete evolutionary tendencies of the social occupation of the Apennines spaces.

The general instrumental approach to the study, from which we are making an extract for the contribution, consists of different successive components and use several analysis tools like aerial photographs of different periods, scanned and geo-rectified; digital maps of relevant environmental factors (geomorphology, topography, land uses, vegetation etc). Their incorporation into a GIS database allowed the subsequent statistical analysis of effects of environmental factors on landscape changes to quantify their impact. Parameters derived from the statistical analysis are then used to calibrate a spatially explicit model of anthropic dynamics. The models are potential for predicting future settlement changes and relating to actual management problems.

2. CASE OF STUDY IN APENNINES SYSTEM

2.1. Study areas

Study areas include the Rocche plateau in the Abruzzo Apennines an Foligno district in Umbria region.

The Apennines mountain territory, base of departure for the individualization of the two areas of study, is in hold relationship with the areas of hill and lowland, composing an only environmental picture.

The transformation of settled landscapes that characterize this territory are direct consequence of the events that have interested, with greater or smaller intensity, the communities of central Italy. In the arc of the last twenty years in the inside areas of the Apennines, even if in smaller measure in comparison to coastal regions, we have a settlement growth with peculiar characteristics, based on emerging of "local contexts of development" (Fabietti, 1994).

Along the wide skeleton of the Apennines the karst morphology is expressed with manifold forms, diversified both in the typology and in the dimension; on these the man has plotted an own cultural and social history that, from the primitive structures of settlement, has carried on in continuity involving in the fruition, in consistent measure also, the surrounding territory.

The plateaus represent homogeneous areas in order to a precise range of phenomenons. They represent also geographical unity situated among elevated citizenship spaces, with a conspicuous density of human exploitation historically stratified thanks to the favorable orography and the pedological characters and that come to interfere with important lines of environmental continuity.

On the great plateaus we found networks of rural mobility and consequential land fittingses from inextricable historical stories, agricultural or zootechnic productive spaces of ancient management, modern tourist structures or, in alternative, strong changing tensions in such sense, the everything in narrow relationship with naturalistic values of enormous national and international importance that adequately attest the real ecological importance.

The contemporary presence of these characteristics on the narrow spaces of the plateaus, has generated numerous elements of complexity, due above all to the fact that the evolution of the referable to the human sphereb dynamics has followed entirely different layouts in comparison to the mountain areas of it neighboring, not only generating forms of environmental alteration referable to the pressure of the transformations physically expounded on the sites, but above all to the physiognomy of the natural relationships (Romano & Tamburini, 2002).

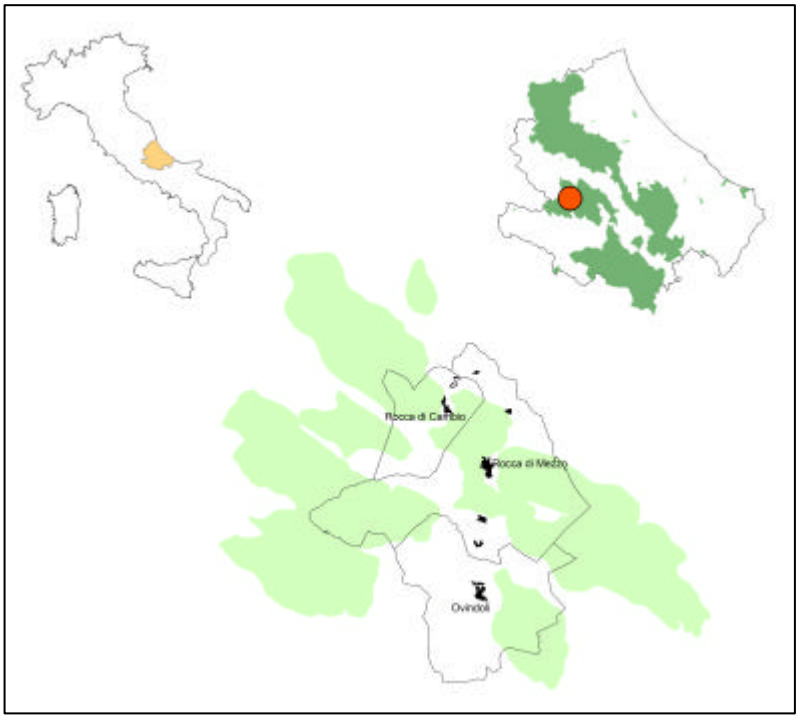
2.1.1 The Rocche plateau (Abruzzo, Italy)

Characterized by a system of plateaus set to different heights (Plateaus of Rocca di Mezzo and Ovindoli, Plain of Pezza, Plain of the Sirente, Plain of Iano) and with a surface that extends it for around 300 Kmqs among the two thick calcareous of the Velino (to west) and of the Sirente (to east), the highland of the Rocche results one of the widest so conformed structures in the Central Appennines. If the highland of Ovindoli extends it to quota 1340 meters for around 4 kilometers, leaning out on the basin of Fucino, the highland of Rocca di Mezzo opens to North and extends it for around 7 kilometers of length to 1270 meters high, leaning out on the valley of the Aterno.

The interested districts are Ovindoli with the little centers of S.Potito and S. Iona, Rocca di Cambio and Rocca di Mezzo, that also includes Rovere, Terranera and Fontavignone fractions. From 1989 the area is contained by the Sirente-Velino Regional Park.

The area represents an important winter touristic pole for Central Italy and the actual economy is based mainly on skiing structures; these activities have a great influence on landscape and social aspects: sprawl of large number of second houses and decreasing of steady population.

Figure 1 – Position of Rocche Plateau (red) in the national parks system (dark green) in Abruzzo region and Sites of Community Interest (soft green) in the study area



2.1.2 Foligno municipal district (Umbria, Italy)

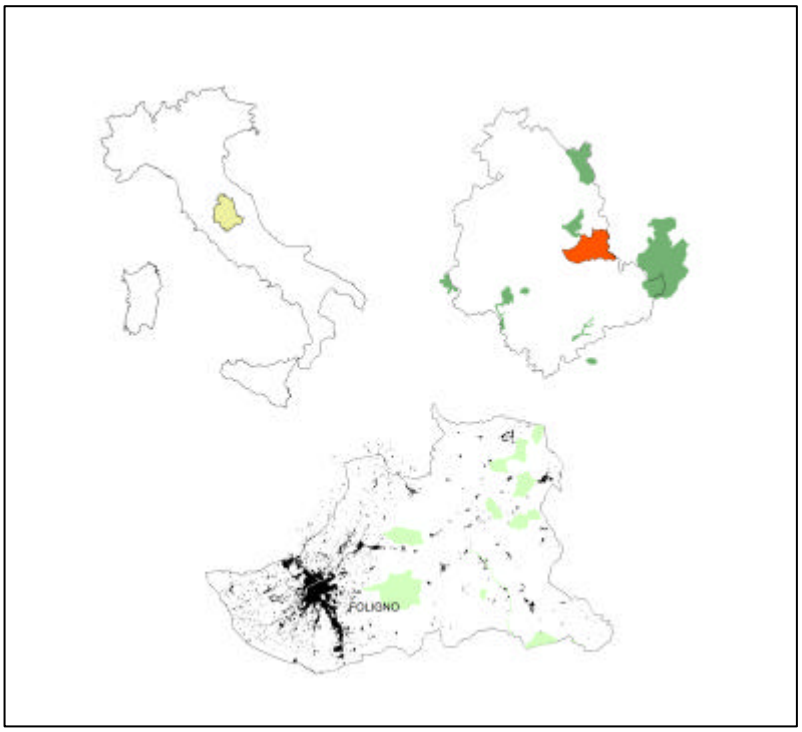
In the Province of Perugia area, Foligno is the second biggest urban center. All the district is characterized by important historical and environmental resources and at the same time by a strongly spread urban settlement composed by lots of fractions.

Foligno center is crossed by Topino river and all the area of its district includes different geomorphologies like valleys, mountains and plateaus; the district confine northerly with Subasio Mount Park and is not far from Sibillini Mounts National Park.

From 740 to 790 meters of heigh, on the north-east side we find the Plestini system of highlands, rich of important natural sites, composed by Colfiorito plateau, Cesi plateau, Popola plateau, Annifo plateau, Ricciano plateau, Arvello plateau e Collecroce plateau.

Foligno town represents an international touristic pole, that produces rich and lively economy often based on sustainable management being realized through a thick web of facilities like bed & breakfast structures, little rural restaurants and many cooperatives that stimulate local development.

Figure 2 – Position of Foligno district (red) and national parks system (dark green) in Umbria region and Sites of Community Interest (soft green) in the study area



2.2 METHODOLOGY

Within this research the methodology of analysis mainly focuses the attention on the human components of the environment.

The sectors of investigation can be divided in:

- social-demografic aspects, analyzed through past and actual situation,
- urban aspects, analyzed through past, actual and potential conformation,

with the purpose to get important information on the tied up phenomenons to the relationship man-environment present in two territories of particular complexity as the highland of the Rocche and the area of Foligno.

The parameters and the themes of investigation used within the research to analyze these two components are the followings:

✍ Demography
- Population trend
- Population structure and old age index

✍ Economic situation
- Economic activity rate
- Employment rate
- Employment in line of business

✍ Settlement
- Urban Evolution Index
- Realization of the urban plan

In some cases analysis results more detailed for the centers of Rocche, of which is available an ampler range of data and uses the data of Foligno with the purpose to conduct a comparison limited to the actual situation.

The tools of analysis can be gathered in the following typologies:

- cartographic data
- statistic data
- vectorial data
- planning instruments
- photographic documents

Such data have been elaborate with GIS technique and through the common softwares for data management.

Table 2 – Sector of analysis, indicators and indexes, data fonts

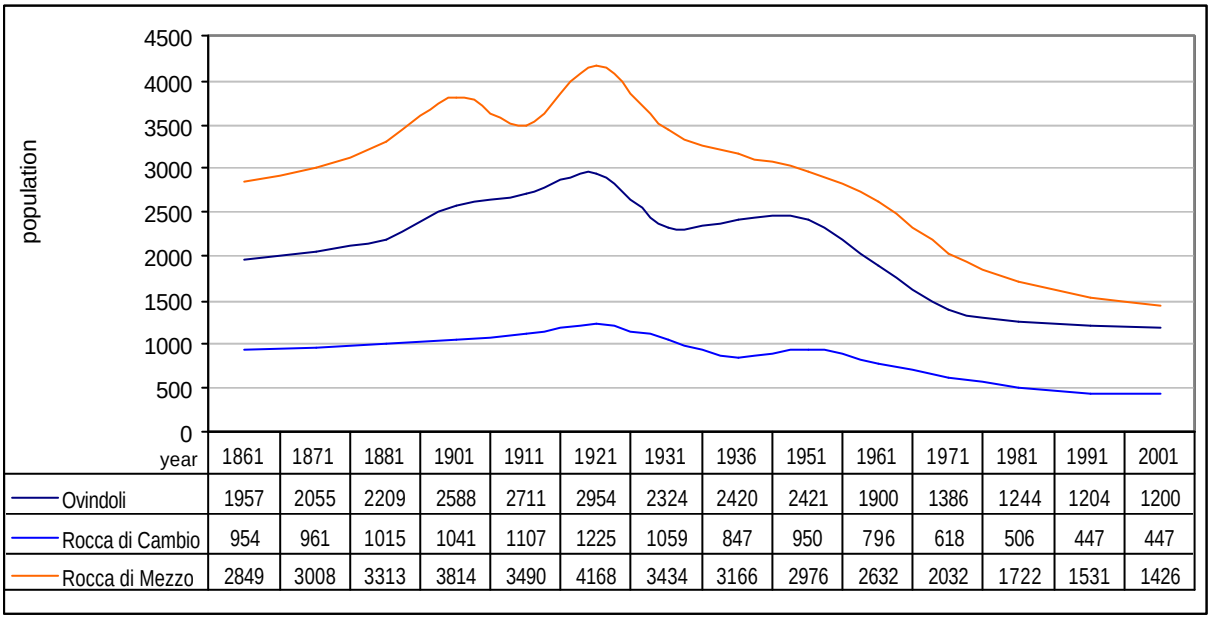
DEMOGRAPHY	- Population Trend 1861-2001	Foligno – Rocche Plateau	Census Data from National Statistics Institute (ISTAT)
	- Old Age Index		
	- Trend 1951 - 2001	Rocche Plateau	
	- 2001	Foligno – Rocche Plateau	
	-Population age structure		
	- 2001	Foligno – Rocche Plateau	
ECONOMY	- Employment rate		Census Data from National Statistics Institute (ISTAT)
	- Trend 1951 - 2001	Rocche Plateau	
	- 2001	Foligno – Rocche Plateau	
	-Employment in line of business		
	- Trend 1951 - 2001	Rocche Plateau	
	- 2001	Foligno – Rocche Plateau	
SETTLEMENT	- Urban Evolution Index		-Topographical maps - Air photos - Urban Plan - GIS data
	- Trend 1954 - 2000	Foligno – Rocche Plateau	
	- Potential	Foligno – Rocche Plateau	
	-Urban Plan realization level		
	-2001	Foligno – Rocche Plateau	
	- Potential	Foligno – Rocche Plateau	

2.3 SOCIAL AND ECONOMIC ANALYSIS

2.3.1 Demography

The graphs in figures 3 and 4 represent population trends in a 130-years period, from 1861 to 2001. In all the districts of Rocche Plateau we have a great loss of population in the last fifty years connected to migration from mountain interland to nearest bigger towns. This phenomenons of abandonment have involved a large parts of little montain villages in Central Apennines, expecially in Abruzzo region where sheep farming crisis generated important structural changes in the society and its economy.

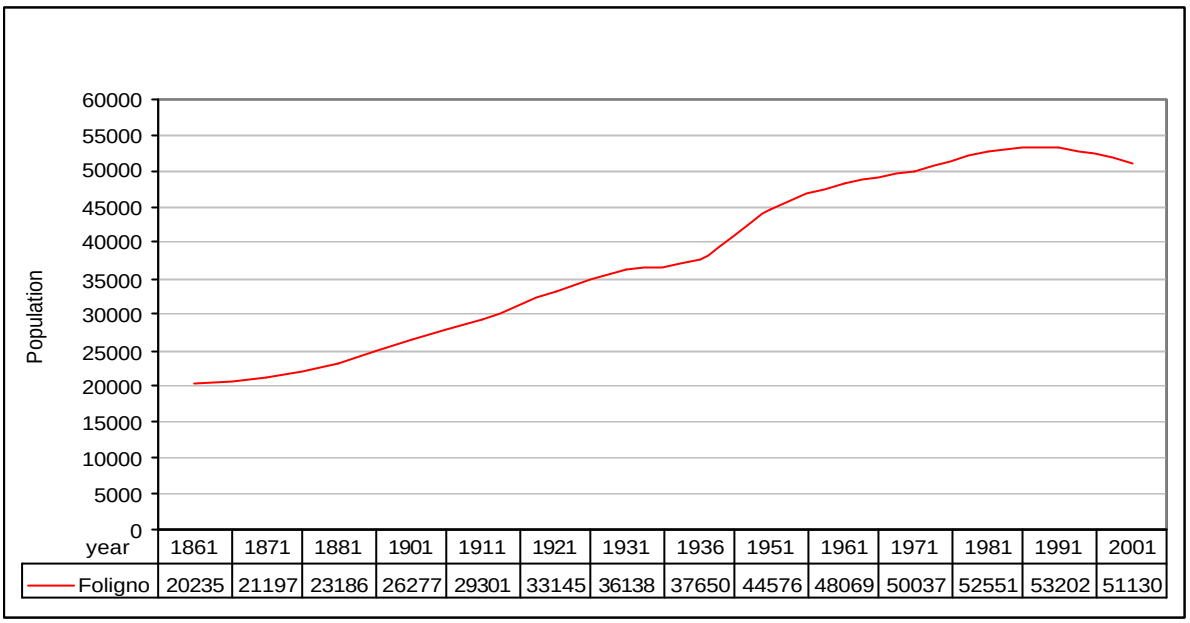
Figure 3 – Population trend in Rocche plateau



year	1861	1871	1881	1901	1911	1921	1931	1936	1951	1961	1971	1981	1991	2001
Ovindoli	1957	2055	2209	2588	2711	2954	2324	2420	2421	1900	1386	1244	1204	1200
Rocca di Cambio	954	961	1015	1041	1107	1225	1059	847	950	796	618	506	447	447
Rocca di Mezzo	2849	3008	3313	3814	3490	4168	3434	3166	2976	2632	2032	1722	1531	1426

In the same period population in Foligno continuosly increases, even if we have a steady state during last decade.

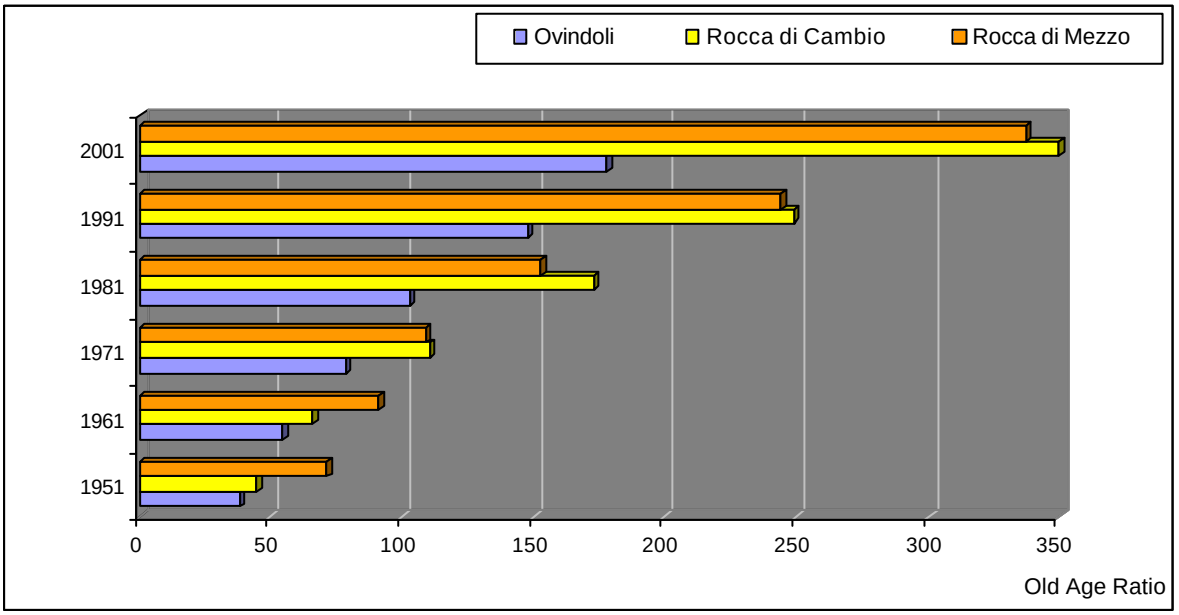
Figure 4 – Population trend in the district area of Foligno



year	1861	1871	1881	1901	1911	1921	1931	1936	1951	1961	1971	1981	1991	2001
Foligno	20235	21197	23186	26277	29301	33145	36138	37650	44576	48069	50037	52551	53202	51130

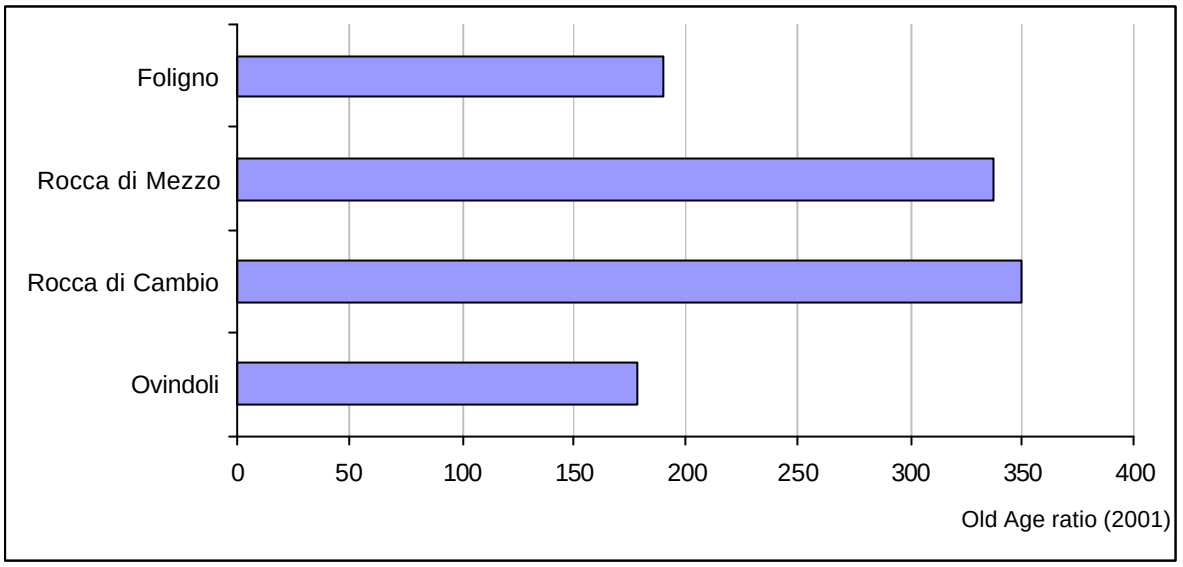
The old age index is the percentage ratio between population over 65 years old and population under 14 years old. In the Rocche plateau this ratio has strongly incresed in fifty years and is higher than national and regional mean values. In Ovindoli the values goes from 38 to 178, in Rocca di Cambio from 44,8 to 350, in Rocca di Mezzo from 71 to 337 (Fig. 5).

Figure 5 – Old Age index from 1951 to 2001 in the district of the Rocche Plateau



The graph in figure 6 illustrates the comparison of old age indexes between Foligno, Rocca di Mezzo, Rocca di Cambio e Ovindoli in the census 2001.

Figure 6 - Old Age index in 2001 in the district of the Rocche Plateau and in Foligno



From the point of view of the demografic structure a strong impoverishment of the young classes (0-14 years old) and an abrupt increase of the elderly population are observed. The impoverishment of the most active classes involves an increase of the weight of the non productive population with precise socio-economic consequences.

The demografic aging has involved in fifty years a radical change of the relationship between the class of the over 65 years old and the young class (less than 14 years old) in the Rocche plateau; such ratio passes in fact from a value of 1:2 to a value of 6:1.

The demografic aging not only involves implications in the course of the social aging, socially defined as advance of the threshold related to the term of the functional activities, among which there is the one that works, but also consequences from the point of view of the macroeconomics like the effects on the employee benefit plan, relief, sanitary, scholastic and on that of the consumptions.

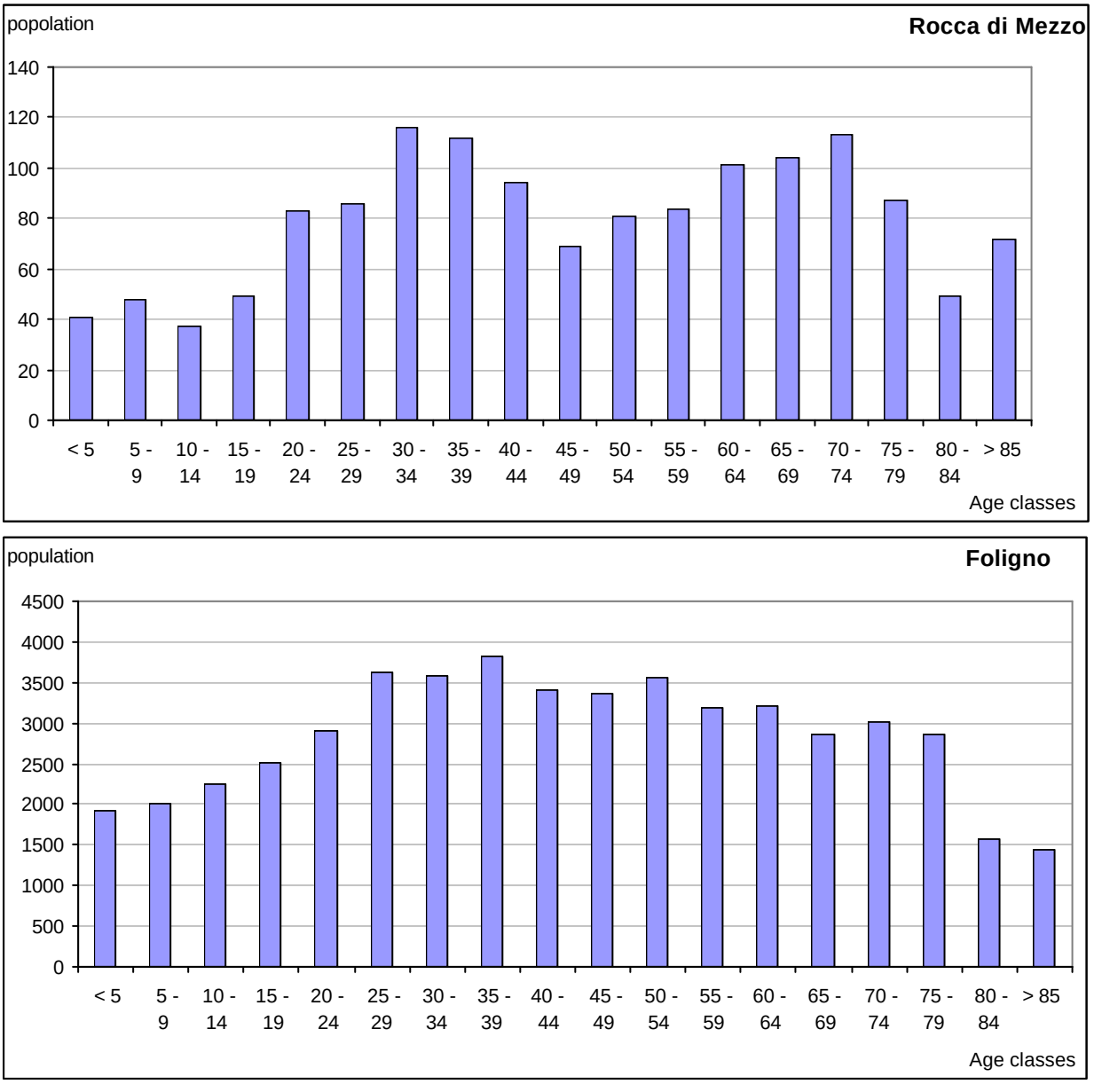
On the employee benefit plan particularly, it provokes immediate effects that strongly are influenced by some structural changes of the population since increasing quantitatively the elderly classes those people that profit some insurances for the old age increase in consistence making more difficulty and heavy the contributive load for the active population.

Table 3 – Ages classe and old age index in 2001

Census 2001	Age classes									
	< 5	5 - 9	10 - 14	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49
Ovindoli	40	45	49	60	85	88	89	96	86	73
Rocca di Cambio	14	9	11	15	26	37	22	36	30	27
Rocca di Mezzo	41	48	37	49	83	86	116	112	94	69
Foligno	1933	2007	2259	2521	2915	3633	3574	3813	3415	3358

Census 2001	Age classes									Old Age Index
	50 - 54	55 - 59	60 - 64	65 - 69	70 - 74	75 - 79	80 - 84	> 85	Total	
Ovindoli	100	67	83	58	58	44	43	36	1200	178,4
Rocca di Cambio	44	24	33	23	35	29	12	20	447	350
Rocca di Mezzo	81	84	101	104	113	87	49	72	1426	337,3
Foligno	3567	3186	3212	2856	3010	2852	1583	1436	51130	189,34

Figure 7 – Age classes structure in Rocca di Mezzo and Foligno

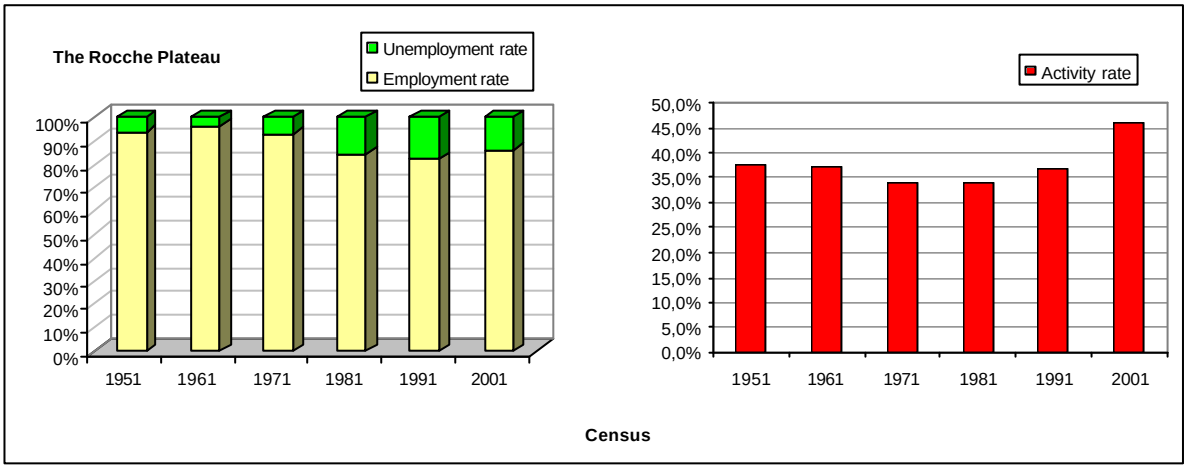


2.3.2 Economic structure

The active population, or rather the labor force, is the population that for age and condition it is able to develop a working activity and it is composed from the employed ones, from the unemployed and from those looking for first occupation. Activity rate so is percentage of the population who are economically active / population over 14 years old while employment rate is percentage of labor force who is employed.

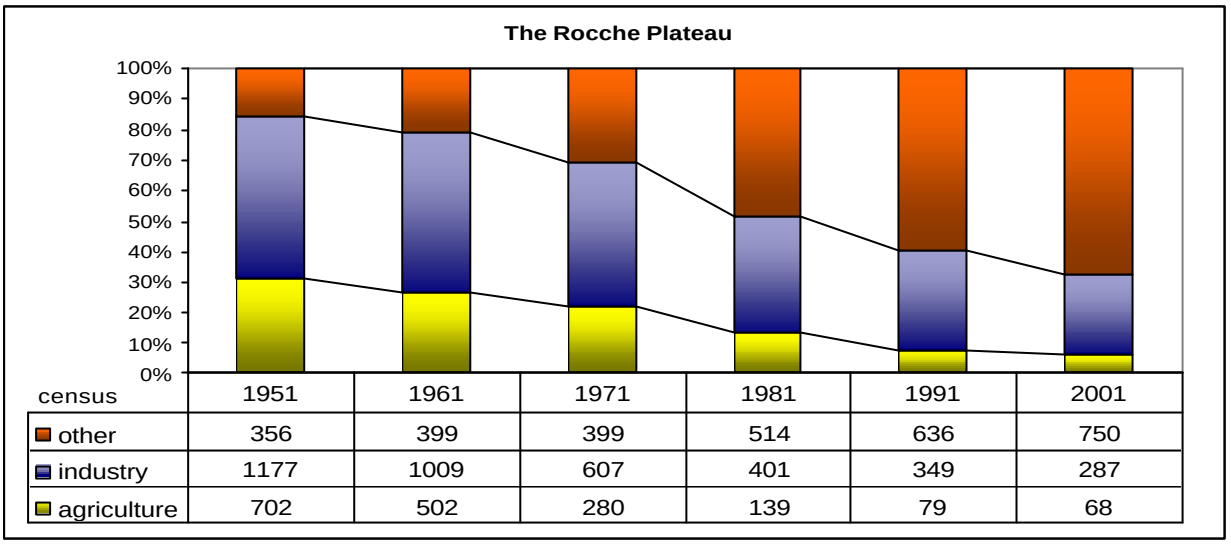
Different proportions among the two components of the work force (emplyment rate and unemployment rate), give meaningful indications on the course of an economic system (Fig. 8).

Figure 8 – Employment rate, unemployment rate and activiy rate during the last fifty years in the Rocche plateau



With reference to the sectors of economic activity, in the Rocche area we have a strong decline of the agriculture and the industry sectors, while the tertiary one is increased. Such phenomenon is due to the insertion of big part of the young workers in the sector of the services and other activities of the tertiary one in the nearest urban centers (Fig. 9).

Figure 9 – Employment in lines of business during the last fifty years in the Rocche plateau



census	1951	1961	1971	1981	1991	2001
other	356	399	399	514	636	750
industry	1177	1009	607	401	349	287
agriculture	702	502	280	139	79	68

Table 4 – Employed in line of business in 2001

census 2001	Agricolture	Industry	Other activities	TOTAL	Employment rate	Unemployment rate	Activity rate
Foligno	547	5726	12916	19189	92,3%	7,7%	46,3%
Ovindoli	30	112	306	448	84,7%	15,3%	49,6%
Rocca di Cambio	6	35	129	170	89,0%	11,0%	46,3%
Rocca di Mezzo	32	140	315	487	86,2%	13,8%	43,5%

Table 4 gives some informations about differences between Foligno and Rocche plateau in 2001. First of all the employment rate in Foligno is higher than one in the other districts, even if the activity rates are similar in the two areas, expecially between Foligno and Rocca di Cambio, while Ovindoli owns the higher value because the oldest classes are less influent.The percentage in different line of business is almost distributed in the same way in both study areas.

2.4 URBAN ANALYSIS

Settlement distribution is influenced at the same time by morphology and original population features and in the Apennine reaches typical peculiarity as it is not diffused but polarized in particular areas (plateau, valley, ridges) and it is conditioned by the ancient street system.

Using the available cartographic documentation, in different temporal sections, the phases of growth/transformation of the built nucleuses during about half century.

Combining different tools, as the topographic cartography in first layout, its more recent updatings and the aerial photos has been possible to admit, inside an only comparative picture, the "movements" of dimensional and functional arrangement that the built and inhabited places of the highland of the Rocche and of Foligno have suffered in the time because of the changes that the society and the external world induced.

The reconstructed images give account of definable trials of "gemmation", of "division", of "agglomeration" and of separation that countersign the analyzed centers with strongly, but not entirely, ways of demonstration dependent from the morphological and interrelated conditions.

The use of the GIS tecniques has undoubtedly offered some not indifferent opportunities of facilitation to the result, through which informative layers of absolutely different derivation and elaborate data have been able to be read and actively compared.

The "historical" lack of a steady tourism is at the base of the particular type of modifications that the territory of the highland of the Rocche has suffered in the last half century, discounting a lack of self identification in the formulation and in the management of the models of fruition, and suffering instead an external wide and clear "colonization" that results well visible from the geographical distribution, from the organizational typology, from the architectures of the "modern" building volumes and from a "shyness" of the local communities in the entrepreneurial initiatives in the sector and in social involvement. The pushes of settlement have been different in the territory of Foligno where the building expansion during the last fifty years is in partnership to a respective increase of the population. As it regards the tied up tourism aspects we totally assist in this case to a different philosophy since planned on standard of high local self identification.

For the formulation of an index of urban evolution reported to the period 1954-2000 the analysis effected on the cartographic bases has foreseen:

1. individualization of the physiognomy of the settlement on 1955 topographical map and recent; through GIS application the edges of the settlement in the two periods of time have

been outlined and subsequently overlapped to the air photos documentation

2. individualization of the areas delimited from the buildings and from the pertinences on air photos 1:2000;

3. classification of the areas individualized in base to the considered periods:

- historical center,
- 1954,
- 2000;

3 calculation of the respective areas through specific applications of the software ArcGis of ESRI

4 calculation of Urban Evolution Index:

(1) $$UEI\ (t_1, t_2) = Su(t_2) / Su(t_1)$$

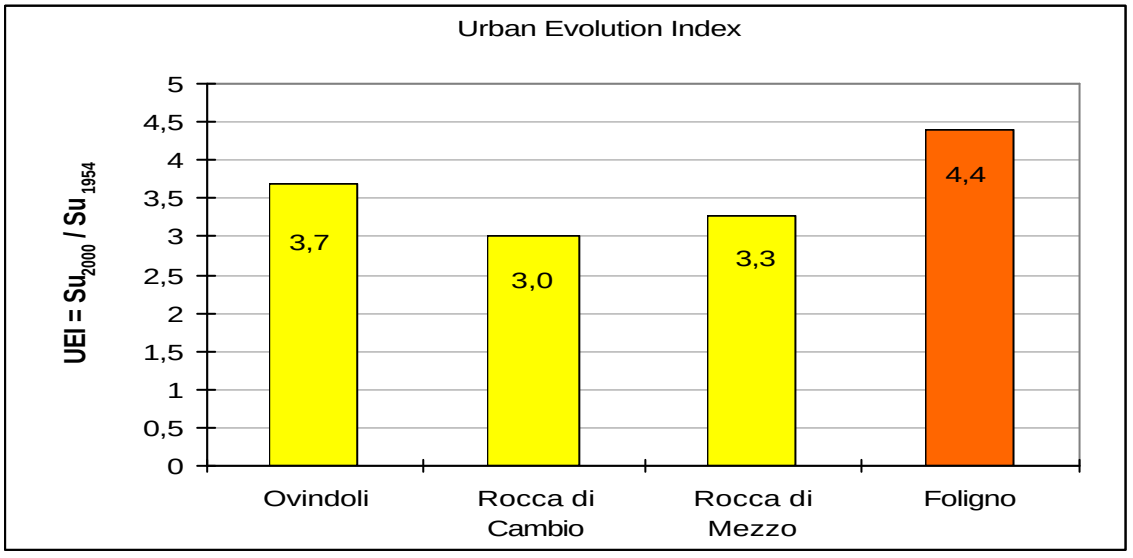
where :

$Su(t_2)$ = Total urban surface at time t_2

$Su(t_1)$ = Total urban surface at time t_1

In this case t_1 = 1954, t_2 = 2000 and the obtained values are illustrated in figure 10.

Figure 10 – Urban evolution index in Ovindoli, Rocca di Cambio, Rocca di Mezzo and Foligno



The comparison between actual settlement and the physiognomy of the planning tools allows to get important indications on the state of realization of the plans themselves, on the urban spaces non anticipated in origin and on the tendencies and preferences of the various

typologies of settlement (destinations of use) due to different socio-economic pushes in the examined area.

Overlapping the urbanized spaces used for the calculation of the UEI with those delineated from the Plan has been possible to distinguish:

a. edifying areas foreseen from the plan and subsequently urbanized, divided for typology of fruition;

b. areas currently urbanized but not anticipated initially from the plan;

c. anticipated edifying areas that however have been unused.

Intersecting the data related to the plan with those of the settlement, new database about information on the buildings inside the areas delineated by the plain have been gotten and also the relative destination of use (historical center, existing center, expansion, productive, facilities, tourist activity).

The data related to the effected urbanistic planning allow besides to calculate the UEI in the year of realization of the Plan and the potential (UEIp), or rather that to be expected for a reported realization to 100%. The calculation of the index relatively to a further year, facilitates the construction of models of urban evolution and it makes them more reliable.

UEIp is an important indicator of evolution of future scenery, since it allows to know the existing orientations of the territorial planning as well as the political and socio-economic affairs that involve the whole area. The knowledge of the UEIp and the trend of urban evolution furnishes besides important indications on the choices to effect in the phases of management and environmental planning today turned to the defragmentation and the individualization of contexts of environmental continuity .

The urbanistic tool of Rocca di Mezzo was elaborated in 1982; it is born with the intent to facilitate the more possible the forms of investment, although "external", although still eradicated by the intentions and the understanding of the resident community , looking at these with gratification and with the conviction that every initiative could bring to a mitigation of the demografic hemorrhage however and of the deeply negative consideration that the rural way of living was living and maturing particularly in the mountain inside areas.

The gratification shines through from the disposition of wide parts of potentially transformable territory , in the conviction that proliferating built spaces was translated, always and however, in benefits for the economies and for the society: in the conviction that any they were the forms of tourism encouraged, the return could not be how positive, both for brief that for a long time term.

Vast portions of territory have been so built, with very low indexes that have provoked extensive urbanistic results, with a urban landscape strongly characterized by the filamentous intensifications along the roads and from some agglomerations that they almost propose lost minuscule and unlikely fragments of metropolitan outskirts in a mountain background with grazes and woods, completely alien from their physiognomy.

The urban plan for Foligno is young because it was elaborated in 2000. It reflects demografic and economic actual tendencies as we can observe in figure 11, where the built residential area is not far from the potential one.

Figure 11 – Expected by planning tools and realized ares

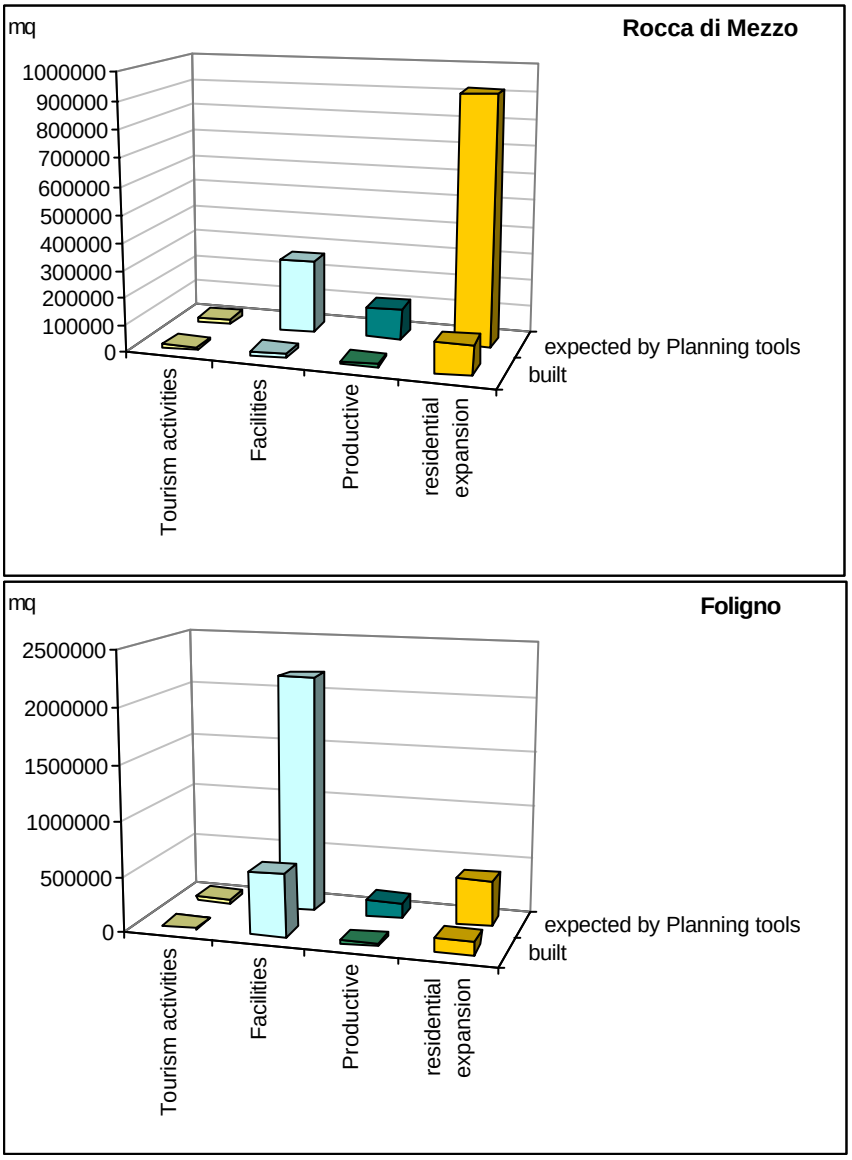
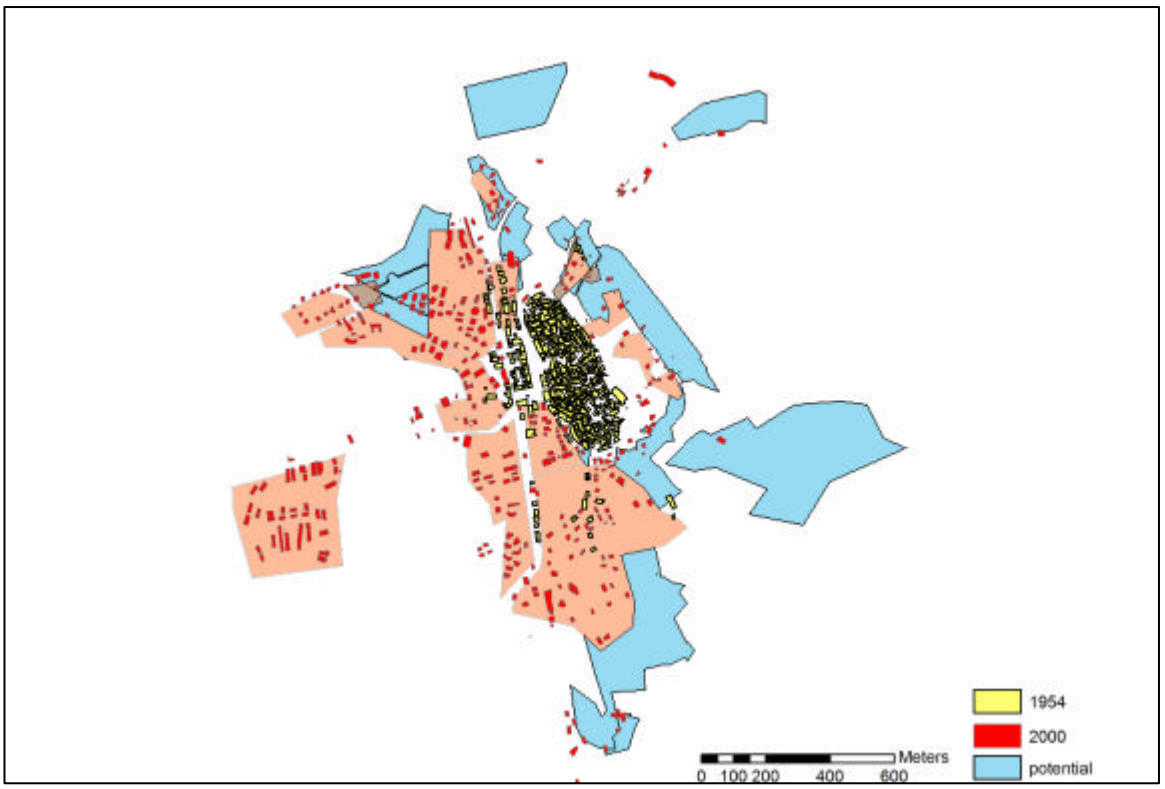
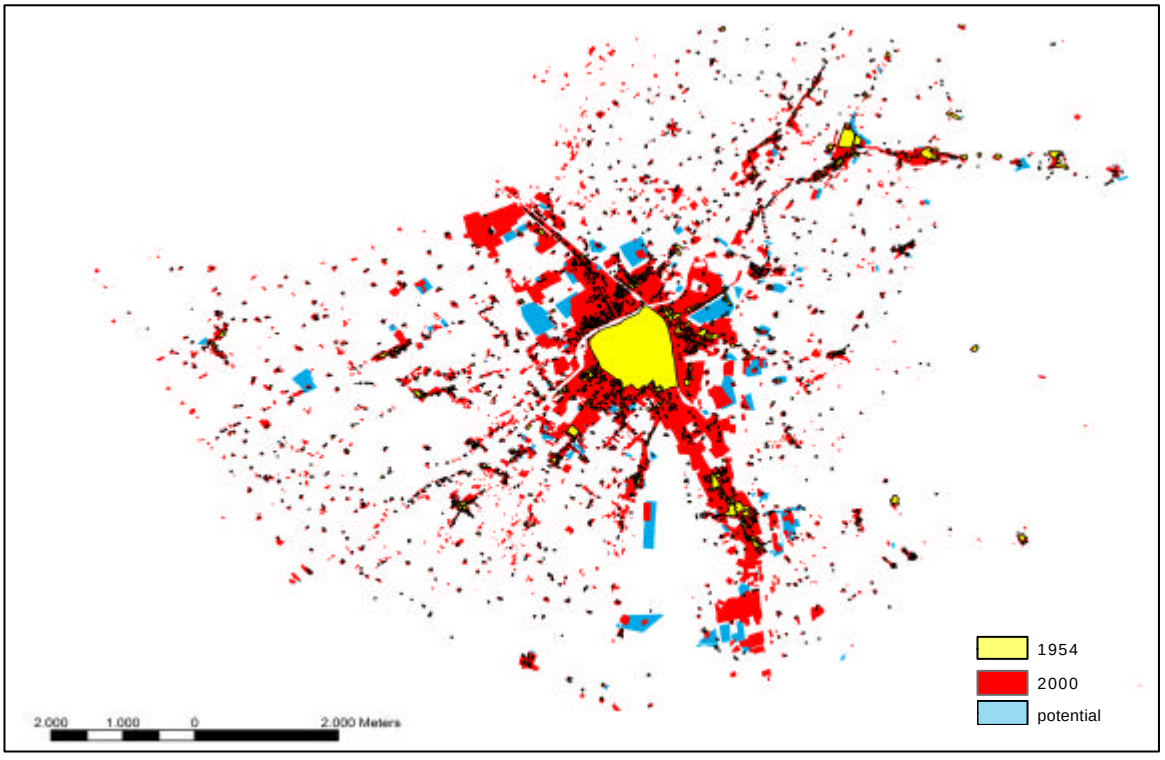


Figure 12 – Urban growth since 1954 and possible future development





3. CONCLUSIONS

What is needed today is a transdisciplinary cooperation of ecologists and landscape planners for the progression of ecological planning (Noss 2001) as a new, hybrid realm combining ecology and planning, nature and culture, holistic and analytic approaches as a new "eco-discipline" (Naveh 2002) of a problem-solving oriented landscape science.

The use of the Geographical Informative Systems allows to elaborate in integrated way data and consequential information from sources and different sectorial analysis. Such results are the product of the overlaps, queries, merges, intersections of the sectorial data of departure and they represent therefore a valid tool of interdisciplinary analysis, especially in the field of the planning. The possibility to prepare and to continually adjourn the database created not only allows to guarantee the monitoring of the territory with the purpose to practise a correct politics of management but also to enrich the patrimony of the scientific knowledge.

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