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Economic forecast and fuzzy spatial analysis: integrated tools for assessing the development tendency of an Italian region.

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Introduction

This paper is articulated in two sections.

In the first, the touristic sector is described within an international perspective and the case of tourism development in the town of Arzachena is illustrated, with reference to the outline of the province of Sassari. An econometric model is implemented to forecast tourist trends in the period 1999-2005, in order to show the magnitude of total revenues. Finally the mixed economy of tourism and agriculture is presented as one of the main development potentials of weak areas, such as those of the interior part of the Island.

In section two spatial analysis is performed in order to point out the tendency of the development to the tourist sector as a catalyst for local economy. Given the nature of the economic situation of several activities, that are caracterized by a mixed economy, rough set analysis is applied to show different kinds and levels of the shift from a pure agricultural to a tourist economy.

A brief paragraph will end the paper presenting some remarks about the outcomes of the study and perspective for future developments.

This paper is based on a cooperative research work: Andrea De Montis has particularly taken care of section one, while Germana Manca of section two.

SECTION ONE

1.1. Italian tourism: an international perspective

Italy ranks fourth in the world for number of tourist arrivals in 1996 (35,5 millions) after France, United States and Spain (Provincia di Sassari, 1997); this shows that Italian lifestyle and, broadly speaking, the "Made in Italy", has entered into the group of the most appreciated objectives of the world tourism. This phenomenon is boosted by internationalization and globalization of the economy. Increasing efficiency of the international reservation system, international cooperation treaties, extension of the average holiday period and consolidation of the European Union are the main reasons of the expansion of the tourist sector.

WTO (World Tourism Organization) Statistics indicate that Italy has a leading position in international tourism, showing very high values of the share of international arrivals (5,5 %) and of receipts (6,7 %), with reference to world figures. The correspondent values with reference to Europe (9,4 % and 13,2 %) are remarkable. According to the WTTC (World Travel and Tourism Council) estimates, in Italy the percentage of tourist revenue with respect to total GDP is 13 %, while the world average value is around 10,9 % (Presidenza del Consiglio dei Ministri, 1997).

1.2. Sardinia in the international tourist market

The regional economy of Sardinia is characterized by a weak structure; the sector of tourism represents strategic for this economy, if it were possible to activate efficient linkages with the other economic sectors.
The President of the Italian Government (1998) has developed a study on Italian regions, based on a multivariate cluster analysis. The final report about the region of Sardinia contains the following statement.

"In Sardinia the most relevant values of sector growth rates are registered for medium sized hotels (4 %) from 1997 to 1998. The other types of hotels do not show any remarkable growth. Italian tourists seem to prefer hotel accommodation (80 % of total bednights is covered by Italians). Foreign tourists like instead complementary structures.

The bednights of Italian tourists in the hotels have grown considerably from 1997 to1998 (8,7 %), and the average length of stay has increased as well (4,5 %, with respect to1996). The utilization indexes enlighten a high seasonal trend of Sardinian tourism: this is shown by the fact that the net utilization index is higher than the gross. The index of utilization refers to the extent to which an hotel is occupied with respect to the number of the days, during which it is open.
Bednights of Italian and foreign tourists have increased in complementary structures.
Places close to the sea and the beaches receive around 50 % of total bednights and have grown by 7 %, with respect to 1997."

Tourist demand and supply can be described through the Istat database (1980-1996) about arrivals, bednights and receptive structures.

Sardinian tourist supply can be ranked in medium-high range. This characteristic is peculiar with respect to many other Italian regions. Natural beauties and favorable weather are well known features of Sardinia and one of the main reasons why many wealthy tourists wish to visit. Regional policies aim to boost the development of tourism with a high standard of the tourist service be maintained, in order to promote the image of an exclusive vacation on land.

Each supply side policy follows this high level objective to provide a receptive system also during the "weak season" (from October to April). Congress tourism, golf tourism and sail-boating tourism are some examples of activities oriented to link Sardinian isolated economy to international cultural and sport networks.

A comparison between the peninsular region of Emilia Romagna and Sardinia may explain the concepts illustrated above and may reveal useful, if we consider that Emilia Romagna has the highest number of hotels in 1997.

In Sardinia arrivals have grown steeply from 1983 to 1996 (from 988,804 units to 1,434,000 units) and bednights have grown during the same period with an even more remarkable trend (form 4,960,022 units to 7,550,398 units).
In Emilia Romagna the corresponding figures mark a high increase of arrivals (form 5,206,745 units to 6,422,176 units) and a sharp decrease of bednights (from 42,493,763 units to 33,704,256 units). Graph 1. and Graph 2. illustrate these figures.

This means that the average lenght of stay, which can be measured by the ratio between the number of bednights and the number of arrivals, has decreased for Emilia Romagna (from 8 to 5 days), while it has remained substantially stable for Sardinia (around 5 days).

The tourist market of Emilia Romagna represents a 10 % share of arrivals and a 12 % share of the bednights with respect to Italy as a whole, while Sardinian market represents a 2 % share of arrivals and a the 3 % share of bednights. These figures show a constant trend. The ratio between arrivals and between bednights in Emilia Romagna and Sardinia has stabilized around 4,5 to 1.

This observation suggests that revenues from tourism in Emilia Romagna be higher than in Sardinia. This is not the case, since the spending capacity of tourists of Emilia Romagna is lower. In Sardinia a tourist normally does not spend less than 300,000 liras daily, according to a recent research (Università di Sassari, Sistema delle Imprese della Provincia di Sassari e Consorzio Costa Smeralda, 1997), while in Emilia he spends around 200,000 liras per day. In other words in Emilia Romagna the diversification of the supply, oriented towards a medium target, allows the tourist to spend his holidays in a cheaper way. The reason of such a difference does not depend on the supply side only. Who decides to go to Sardinia for holidays must face also very high travel costs.

One of the main problems of Sardinian tourism is its seasonality. This phenomenon can be detected by means of the percentage ratio between the number of total arrivals and bednights in summer and the number of total arrivals and bednights in the whole year.
The time series of this "seasonal index" indicates that Sardinia presents an opposite trend, with respect to Emilia Romagna and Italy,. This index increases for Sardinia, while it decreases in the other two cases.
The percentage share of arrivals increases from 1983 to 1996 from 61 % to 68 % in Sardinia, while it decreases from 65 % to 57 % in Emilia Romagna. These regions shows figures well above the national average: the percentage of arrivals in summer time for Italy has decreased from 53 % to 48 %.
The percentage of bednights in summer time shows an even higher seasonal trend: in Sardinia it increased from 1983 to1996 through the range 79 % - 84 %, in Emilia Romagna it decreases from 86 % to 77 % and so does it for Italy from 71 % to 62 %.
While the supply diversification has caused an important redistribution of tourist movements along the whole year, in Sardinia the policies of "de-seasonalization" have not been effective as well. Tourism is still a monocultural economic activity mainly referred to coastal attractions. Graph 4. shows the seasonal index time series, with reference to the distribution of bednights.

1.3. The Province of Sassari: tourism as a catalyst of local development

The Province of Sassari has a leading position among the provinces of the region of Sardinia. From the Isat database about tourism, it can be noted that the percentage share of arrivals and of the bednights in the province of Sassari, with respect to the entire region has been fluctuating around 50

%. The Province of Cagliari ranks second, showing figures around 30 %; the remaining 20 % is divided between the provinces of Oristano and of Nuoro.

Data on the supply side points show how the Province of Sassari is ready to receive the mass of tourists previously described. The percentage share of hotels of the province of Sassari with respect to the region of Sardinia is stable around 45 %. The provinces of Nuoro and Cagliari follow, with values around 27 % and 22 %.

Data about the percentage share of value added reveal that tourism in hotels and trade is 20 % with respect to total regional value added (Istituto Tagliacarne e UNIONCAMERE, 1998). Percentage sharer of tourism is about 3 %.
Many signals suggest that tourism can become a key sector for the economic development of the province of Sassari, whose gross province product has grown from 1991 to 1995 well below the Italian average (under 3 %). The province of Sassari is not very dynamic, if we consider the growth rate of gross province product, which is an indicator of the standard of living.

1.4. The city of Arzachena: strategic actor of the Sardinian tourist sector

Arzachena is a small town located in the northeastern part of Sardinia. It is the corer tourist area called "Costa Smeralda". In this zone huge investments in the building industry from the middle of the sixties have boosted the development of a highly qualified system of hotels, residences and ports that is still one of the most favorable vacation places in the western Mediterrean region.

An analysis of tourist movements points out that an important share of arrivals and bednights can be attributed to the city of Arzachena. The share of bednights fluctuates around 20 % with respect to the province of Sassari and around 10 %, with respect to Sardinia. The share of arrivals fluctuates around 15 %, with respect to Sassari and around 8 %, with respect to Sardinia. Graph number 5 and 6 point out this trend thoughout the period 1983-1994.

In the time period from 1980 to 1994 the number of arrivals doubbles from around 60,000 units to 120,000, while the number of bednights increases from around 400,000 to 800,000.
The study of this trend allows one to forecast the number of arrivals and bednights, by means of interpolation lines: linear, logarithmic and exponential. Among these the best fitting line has been considered, on the assumption that the highest value of the R^2 is a reliable measure of the "goodness of fit". The algorithm is the OLS method.

According to this model, the forecast estimate of arrivals in 2005 is 127,270 units and the fitting line is the exponential function $Y = 57,858 \cdot X^{0,2449}$, with $R^2 = 0,9317$. This is connected to a growth rate of around 50 %. Graph 7 refers to the line-fit-plot of arrivals forecast.
The fitting line of the bednights is much more important, because it allows us to have an estimate of potential revenues of the tourist sector at the beginning of the next century.
According to the best fitting line, the linear function $Y = 26,076 \cdot X + 406,94$, with $R^2 = 0,8077$, bednights are expected to reach by 2005 the value of about one million tourists. Graph 8 describes the line-fit-plot of this estimate.

The daily spending capacity of a tourist in Arzachena is about 500,000 liras. It is necessary to consider wide range of consumption, which can not be described completely using that high value. In other terms, the level of spending within the "Costa Smeralda" –estimated in about 500,000 liras- does not represent the average spending of the entire territory of Arzachena, since many tourists in
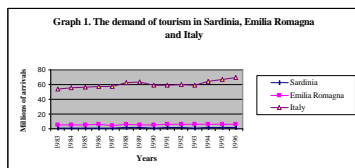
complementary structures spend much less. Therefore that value is corrected into the lower value of 300,000 liras. The expected total yearly revenues associated to tourist movements are calculated in 347 billion liras in year 2005, with an expected fixed inflation rate of 1,5 %. Table 1 contains the results for the time period from 1999 to 2005.
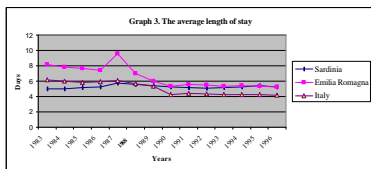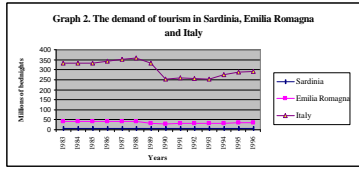

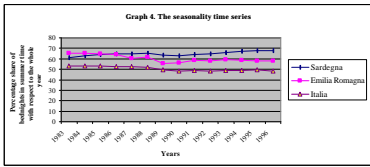## 1.5. New trends of tourism and linkages with agricultural sector

New trends of the receptive system are described in many documents of the European Union (1997). In particular there is a new type of tourist supply, which is expected to become a key part of the receptive apparatus. It is based on the concept of diffused hotel system and agritouristic actvity.
This seems to be linked to two main issues:

1. the diffused-hotel system creates a network, to connect the interior areas to the coastal richer zone;
2. Revenues from agriculture are poor: the sector may be associated to other activities, like tourism. In this way the two activities support each other and expand production and revenues.

Many programs linked to investments financed by the European Union suggest that this direction is the most suitable for weak internal areas of Sardinia (Pluri-funded Operative Program 1994-1999, Multi-regional Operative Program, 1994-1999).

Graph 1. The demand of tourism in Sardinia, Emilia Romagna and Italy

Graph 2. The demand of tourism in Sardinia, Emilia Romagna and Italy

Graph 3. The average length of stay

Graph 4. The seasonality time series

Percentage share of bednights in summer time with respect to the whole year

- Sardegna
- Emilia Romagna
- Italia

Years

Graph 5. The percentage weight of Arzachena with respect to Sardinia and to Sassari – Bednights

Graph 6. The percentage weight of Arzachena with respect to Sardinia and to Sassari - Arrivals

Legend:
- With respect to Sardinia
- With respect to Sassari

Y-axis: 0,00 – 5,00 – 10,00 – 15,00 – 20,00 – 25,00 – 30,00

X-axis (Years): 1983, 1985, 1987, 1989, 1991, 1993

Graph 7. Commune of Arzachena - Tuorism forecast

$y = 65.203e^{0.027x}$
$R^2 = 0.8961$

$y = 4.7312x + 62.992$
$R^2 = 0.9195$

$y = 57.858x^{0.2229}$
$R^2 = 0.9317$

$y = 21.076Ln(x) + 53.657$
$R^2 = 0.896$

Total arrivals

Lineare (Total arrivals)

Log. (Total arrivals)

Espo. (Total arrivals)

Potenza (Total arrivals)

Graph 8. Commune of Arzachena - Tourism forecast

Total bednights

Lineare (Total bednights)

Log. (Total bednights)

Potenza (Total bednights)
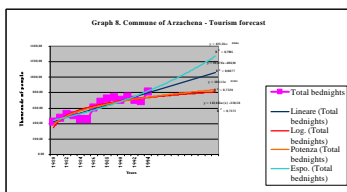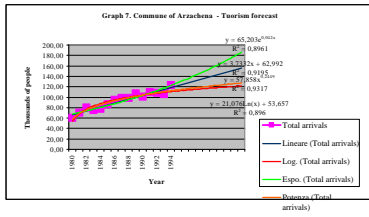
Espo. (Total bednights)

Table 1. Revenues forecast - Commune of Arzachena

Years	Expected Bednights	Daily willingness to pay	Inflation rate	Total revenues forecast (billions of liras)
1999	902,38	300000	1,5	270,715
2000	928,46	304500	1,5	282,716
2001	954,54	309068	1,5	295,016
2002	980,61	313704	1,5	307,621
2003	1006,69	318409	1,5	320,539
2004	1032,76	323185	1,5	333,774
2005	1058,84	328033	1,5	347,334

SECOND PART

2.1. General remarks

The second part of this article will study the influence of coastal tourism on the agricultural activities and farming holidays of the area. Through the use of tools such as GIS (Geographical Information Systems) for landscape and regional planning and fuzzy logic, it is possible to analyse the changes that have taken place in traditional agricultural farms. An environmentally homogeneous area has been chosen, containing farms, which are either zootechnic, or used for holiday purposes. These areas are characterised by different economic, social and environmental features. By means of criteria-indicators and their organisation, we can define the agricultural context. The use of these indicators, in conjunction with the real situation, shows a shaded reality. This kind of picture does not match with the traditional tools of territorial assessment. In actual fact, all the indicators have been analysed by means of fuzzy logic cluster analysis. The results will be discussed and compared with the 2080/92 CEE regulations. This further check shows the grade of penetration of the law for the conversion of traditional agricultural activities. Thank to spatial and fuzzy analysis, we have shown that there is a link between the influence of coastal tourism and farm holidays.

2.2. Farm holiday as a way of overcoming the crisis

The area of Arzachena, as described above, is known also for its archaeological sites, landscape corners, and diversified rural scenes; these particular features build a thin grid dressing the land, and conjunctions between the nodes represent the economic activities. The relationship between the social and economic tissue with the municipal land shows a shadow reality in which it is difficult to give an unbiased opinion.

The introduction of the regulations, such as the new regulation for farm holidays, illustrates the difficulty of defining the new agricultural activities. The agriculture is in constant evolution. This evolution is gradual and hard to quantify, using the classical criteria of measurement. These methods fail when many inputs, of various sectors, come through the analysis. The visual resolution of the real complexity does not appear with clear boundaries. The play of the indicators moves the results inside different domains. Moreover, urban and landscape planning, based upon a deterministic model, does not work when the structure of the indicators is based upon social, economic, environmental and political relationships.

The shadow or fuzzy concept is based upon the definition of agricultural and farm holiday activities. It would be arbitrary to set a clear separation between them. This evolution starts from the pressure moving in from the coast, and penetrates inside the mind of the farm. The vitality and the energy of the coast influence the neighbourhood agriculture, driving the farmers to adapt to the requests of tourism.

The environmentally homogeneous areas do not have a simple definition, but depend upon the mixture of holiday or zootechnical farms. These concepts, far from a clear classification, are better explained by means of a fuzzy clustering technique.

2.3. Fuzzy sets theory: an overview

Fuzzy sets were introduced by Lofti Zadeh (1965), as generalisations of ordinary or crisp sets. In a fuzzy set, there is not a careful distinction between items belonging to a given set and those that do not belong to it. Nevertheless, fuzzy sets allow "grades of membership" expressed by a real numbers between 0 and 1. This point of view "provides a natural way of dealing with problems in which the source of imprecision is the absence of sharply defined criteria rather than the presence of random variables" (Zadeh, 1965; pag.339).

Many daily judgements deal with a grade of uncertainty. This uncertainty is induced neither by measurement errors, nor by random occurrence. This is a philosophical dilemma based upon our perception and by a level of acceptable consent concerning the meaning of crucial dilemma.

Consequently, in order to tackle the "dilemma", good philosophical support helps to overcome a severe mathematical structure, providing an application based on the premise of fuzziness. The strict boundaries of a deterministic mathematical model and the level of usefulness of a probabilistic model are eased. This general rule seems to be unacceptable for mathematical structures that are used to model physical realities. Fuzzy sets do not appear as the solution of the uncertainty, but rather show the "likely" philosophical structure.

In keeping with this assertion, fuzzy sets are able to provide a general picture, and to improve a model's powerful fits that describe real situations. They help to translate qualitative judgement, and express a tuned process of human knowledge.

Zadeh (1973) motivated his work on fuzzy logic with the observation that ' the key elements in human thinking are not members, but labels of fuzzy sets.'

Moreover, he saw each word x in a natural language as a 'summarised description of a fuzzy subset M(x) of a universe of discourse U, with M(x) representing the meaning of x.' He introduced linguistic variables as 'variables whose values are sentences in a natural or artificial language.'

Consequently, until each ordinary set is a fuzzy set too, operations such as union, intersection, complement, equality and containment, defined for fuzzy sets, should provide proper results when applied to ordinary sets. Taking into account the membership grade of an element x in a fuzzy set A, expressed by μ_A (x), as the 'fuzzy truth value, of the proposition x$\in$A, leads to fuzzy logic as a generalisation of first order predicate logic

In fuzzy set theory, the elements within the universe of discourse over which the set is declared to operate are assigned a grade of membership between 0 and 1, which describes the degree of membership. All input variables to a fuzzy system must be firstly converted into fuzzy variables using the membership functions. This process is known as 'fuzzification'. Fuzzy sets can be conveniently represented as vectors. The grades of membership are often assigned subjectively by one or more experts during a knowledge elicitation process. The shape of the membership function is subsequently optimised. The fuzzy technique enables recognition of the significance of lesser points within the universe of discourse, which, although not falling within the conventional set, signify many profitable aspects of that sets. The relative grade of equivalence with the set is inside the derived membership value.

2. 4. The algorithm

Clustering is one of the most fundamental issues in pattern recognition. It plays a key role in searching for structures in data. Cluster analysis generally refers to a wide range of methods that attempt to assign labels to objects, in a way that they can be considered to be "natural subgroups" in X, a finite set of data.

[In general the problem of clustering in X is to find out several clusters that might characterised by relevant classes of X.]

These "c" subsets are pairwise disjoint, all non-empties and reproduce X through union. They are called a non-fuzzy c-partition of X. The fuzzy approach allows the characterisation of an individual point's similarity to each of the clusters. This concept is declared by a membership function, as described above. Each sample will have a membership in every cluster. Membership close to unity signifies a high degree of equivalence between the sample and cluster, while membership close to zero implies little similarity between the sample and that cluster.

The FCM (Fuzzy c-Means) algorithm is associated with the generalised least-squared errors functional

$$J_m(U, v) = \Sigma\,^n_{k=1}\,\Sigma^c_{i=1}(u_{ik})^m\,(d_{ik})^2 \quad *1$$

Where

$U\in M_{fc}$

Mfc = {UcxN | uiksymbol 206 \f "Symbol" \s 12$\in$[0,1]symbol 125 \f "Symbol" \s 12 Sets of fuzzy c-partition

The variables are:

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[1] J.C.Bezdek "Pattern Recognition with Fuzzy Objective Function Algorithms" Plenum Press, 1988

$Y = \{y_1, y_2, \ldots y_n$ symbol 125 \f "Symbol" \s $12 \subset R_n$
c = number of cluster in Y;
m = weighting exponent
v = cluster centres
$(d_{ik})^2$ = norm on R

2.5. Fuzzy clustering and coastal territorial phenomena

Many of the problems encountered in determining policy in the coastal area are related to the fact that activities and features of territory interact in such a way as to create fruitful and unfavourable feedback amongst themselves. Each set of interactions has got its own capacity of impact on different targets such as tourism, environment, human geography and agricultural production. The comparison might be established on the basis of some common scale.

The impact of tourism has been dealt with in the former section.

The environment can be divided into a series of particular features referred to as attributes and parameters. Some characteristics able to depict fuzzy areas have been identified.

Human geography consists of many domains, but the principles are social, economic and political.

The agricultural impact on the fuzzy area has been studied through a cross section. It shows the interaction between other elements, within the area under investigation. These farming systems, rather complex, interact with the coastal tourism environment. This cross tab analysis represents a combination of researcher and employer of government understanding of the human management strategies in a natural resource environment, based on a system in equilibrium. This equilibrium has been built by the physical environment, measured and qualified, with the unseen mental organisation of environmental knowledge, past experience and management practices. The overall environment gives the input for a necessary policy for decision making. The tools, able to identify the dominant processes, activities and issues, have a significant influence on the whole system.

Building the fuzzy area

The use of GIS helped to depict the boundaries of a homogeneous area. The data used for this purpose was the following:

- Slope
- Landuse
- River network
- Soil
- Vegetation
- PTP (Piani Territoriali Paesistici)
- Galasso's line.

The natural resources have been processed using GIS. In particular, the following geographical analysis, such as surface hydrologic analysis, terrain models analysis, simple overlay analysis were carried out. All the data was converted from the Gauss-Boaga system in UTM ED 50. This operation allows us to carry out basic geographical analysis, inside Arc/Info. A simple piece of C++ code computes the values of the UTM coordinates. The geographical scale is 1:10.000. This details helps to define with more accuracy the boundaries of the fuzzy areas.

For example, hydrologic analysis allows the definition of river streams in an area. This was made using a DEM, digital elevation model, and some other commands.

With four defined limits, the areas seem to be quite homogeneous for environmental characteristics.

Inside these areas are the farms. The farms represent the input for the fuzzy c-means. Taking into account the environmental and economic indicators, it is possible to build an initial matrix for the

fuzzy analysis. In the columns of the matrix there are the fuzzy area, and in the rows there are the following indicators:

- Groups related to economic field:
- Workmen of the farm holiday farms
- Workmen of the zootechnic farms
- Revenues of both
- Groups related to physical criteria:
- Distance from the coast area
- Groups related to social field:
- 2080/92 regulamentation

2.6. Discussion of the results

The parameters of FCM are the following:

- $C = 2$, farm holidays activity and zootechnic activity;
- $1=m=1.9$, 1 is hard cluster 2.5 is a fuzzy membership;
- n = numbers of observations (fuzzy area)
- d = value of indicators.

The analysis starts from $m = 1$ (hard cluster). The centroid coordinates (XC) are the following for zootechnic farm and farm holidays:

m = 1   U

XC	Zoot.	Holid.		Fuz-area	Zoot.	Holid.
Ha 2080	27.333	0		A1	1	0
R.z.	56.333	149		A2	1	0
R.f.h.	46.333	37		A3	1	0
W.f.h.	5.333	11		A4	0	1
W.z.	4	3		Membership value for each farm		
Dist.	6	4				

m = 1.5   U

XC	Zoot.	Holid.		Fuz-area	Zoot.	Holid.
Ha 2080	27.345	0.0532		A1	0.9	0.1
R.z.	56.338	148.8		A2	0.98	0.01
R.f.h.	46.383	37.007		A3	0.9	0.08
W.f.h.	5.348	10.9		A4	0	1
W.z.	4.01	2.9		Membership value for each farm		
Dist.	6.009	4.004				

m = 1.9   U

XC	Zoot.	Holid.		Fuz-area	Zoot.	Holid.
Ha 2080	27.485	0.37		A1	0.97	0.02
R.z.	56.48	147.65		A2	0.92	0.07

R.f.h.	46.71	37.06		A3	0.93	0.06
W.f.h	5.4	10.8		A4	0.001	0.99
W.z.	4.09	2.99		Membership value for each farm		
Dist.	6.017	4.02				

m = 2.5   U

XC	Zoot.	Holid.		Fuz-area	Zoot.	Holid.
Ha 2080	27.943	0.37		A1	0.91	0.08
R.z.	57.06	146.10		A2	0.81	0.18
R.f.h.	47.35	37.15		A3	0.82	0.18
W.f.h.	5.6	10.78		A4	0.009	0.99
W.z.	4.27	2.99		Membership value for each farm		
Dist.	6.07	4.05				

In the first table, it seems to be clear that the farm holidays have a high value of revenue and a low value of distance from the coast. This implies that the farm changes from zootechnic to holiday's farm if it is close to the coast. The unexpected result is the behaviour of regulation 2080. It helps, in the general opinion, the farm's conversion, but, at the present situation, it doesn't influence the overall result. It is probably due to the low value of hectares involved in the fuzzy areas. In a close future we could assist at the wide application of this regulation, especially in a marginal agricultural area. This will push the conversion process.

By the light of these results, the fuzzy c-means need more information to accurately discriminate the fuzzy area. This simply gives an idea of the trend of the area. It notes that increasing m, the coordinate's centroids set to be closer, due to the fact that the importance of the fuzzy areas is minor. The m variation makes the behaviour of the fuzzy areas different, going trough a fuzzy shadow.

2.7. Conclusions

The results obtained from the analysis show how the FCM approach, applied to territorial planning, is interesting in the interpretation of phenomena.

A fuzzy area's membership grade belongs to the cluster, and shows the way of development; this in turn helps the actors of regional policy undertake actions in order to modify or improve the development. It also allows, in a conceptual way, to empirically measure the effort required for the above purpose.

A cluster's logic overcomes the yes/no dichotomy, and the phenomena that do not have clear boundaries, because of a variable's complexity, are well represented in a fuzzy environment. The wide amount of information, especially environmental information, together with the difficulty of computing real events, does not allow the use of a rigid mathematical tool. The link between real events and a way of measuring them suggests that applying a flexible mathematical tool such as cluster analysis is a more profitable strategy. Such a technique must be capable of capturing the differences arising from the territorial criteria. Fuzzy logic seems to be appropriate for our land, whether for the topographically uneven, or for the economic and social features, which are difficult

to quantify. Its application connects linguistic concepts to real events, leading to a new overview of the vitality of the land.
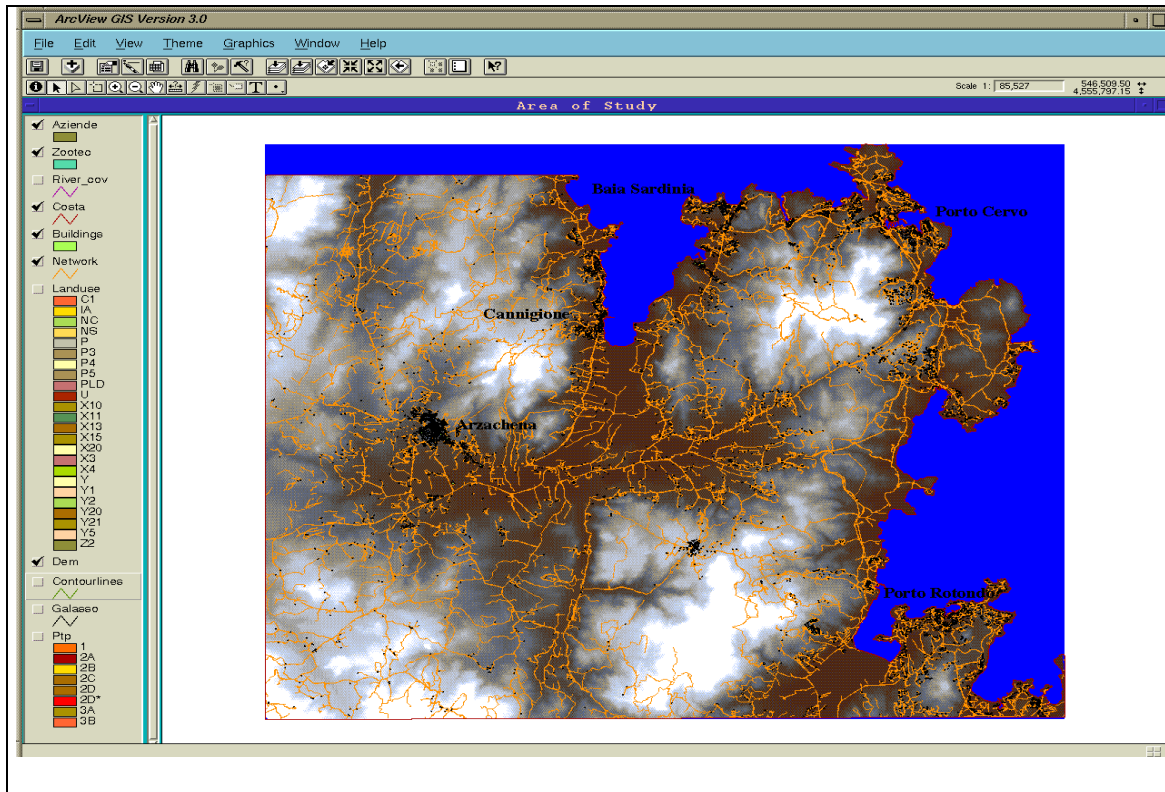

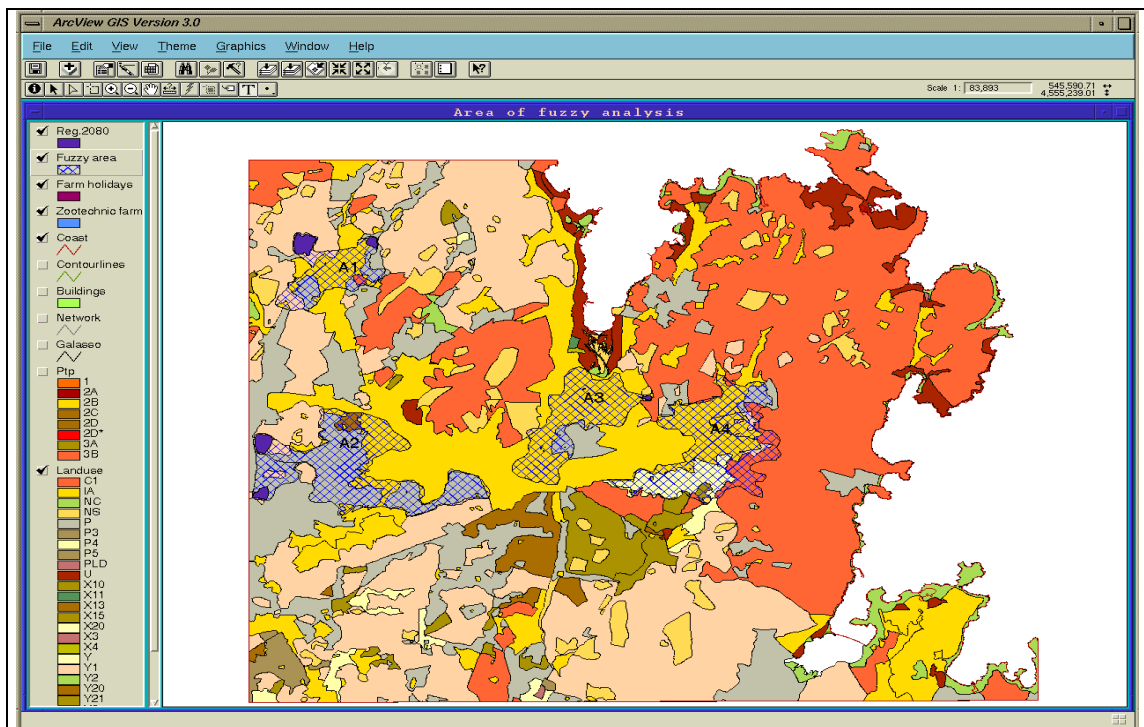**Figure 1 Elaboration of the DEM in order to select fuzzy areas**

Figure 2 Landuse and spatial distribution of the fuzzy areas

GENERAL CONCLUSION AND PERSPECTIVES FOR FUTURE RESEARCHES

This paper represents a contribution towards the integration of spatial analysis, statistical forecasting and scenario analysis. The nature of fuzziness of the economic situation has led to outline a slight shift from pure agriculture to a mixed economy, that implies a merge between tourism and agricultural activities.

Future perspective of the research is connected to the development of integrated and ad hoc systems, that are able to process data referring them to spatial distribution. In this way it will be possible to individaute the most appropriate directions for seeking satisfiing policies.

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