sustainability

MDPI

Article

Sustainable Use and Conservation of the Environmental Resources of the Etna Park (UNESCO Heritage): Evaluation Model Supporting Sustainable Local Development Strategies

Luisa Sturiale [1,*], Alessandro Scuderi [2], Giuseppe Timpanaro [2] and Benedetto Matarazzo [3]

[1] Department of Civil engineering and Architecture (DICAR), University of Catania, 95127 Catania, Italy
[2] Agriculture, Food and Environment Department (D3A), University of Catania, 95127 Catania, Italy; scuderia@unict.it (A.S.); giuseppe.timpanaro@unict.it (G.T.)
[3] University of Catania, 95127 Catania, Italy; matarazzo@unict.it
* Correspondence: luisa.sturiale@unict.it; Tel.: +39-095-7382720

Received: 29 November 2019; Accepted: 10 February 2020; Published: 15 February 2020

Abstract: Rural areas are recognized as multifunctional spaces, where traditional agro-silvo-pastoral and other human activities (unrelated rural tourism, ecotourism, processing industries of agricultural and or extractive products, land maintenance, trade in local products, etc.) take place alongside each other. The integrated endogenous development model, established to mitigate the effects of human activity in protected areas, relies on the enhancement of specific resources of individual territories through the active participation of the community to promote local development. This model is intrinsically connected with the model of sustainable development, based on three cornerstones: environmental, social, and economic sustainability. The difficulty in achieving a reasonable balance among these values relates primarily to areas subject to protection (i.e., Parks and Natural Reserves). Ultimately, the environmental culture emphasizes the sustainability of natural resources, obviously in relation to these values and to the vulnerability of these areas. This paper outlines some relationships between environmental protection and the exercise of agricultural activities and other human activities in protected areas by using the theory of "rough sets". The study aims to show that in the complex context of Etna Park (recognized World Heritage of Humanity by UNESCO in 2013), the model developed by the "rough sets" could provide useful guidance to policy makers to formulate local development strategies according to a model of the sustainable management of protected areas.

Keywords: landscape management; agriculture; evaluation; multi criteria decision aide (MCDA); rough sets; multifunctionality

1. Introduction

In contemporary society, the need for human progress and for nature conservation are often perceived as conflicting values, which define obvious issues and contradictions in land management [1–3]. The process of industrialization, urbanization, and the associated socio-cultural changes that started in the nineteenth century has culminated in the bipolarization of the relationship between progress and nature [4]. On one hand, the urban-industrial condition, in which one lives and works, on the other, the natural condition in which one takes refuge [5]. The first concept of a protected area took shape according to the American model, dominant until the start of the 1980s and was defined as: "a different, exceptional place, made of uncontaminated nature, where the intervention of man is almost completely absent. The local community is completely excluded from the use of the territory, and seen as a threat to the preservation of natural ecosystems, while visitors are allowed access, only to benefit from them for tourism" [3]. This idea of protecting the natural environment is understood as a safeguard action through the imposition of specific legislative constraints provided for protected areas [6]. Over the years in Italy, the legislative orientation passed by a vision of protection to a vision of protection and sustainable use, with the aim of conserving the natural environment (as enshrined in National Law No. 394/1991).

There are 871 protected areas in Italy, covering approximately 32,000 km^2. A reality of enormous value both from an environmental point of view and in terms of history, culture, and traditions [7]. Protected areas constitute a great laboratory for new innovative and eco-compatible practices, which, in recent years, have been at the center of an interesting socio-economic awakening. In terms of sustainability and the economy of local communities, this is the true essence of the Italian production model [8]. For this reason, attention to protected natural areas is in harmony with the theme of development and the revival of the economy [9]. A winning model is needed that can generate a transition for local economies toward sustainable growth [10–14].

The role of a multi-functional environment [15] in which traditional agriculture remains very important also relies on other activities that may or may not be related to those of agritourism, rural tourism, ecotourism, processing industries for agricultural products, handicrafts, land maintenance, trade in local products, and so forth [16–18].

At the same time, the integrated endogenous development model is making headway and affirming itself, which validates the use of specific resources such as individual territories through the mobilization of the local community. This endogenous development model proposes change based on innovation, but with the conservation of local social values and natural resources [19,20].

This model is intrinsically connected with the theory of sustainable development, variously formulated, although the most widely known is the definition formulated in the famous Brundtland Report in 1987 (WCED) [21], which is based on three benchmarks [9,22]:

- environmental sustainability (sustainable use of natural resources: air, soil, water);
- social and cultural sustainability (health and hygiene; food standards, health and safety); and
- economic sustainability (income for economic operators).

These are conditions, all equally important, that can, however, also be in conflict for certain activities, especially based on organizational and operational methods and with reference to different territorial areas [23–25].

In the latter case, it is clear that the greatest difficulty in achieving a reasonable balance between these three conditions relates primarily to areas subject to protection (i.e., Parks and Natural Reserves), which above all emphasizes environmental culture and the sustainability of natural resources [18,19,26].

The research outlines some relationships between environmental protection and the exercise of agricultural activities in the delicate environment of protected areas, and exposes some ideas on the theory of rough sets, which are believed to contribute to the resolution of the relationships that are sometimes rather complex in certain situations. The application of this decision model was carried out in a study of Etna Park, which surrounds the largest active volcano in Europe. The area was recognized as a UNESCO World Heritage Site in 2013 where the issues of progress and protection are at the center of debate amongst local operators. At times, there are tensions due to this dichotomy, with stakeholders declaring the need for evaluation methods and decision support, precisely because of the complexity of the activities in the area and because of the vulnerable natural and socio-cultural environment.

2. Relationship between Protection and Use in Protected Areas in Italy

The factors that have allowed an increasing number of protected areas in Italy are both political and institutional [27]. In the former case, it is important to underline the gradual change in the philosophy on which the establishment of a park is based, since we have moved from a restrictive and protectionist concept in managing protected areas, to a more flexible approach of sustainable and balanced management of natural resources, which is more compatible with economic growth in the area [28]. In Italy, there are a total of 871 protected areas of over three million hectares, which accounts for around 22% of the entire country. Based on the American classification of wildland economics and benefits, Italy's protected areas are rich in so-called non-market values (conservation of biodiversity, well-being, exchange of carbon dioxide in the forests, ability to regenerate the layers of pure water, mitigating the effects of climate change, landscape, etc.). This is not the case, however, as none of the Italian parks bear comparison with the gross domestic product (GDP) produced by parks in the European Union (EU). The Italian National Parks has pushed the growth of wealth in many areas in the north, while the south, they have still not managed to enhance them in economic terms. The Italian National Parks guarantee 3.2% of the country's wealth. The natural heritage of the Italian National Parks covers a total area of 34 thousand square km within the territory of 527 different municipalities. Tourism, eco-tourism, the chain of eco-sustainability, and agriculture are the economic wealth. There is a "park effect", that is, a greater ability to create wealth and well-being by companies located in areas subject to environmental protection. It is a new development model based on the mix of economic growth, environmental sustainability, quality production, and respect for the knowledge and well-being of the territories.

In legal terms, there are several weak points, as there are few national parks that could beclassified as "active", in the sense that they operate at full capacity. According to Law 394/1991, parks must have a territorial plan and the regulation must be perfectly in force. Therefore, a push toward the strengthening of the role played by protected areas in the sustainable development of local communities (in terms of the management and use of natural landscapes and cultural resources as well as the positive effects in terms of employment and income this would have) could be derived from Decree 119 of 2017 (which reforms Law 394/91, and provides for the simplification of procedures) [6,15].

Turning to the relative consistency of all protected areas in Italy, the available documentation for 2018 reports that protected areas across national territories amounts to about 22%, although in some regions this is higher (i.e., in Lombardy, Trentino Alto Adige, Abruzzo, Campania) [29].

Protected areas established by private or public initiatives, and then managed by environmental associations must be also be included in that figure. In particular: (a) protected areas managed by the WWF (World Wildlife Fund), which amount to 94 units (oases, areas, and shelters) covering an area of about 30,000 hectares; (b) those managed by the LIPU (Italian Bird Protection League), equal to 43 structures (36 oases and reserves, six recovery centers, and a museum); (c) those managed by the FAI (Italian Environmental Fund) that are engaged in the conservation of 12 areas of natural interest, covering 95 hectares; and (d) those managed by the "Italian Wilderness Association", who have proposed 15 areas of "wild space" that have been recognized.

As stated in Article 1 of Law 394/91 (currently in force), the main purpose of the legislation consists of maintaining the balance of the ecosystem both by preserving the set of biotic and abiotic elements in protected areas and by developing management methods to achieve harmonization between the natural environment and human progress. That is to say, a sort of integration between anthropic and natural elements to safeguard vulnerable architectural, archaeological, and landscapes as well as preserving traditional economic activities in particular, agricultural ones [18,30,31]. Article 1 also adds that eco-compatible production activities can be promoted in these areas. It is therefore clear that in terms of priority, the preservation of the balance of the ecosystem is in a pivotal position, and one with which economic activities must be compatible.

Agriculture and its associated activities play an eminent role in consolidating the combination of protection and enjoyment, which has relevance not only for protected areas, but for the entire rural area. Guidelines on the subject issued by the OECD (Organization for Economic Cooperation and Development) and the EU have their own application in relation to the degree of anthropization of the areas concerned and with specific reference to protected areas (integral reserves, general areas of protection, and areas of economic promotion).

On a theoretical level, this regulatory combination does not present difficulties to the extent that economic activities do not give rise to negative or positive externalities in the ecosystem. However, the same cannot be said in operational terms as the performance of economic activities can also impact the environment in ways that are not always considered neutral [32,33].

With specific reference to protected areas, and bearing in mind the priority of protecting the ecosystem whilst also associating it with the use of agricultural areas, asynoptic framework (deliberately simplified, but undoubtedly emblematic) can be reasonably constructed [3,15,18].

The primary purpose of protection consists of conserving the ecosystem balance, which is attributable to the macro-variables listed under (a)–(g); (see Table 1 below), and that must not be impacted by negative externalities from economic activities in the area.

Table 1. Synoptic framework of some protection activity fruition reports.

Ecosystem Protection	Territorial Use
(a) Physical, geological, geomorphological components	- Land transformations affecting component (a)
(b) Biodiversity	- Crop changes affecting component (b) (crop conversions)
(c) Traditional agroforestry landscape	- Modifications of the cultivation framework with effects on (c).
(d) Physical-chemical component of air, soil, water	- Production methods that cause changes in the relative composition of (d) (physical-chemical composition of air, soil and water)
(e) Hydrogeological and hydraulic structure	- Interventions in the area that affect on (e).
(f) Rural and architectural building heritage	- Restructuring, modernization, building extensions that interfere with component (f)
(g) Forest and forest mass	- Biomass and other undergrowth products

Source: Our elaboration.

In the case of agro-silvo-pastoral human activity, this impacts the environment in one or more ways reported in the "fruition" part of the table. Therefore, this activity cannot always be included among those that give rise to positive externalities.

Indeed, such activity can affect biological diversity and traditional landscapes, affecting orography and hydrogeological structure, causing pollution of various kinds (physical, chemical, acoustic, etc.). It can also modify rural construction and architectural heritage, reducing the scale of forests, or the "lungs" of the environment, as they are known. Given that in protected areas the fundamental objective is to maintain these essential ecosystem macro-variables, it is essential to develop strategies for the use of these areas that allow for activities without compromising protection.

The existence of binomial protection/fruition appears completely evident, especially with reference to protected areas that are more or less strongly anthropized and that provide vital economic activities for local populations, already present before the establishment of these areas subject to constraints [6]. This is the case with the Sicilian Regional Parks (Etna, Madonie, and Monti Nebrodi) and more generally with most of the Italian protected areas.

It is precisely in these circumstances that the problems of sustainable development are exacerbated, when the emphasis is on the environmental benchmark, attributing a subordinate role to the other activities (especially economic activity).

This position can lead to conflicting situations if the territories have deep-rooted human settlements and are also sites with a multiplicity of economic activities, sources of income, and employment on which the local population is dependent for its survival [22].

A notable case is Etna Park, which 30 years after its establishment, is now adopting a Territorial Coordination Plan. This plan will see the complex merging of the local ecosystem and the economic activities traditionally practiced in the region. At present, the plan has been drawn up and is in the process of being adopted with a view to integrating the economic, political, and environmental problems that intertwine, generating a block of activities [34].

The general objectives of the plan and of the regulations are those aimed at forming a unitary instrument of the government of the park territory thatis flexible and capable of combining different development interests against the socio-economic and cultural background of the populations established in the park municipalities with the priority interests of naturalistic, environmental, landscape protection, and the anthropic cultural values that determined the institution of the park itself.

From an environmental point of view, Etna Park, recognized as a UNESCO Heritage site in 2013, has the largest active volcano in Europe (Figure 1). The recurrent magmatic eruptions have shaped and reshaped the territory over the centuries, widening the sterile surfaces covered with lava and narrowing those usable for primary activities. The eruptions have recreated the landscape with the formation of volcanic cones (of great landscape value), but which are extremely vulnerable due to anthropic activity. Ranging from 550 m to over 3300 m, the site is populated by a multitude of plant species (stratified by altimetric bands), together with variegated terrain (volcanic), which contributes to the formation of natural and agroforestry landscapes of great value that are characterized by panoramas of incomparable beauty. UNESCO has registered Etna Park on the World Heritage List as a "Natural Site", giving this brief description (Decision: 37 COM 8B.15): *"Mount Etna World Heritage Site (19,237 ha) comprises the most strictly protected and scientifically important area of Mount Etna, and forms part of the Parco dell'Etna Regional Nature Park. Mount Etna is renowned for its exceptional level of volcanic activity, and the documentation of its activity over at least 2700 years. Its notoriety, scientific importance, and cultural and educational value are of global significance"*.

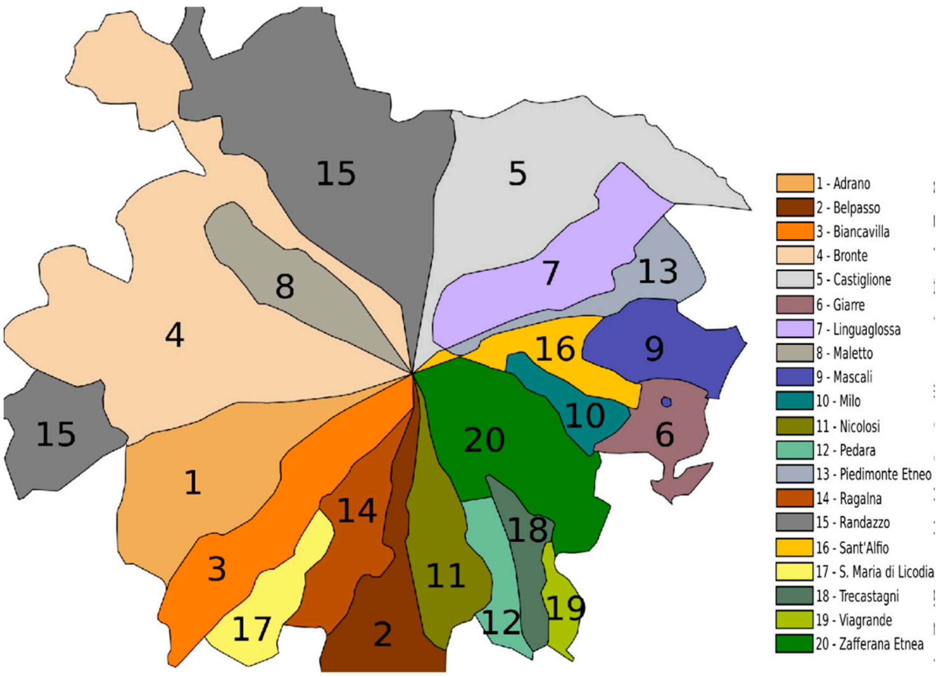

Figure 1. Communal territories that fall within Etna Park.

The Parco dell'Etna (Etna Park) was established as a Regional Nature Park by Decree of the President of the Sicilian Regional Authority in May 1987. Etna Park comprises a zone defined as an integral reserve, in addition to which, nine Natura 2000 sites overlap the area to various degrees, providing additional protection for 77% of the site under EU legislation. The territory of the district is characterized by excellent lands for agricultural production, thanks to the particular fertility of volcanic debris. The inhabited area reaches up to 900 m, while the cultivated areas and woodlands reach over 1500 m. The area is managed and coordinated by Ente Parco dell' Etna, established as the managing authority for Etna Park by Decree of the President of the Sicilian Regional Authority in May 1987, working in close cooperation with the Regional Authority of State Forests and the Regional Corps of Forest Rangers (Corpo Forestale). Management of the Park is guided by a long-term management plan and Triennial Intervention Programs.

All this gives rise to remarkable biological diversity, both in flora and fauna, a fundamental inheritance for society that the Park enriches or at least "conserves" as a precious germplasm for future generations [35].

The Park zoning shows that areas A (integral reserve) and B (natural reserve) constitute 77.5% of the entire Park surface, while the remaining part is represented by zones C and D (protection and control, respectively) (See Figure 2).

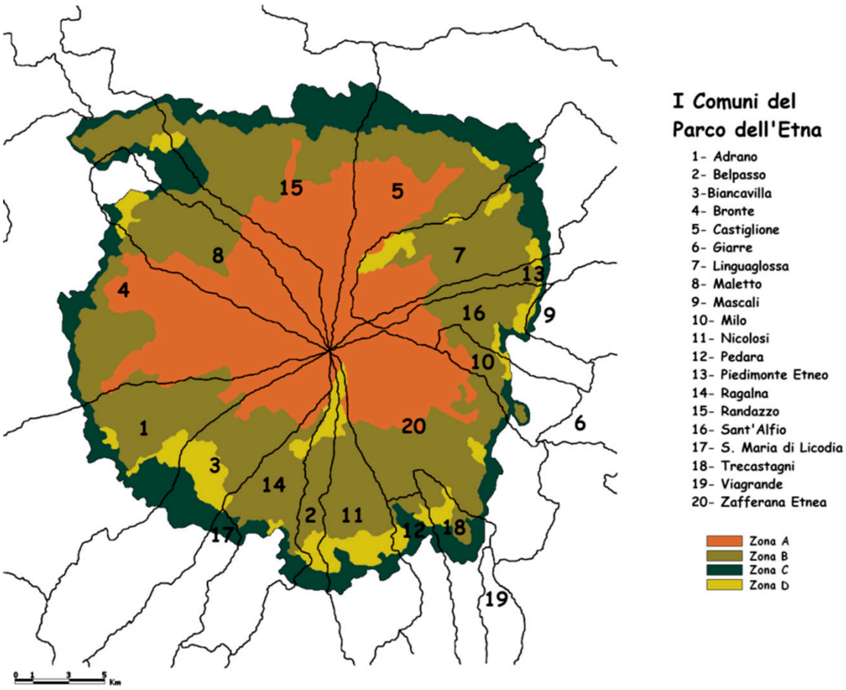

Figure 2. Delimitation of the areas A, B, C, D at Etna Park.

The "Mount Etna" site has a core zone coinciding with "A" of the Park and a buffer zone coinciding with "B" of the Park. The UNESCO site management plan coincides with the Natura 2000 site management plan where a project is underway to revise and update the UNESCO Site Management Plan.

With reference to agroforestry in Etna Park, this appears to be increasing from zone A to that of D (Figure 2), resulting in a total of 30,830 hectares, equal to 53.1% of the entire area of the Park. Obviously, the forest area is prevalent in zones A and B, while the agrarian areas are located in B, C, and D.

Centuries-old traditions of agricultural activities exist within the Park, albeit progressively reducing, but with the expansion of "abandoned" agricultural areas, pastoral forest and undergrowth have increased. However, Etna Park is also a privileged destination for mountain tourists throughout the year. In relation to the worldwide development of the Park, this represents an expansive trend because tourism is associated with traditional tourism (i.e., food, wine, and more generally rural tourism) [34].

Finally, the flourishing trade in local products should be added: agricultural, zootechnical, and artisanal items, based on direct (producer–consumer) interaction, and seen by the continuous growth of agricultural revenue with the intensification of the tourist wine trade.

As predicted in the study, there is a very diverse range of economic activity present in the Park (vital on a social level), and one that certainly does not favor the resolution of the relationship between protection and use. The same applies for the multiplicity of co-operative activities and the corresponding professionals involved regarding the complexities within the activity.

Analyzing agricultural activities in the Park, the research carried out in the field by [26,35,36] highlighted the presence of numerous trees and herbaceous species. The information acquired allowed us to deduce that the effects of agricultural activity on the macro-elements of the ecosystem are not perfectly quantifiable, but to state that although the qualitative cause–effect relationships are known, inevitably, they are surrounded by a certain imprecision.

This conclusion justifies the search for methods of analysis that compare protection parameters with those of fruition, and that can offer significant assessment for decision-makers, allowing them to choose options that safeguard protection but that do not stifle progress.

3. Method—The Theory of *Rough Sets*

There are several theories and mathematical techniques which, over time, have been developed to analyze problems characterized by uncertainty and in accuracy. Included in these theories is the theory of probability, the theory of evidence, discriminatory analysis, and the theory of fuzzy sets. The theory of *rough sets* can also be added to this group, as it has been proven to be a suitable tool to analyze data characterized by a certain vagueness and inaccuracy and to highlight the possible cause–effect relationships that exist between them. These relationships are not immediately evident, but can be useful in the context of choice. The theory of *rough sets* has different points of intersection with the theories above-mentioned and in some applications, it is complementary.

The theory of *rough sets* was introduced by Pawlak (1997) [37] and has been the subject of in-depth studies by various researchers and applied to different fields as well as to decision problems relating to cultural heritage. One particularly interesting aspect is the analysis of problems of multi-attribute classification and more recently, in the analysis of multi-criteria decision problems such as classification, choice, and sorting; making methodological changes to the original theory by [38–40].

This theory is based on the premise that information is associated with each unit of a given universe, which are expressed by employing determined attributes that describe the aforesaid units. For example, if the units represent the agricultural companies whose objective is to reduce negative externalities on the ecosystem, the information is represented by the activity location, the cultivation method adopted, etc. The units characterized by the same description are considered to be indiscernible (or similar), depending on the information available [41,42].

As demonstrated by several researchers [43–45], the relationship of indiscernibility generated constitutes the mathematical foundation for the theory of rough sets, the bricks (or granules) with which the knowledge reality is constructed.

Each set of indiscernible units is defined as an elementary set and represents an atom of knowledge of the universe. Any subset Y of the universe can be defined in terms of granules, union of elementary sets, or an approximation. In the latter case, the subset can be characterized by two ordinary sets: lower approximation and upper approximation. The "rough set" is defined by the previously mentioned approximations, which coincide in the case of ordinary sets, and the difference between the lower and upper approximations represents the frontier [37,42] of the *rough set*.

The lesser approximation of Y is constituted by all the elementary sets included in Y, whose elements surely belong to Y; the upper approximation is given by all the elementary sets that have a non-empty intersection with Y, whose elements can belong to Y. The elements that belong to the border of the *rough sets* cannot therefore be characterized with certainty as belonging to Y using the available information. According to the approach of *rough sets* I, therefore, a concept described in an imprecise way can be replaced by a pair of precise concepts, its inferior and superior approximations [40].

The peculiarity of rough sets is that it deals with an imprecise representation of reality due to the granularity of knowledge, a consequence of the indiscernibility between objects having the same description (*granules*) [41].

This methodology, because of its peculiar characteristics, is particularly interesting for application to different concrete problems. This approach allows the possible cause–effect relationships between the available data to be highlighted, underlining the importance and the strategic role of some information and the irrelevance of others [40].

Only qualitative data are required, and it is not necessary to perform a prior analysis on the consistency of the data, while quantitative data must be *discretized*. This method takes into account inconsistent information that is not automatically eliminated a priori, as it is possible to obtain elements from both positive and negative examples. It is also possible to gain a posteriori information on the importance that some attributes have in the analysis and the results are presented in the form of decisional rules of the type *if, then...*, [43]. The set of decision-making rules obtained constitutes the global model of the decision maker's preferences based on the set of examples provided and can be used as a support to the decision-making process [40].

In order to apply the theory of *rough sets* to choices relating to the use of natural resources in protected areas and, in particular, to the compatibility between agriculture and the protection of the ecosystem, the main concepts that characterize the issues will be illustrated.

The information in the units that make up the universe of the analysis are provided in the form of a table (defined as an information table). Each table row refers to a different unit and each column to the different attributes being examined; each cell, therefore, will indicate the evaluation, quantitative or qualitative, of the unit placed in the row through the attribute of the corresponding column. With reference to the quantitative evaluation of a given q attribute, the relative domain is subdivided into *coded* sub-intervals [40].

The information table is:

"... the 4-upla S =<V,Q,V,f>,

where U is the finite set of objects (universe), Q is a finite set of attributes, V=U Vq and Vq is the domain of the attribute.

Q, f: UxQ → V is a q ∈ Q function that (x,y) ∈ Vq for each q ∈ Q, x ∈ U, defined as the function of information.

Each element x of the universe U will be described by a vector where each element represents the value that the relative attribute assumes with reference to x. This vector is called the description of x in terms of the evaluations of the attributes of Q and indicated DesQ (x) [40]. It is thus possible to obtain a description of x ∈ U in terms of any non-empty subset P ⊆ Q.

Each subset (not empty) of P attributes is associated with an indiscernible relation on U, indicated with Ip:

Ip = {(x,y) ∈ U × U: fq (x) =fq (y), q ∈ P}.

Obviously, the binary relation of indiscernibility thus defined is a relation of equivalence (reflexive, symmetrical and transitive).

If (x,y) ∈ Ip, it is stated that objects x and y are P-indiscernible. The equivalence classes of the Ip relation are defined as P-elementary sets.

If P = Q, the Q-elementary sets are defined as "atoms".

It is necessary to develop two other key concepts when using rough sets to aid definition: lower approximation and upper approximation.

A subset P of attributes Q, P ⊆ Q, and X is defined as a non-empty subset of U. The lower P-assessment of X (PLX) is defined as the subset of U, having as its elements all the objects belonging to the P-elementary sets contained in the X set, and only those.

The subset of U is defined as the upper P-approximation of X (PUX), made up of all the objects belonging to the P-elementary sets with at least one element in common with set X, and only those [40].

The difference between these two sets is referred to as the X-frontier, indicated by BNp (X):

BNp(X) = PUX − PLX

If an object x belongs to the lower P-axis of X, it is certainly an element of X, while if x belongs to the upper P-axis, it can belong to set X.

If the frontier of X is empty, then set X is an ordinary set, obtained by the union of a certain number of P-elementary sets. If the frontier of X is not empty, set X is an approximate set (*rough*) with respect to P, definable through the lower and upper P-approximations.

This approach leads to an imprecise representation of reality due to the "granularity" of knowledge, which is in fact, the key concept of the theory of rough sets. Reality is represented by granules that correspond to the P-elementary sets; whose elements are P-indisputable because they have the same description in terms of the attributes of P. The size of these granules depends, obviously, on the number of attributes used for the description of the objects in the original information and on the domain of each attribute. The representation of reality depends on the knowledge possessed with reference to it and on the ability to classify the information obtained.

Another particularly important aspect for operational applications is the possible presence of *superfluous* data in the information table, which can be eliminated without altering the content of the original table [42].

It is possible to determine a reduced, minimal subset of attributes that allow the same quality of approximations of the units of U obtainable by employing the complete set of attributes of P. In a table of the information can exist attributes smaller than P, and it is defined as the nucleus (*core*) of P, the set containing all the indispensable attributes of P. Being included in each reduced P, the nucleus is configured as the most important subset of attributes of Q, for which none of its elements can be removed, otherwise the quality of the information would deteriorate.

Q is reduced in concrete applications because it is often difficult or expensive to acquire assessments of certain attributes. However, these assessments can be left out if they are *superfluous*, allowing significant savings of time and resources.

If the Q attributes in the information table are divided into conditional attributes (set C) and decision-making attributes (set D), then it is defined as the decision table. It can be expressed as a set of decisional rules, as it tends to underline the functional dependence between conditional and decisional attributes. In operative applications, the tendency is to employ the least possible number of conditional attributes, without deteriorating the quality of the approximation of the classification induced by the decisional attributes, in such a way as to allow decisions to be made using less information. Very often the calculation of the decisional rules is complex, so that in applications with concrete cases, it is sufficient to know the minimal set of attributes. This method allows the same information to be used, resulting in more comprehensible results even if the sample is dimensionally reduced.

The decision rules are configured as logical propositions of the type *if ... then*, in which the antecedent is given by values assumed by one or more conditional attributes and the consequent is represented by the partitions generated by one or more decisional attributes. There are two types of decisional rules: exact (or certain), if the partitions generated by the decisional attributes contain those corresponding to the considered conditional attributes; and approximate (or uncertain) in the opposite case.

The expression used to define the decision-making rule not only has the advantage of being perfectly understandable to the decision-maker, but also has the advantage of being the simplest and most natural way to build a model of preferences in light of a sufficiently large sample of explanatory comparisons.

From the decisional point of view, the construction of the preference model does not require any parameters, but simply uses the examples provided by the decision-maker and the rules obtained can be adopted as support to the decision-making process. It is important to note that it is possible to verify the information contained in the original decision table and to implement it, acquiring further elements also in the form of decisional rules, following interviews or discussions with experts.

The concepts exposed constitute the key points of the original theory of *rough sets*, to which methodological adaptations have been made to apply it to the multicriteria problems of classification, choice, and sorting. The methods applied by previous researchers using this theory suggest considering the ordinary properties of the criteria and information on the decision-maker preferences and to proceed to the comparison by *pairs of action*.

4. Results: The *Rough Sets* Approach in the "Etna Park" Study

The theory of *rough sets* has been successfully applied to various real problems of classification in research fields.The most significant of these are medicine; engineering; credit; market research; financial analysis; and economics.This study proposes that the theory of *rough sets* can be applied to a very complex and difficult field to explore such as environmental economics. Focusing on the related environmental issues, and in particular, the use of agricultural land in protected areas, this methodology supports decision-making rules that can aid the definition of strategies for the management of agricultural activities that are compatible with both environmental protection and the maintenance of the ecosystem.

The subject area of this research was Etna Park, to which the theory of rough sets was applied, with a view to solving decisional problems related to the choice of crops to be adopted within the protected area (see Figure 3). These decisions need to be compatible with the maintenance of the ecosystem balance, which has been altered to an extent due to the increase in human activity.

Figure 3. Landscapes and agricultural productions in Etna Park.

On the basis of information provided by experts and scholars, an information table has been drawn up with the x units that make up universe D, in the individual lines. The sex units represent the main types of farms in the Park, (see Table 2 below), whose details are represented by the following:

Table 2. Average profitability expressed as EBITDA * referring the main Etna park crops.

Crops	EBITDA €/ha
x1. hazelnuts;	650
x2. pistachios;	1.700
x3. fruit (pear, apple, cherry, peach);	2.700
x4. wine grapes;	3.000
x5. olives;	1.200
x6. vegetables;	4.500
x7. cereals;	180

Source: Our elaboration. * EBITDA (Earnings Before Interests Taxes Depreciation and Amortization).

The information table below was produced by inserting the attributes that mainly influence the equilibrium of the ecosystem as a result of agricultural activity. Only five conditional attributes were considered amongst the various possible ones, four of which were qualitative and one was quantitative (see Table 3). The column attributes are as follows:

c1. Ability to maintain biodiversity (quality attribute).

c2. Influence on the landscape (quality attribute).

c3. Environmental pollution due to conventional production methods (qualitative attribute).

c4. Alterations in the ecosystem equilibrium with the adoption of the organic production methods (qualitative attribute).

c5. Profitability expressed as EBITDA (Earnings Before Interests Taxes Depreciation and Amortization), in the agricultural year (2017/18) obtained without subsidies or income supplements provided for in community and national legislation for the various production sectors (quantitative allocation).

U = {l, 2, 3, 4, 5, 6, 7}, Q = {cl, c2, c3, c4, c5, d}, V1= {weak, medium, high}, V2 = {weak, medium, strong}, V3 = (low, medium, high}, V4 = {low, medium, high}, V5= {low, medium, high}, Vd= {A, B, C, D}.

Table 3. Information and evaluation table.

U	c1	c2	c3	c4	c5	d
x1	high	strong	medium	low	low	A
x2	medium	strong	medium	low	low	B
x3	weak	medium	high	medium	medium	D
x4	weak	medium	medium	low	medium	C
x5	weak	medium	medium	low	low	C
x6	weak	weak	high	medium	high	D
x7	weak	weak	medium	low	low	C

Source: Our elaboration.

With reference to the coding of attribute c5, linked to profitability level, the original quantitative values of c5 were classified as follows (Table 4):

Table 4. Classification of the level of profitability.

Original Values of c5 (€/ha)	Coded Values of c5
X< € 1.000	low
1.000 <X <€ 2.500	medium
X> 2500	high

Source: Our elaboration.

The decision-making attribute "d" determines a set of alternatives according to the following ranking:

A = optimal culture for the maintenance of the ecosystem balance;

B = fully compatible culture;

C = crop with a low risk of disturbance of equilibrium; and

D = crop with a medium risk of disturbance of equilibrium.

The classifications originate from the set of information derived from previous studies and research carried out by naturalists and biologists on the influence of different crops that are present in the ecosystem in Etna Park.

Each type of farm is characterized by a different description in terms of the attributes considered: cl, c2, c3, c4, and c5. Therefore, based on the information derived from them, they were discernible. Formally, the relationship of indiscernibility based on all of the attributes considered was IQ = {(l,l), (2,2), (3,3), (4,4), (5,5), (6,6), (7,7)}, so there were no two types of farm x and y so that (x.y) ∈ IQ.

From the evaluation of the information table, it can be observed that the farm types 1 and 2 are indiscernible in terms of the attributes of P = {c2, c3, c4, c5} because they have the same evaluation for each of them. Formally, we have Ip= {(1,1), (1,2), (2,1), (2,2), (3,3), (4,4), (5,5), (6,6), (7,7)} for which (1,2) ∈ Ip (and obviously also (2,1) ∈ Ip. Just as company types 3 and 4 are indiscernible in terms of attributes P′ = {c1, c2, c5} and formally we have Ip′ = {(1,1), (2,2), (3,3), (3,4), (4,3), (4,4), (5,5), (6,6), (7,7)}, so (3,4) CE Ip′ (and (4,3) CE Ip′). In this way, it would be possible to proceed considering all possible sub-sets of Q.

Each subset P of the attributes of Q originates a partition of the universe U that classifies equivalent groups that have the same description in terms of the attributes of P as equivalent objects, for example, for P = {cl, c2}, we have U Ip= {{l},{2},{3, 4, 5},{6, 7}} and therefore {1},{2},{3,4, 5},{6, 7} are the sets P-elementaries.

Suppose that using the set of attributes P = {cl, c2, c3} we intend to approximate the set of X farms types that involve a low risk of alteration to the ecosystem balance, X = {x4, x5, x7}.

Then, U I/Ip= {{1},{2},{3},{4,5},{6},{7}}, the approximations will be:

PL (X) = {4,5,7}

PU (X) = {4,5,7}

The BNP frontier (X) is empty, for which set X can be described with the attributes of P and is an ordinary set (i.e., it is precise), since the units contained certainly belong to the set of business types that determine a low risk of ecosystem alteration.

From the information table, let us consider the set of attributes P = {cl, c3, c4}, which determines the following indiscernibility relation U/Ip= {{l}, {2}, {4, 5, 7}, {3, 6}}. Now, let us consider the following subsets of Q: P = {cl, c3, c4}, R = {cl" c3}, S = {cl, c4}, T = {c3, c4}.

It is observed that IR = Ip, IS = Ip, while EN # Ip.

What has been observed means that R and S are reduced of P, while T is not, that is, R and S are sub-sets of P that have generated partitions of the universe U equal to those obtained by using all the attributes of P. It is possible, therefore, to use any of the two determined reduced attributes without affecting the quality of information deduced with all the attributes present in P.

If we had considered as a set of attributes P = {cl, c2, c3}, the relation of indiscernibility generated would have been U/Ip = {{1},{2},{3}; {4,5},{6,7}. By determining how subgroups of P, R = {c1, c2}, S = {c2, c3}, T = {c1, c3}, we would have identified only one reduced attribute, namely T, as IT = IP, while IR # IP and IS # IP. It is therefore possible to identify the "superfluous" conditional attribute in P, which corresponds to c2.

From the intersection of the reduced R and S, we can determine the core of P as core P = R ∩T or core P = ∩ R and P, which in this case corresponds to the conditional attribute c1. Therefore, c1 is "the most important attribute" of the whole P, and is the attribute without which the quality of the information would deteriorate, that is, it represents the most important attribute to describe the business types considered (we could define it as the essential one), while c3 and c4 can be exchanged without the quality of the information deteriorating.

The information table constructed containing conditional attributes C ={c1, c2, c3, c4, c5} and the decision attribute D = {d}can be read as a decision table, through which it is possible to explain the evaluations of the decision attribute, by means of the values attributed to the conditional ones. It is possible, therefore, to interpret the information able as a table of decisions. Referring to the example given, the set of decision-making rules obtained from the illustrated decision table is as follows:

if f(x,c1) = high and f(x, c2) = strong and f(x, c3) = medium and f(x, c4) = low and f(x" c5) = low, then f(x,d) = A;

if f(x, c1) = average and f(x, c2) = strong and f(x, c3) = average and f(x, c4) = low and f(x, c5) = low, then f(x, d) = B;

if f(x, c1) =: weak and f(x, c2) = medium and f(x, (3) = high and f(x, c4) = medium and f(x, c5) = medium, then f(x, d) = D;

if f(x, c1) = weak and f(x, c2) = medium and f(x, c3) = medium and f(x, c4) = low and f(x, c5) = medium, then f(x, d) = C;

if f(x, c1) = weak and f(x, c2) = medium and f(x, c3) = medium and f(x, c4) = low and f(x, c5) = low, then f(x, d) = C;

if f(x, c1) = weak and f(x, c2) = weak and f(x, c3) = high and f(x, (4) = medium and f(x, c5) = high, then f(x, d) = D

if f(x, cl) = weak and f(x, c2) = weak and f(x, c3) = medium and f(x, c4) = low and f(x, c5) = low, then f(x, d) = C

The set of rules just described can be suitably reduced to a minimal set by using fewer attributes in each rule. Considering only attribute c1, the following decision rules are reached:

1′) if f(x, c1) = strong, then f(x, d) = A;

2′) if f(x, c1) = average, then f(x, d) = B;

3′) if f(x, c1) = weak, then f(x, d) = C or D;

and again, by adding attribute c4, it is able to unambiguously explain both value C and the value D of the decisional attribute. That is:

4′) if f(x,c1) = weak and f (x, (4) = low, then f(x, d) = C;

5′) if f(x, c1)= weak and f (x, c4) = average, then f(x, d) = D.

It is possible to observe that the rules 1′), 2′),4′), and 5′) are certain and exact because they have a consequent univocal, instead rule 3′) is an approximate rule because it does not have a consequent univocal.

5. Conclusions

The multi-functionality in Etna Park highlights the related problems of the choice of location of the various activities in the area and the difficulties of managing such activities within an agricultural environment that assumes a fundamental role for both its traditional productive function and for the environmental and landscape services it provides. These functions are underlined and recognized in the latest community policy guidelines [22,44,46–48].

The multiplicity of activities in the Park also defines the presence of various operators who obviously tend to pursue diverse objectives that are often in conflict with each other [49]. Clashes of opinion are well known between naturalists, farmers, agro-industrial industry, tour operators, traders, urban planners, and so forth, relating to the allocation of human activity. The situation is even more complex when these problems surface within protected areas, where the protection of the natural environment and the use of resources must find a sustainable solution to coexist without stifling human activities that are subject to environmental restrictions [50]. Moreover, Etna Park is characterized by the presence of an active volcano, which frequently impacts the Park's management activities, agricultural production, and its collectivity.

The *rough sets* theory adopted in this research has allowed the treatment of data characterized by vagueness and imprecision, using qualitative and quantitative data, by adopting specific discretization to generate results based on the preferences expressed. These results are fundamental in the evaluation phase used by decision-makers. The resulting information table, even with inconsistent data, confirms that marginal data must not be eliminated as they highlight possible cause–effect relationships between the available data. These elements allow us to emphasize the importance and the strategic role of some attributes and the irrelevance of others (reduced and essential) [42].

The interventions on cultural heritage and, more generally, urban and territorial transformations determine direct effects in the physical–environmental system of a given area and indirect effects in the social and economic system [51–53]. Then, the construction of a model of preferences in terms of decision-making rules such as "if ... then" facilitates a model of understanding for decision-makers, which could become an operational tool to support land management policies. The final decision analysis allowed us to define aspects inherent to the decision (retrospective analysis) and to provide help to decision-makers on how to make decisions in the future (prospective analysis). The latter is based on decision-making rules obtained from the decision tables: "the explanation phase, therefore, prepares that of the prescription, giving useful information for the aid of decisions. In this respect, the rough sets approach is similar to an inductive process" [45].

The theory of rough sets in the case of Etna Park has made it possible to define more clearly that the crops present (apart from vegetables) are perfectly integrated with the landscape and have a limited impact on the ecosystem. Pistachios are the crops that integrate well and have no impact on the landscape, while other crops such as vines and olive trees, although showing a slight impact, represent crops of high landscape importance such as active components like woods and natural meadows.

In relation to the results obtained, using the *rough sets* approach to the analysis of decisions, agricultural cultivation appears to be perfectly sustainable as a whole. Recently, however, other applications of the original rough sets approach have been developed, based on approximations constructed using dominance relationships instead of indiscretions, which allows its application to all classes of multi-criteria problems.

The results of this study could be used by the local decision-makers and interested stakeholders to review and update management planning of the Etna Park, with the aim of being able to achieve what is indicated as *recommendations* by UNESCO (Decision: 37 COM 8B.15):

(a) Strengthen harmonization between the various management organizations and private sector partners inensuring that the outstanding geological features in the Park are not adversely impacted by increasing tourism pressures.

(b)Strengthen mechanisms to monitor visitor use so that the protection of natural heritage and enhanced visitor experience and safety are balanced.

(c) Encourage improved research and monitoring of the eco-balance by including technical staff (geologists, geomorphologists, and volcanologists) as an integral part of the site management team.

This study has shown that when the *rough sets* theory is applied to the conservation of resources in Etna Park, the model used provides an excellent *eco–eco* tool (*ecological–economic*) [48,54,55] for decision-makers where the application of multi-disciplinary contributions [56] is needed.

Author Contributions: Conceptualization, L.S., A.S. and B.M.; methodology, B.M.; software, S.A. and G.T. and B.M.; validation, L.S., A.S. and B.M.; investigation, L.S., A.S. and G.T.; data curation, A.S.; writing—original draft preparation, L.S. and A.S.; writing—review and editing, L.S., A.S.; funding acquisition, L.S. All authors have read and agreed to the published version of the manuscript.

Funding: This work was financed by the University of Catania within the project "Piano della Ricerca Dipartimentale 2016–2018 of the Department of Civil Engineering and Architecture".

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Bresso, M. *Per un'Economia Ecologica*; NIS: Roma, Italy, 1993.
2. Fusco Girard, L. I beni ambientali: Valutazioni e strategie di conservazione tra conflitto e cooperazione. *Genio Rural.* **1994**, *5*, 35–44.
3. Peano, A. Aree protette e governo del territorio. In *Parchi D'Europa. Verso Una Politica Europea per Le Aree Protette*; Gambino, R., Talamo, D., Thomasset, F., Eds.; Edizioni ETS: Pisa, Italy, 2008.
4. Shmelev, E.S.; Rodriguez-Labajos, B. Dynamic Multidimensional Assessment of Sustainability at the Macro Level: The Case of Austria. *Ecol. Econ.* **2009**, *68*, 2560–2573. [CrossRef]
5. Tempesta, T. La stima del valore ricreativo del territorio: Un'analisi comparata delle principali metodologie. *Genio Rurale.* **1995**, *12*, 15–34.
6. Salberini, G. L'evoluzione della legislazione italiana in materia di aree protette. In *Codice Delle Aree Protette*; Marchisio, S., Salberini, G., Della Fina, V., Ferrajolo, O., Eds.; Giuffrè Editore: Milan, Italy, 1999; pp. 177–194.
7. Pappalardo, G.; Pilato, M.; Bracco, S. To what extent are local communities involved in the governance of protected areas? Experiences from a case study in Sicily (Italy). *Qual. Access Success* **2015**, *16*, 102–109.
8. Scuderi, A.; Sturiale, L.; Bellia, C.; Foti, V.T.; Timpanaro, G. The redefinition of the role of agricultural areas in the city in relation to social, environmental, and alimentary functions: The case of Catania. *Riv. Studi Sulla Sostenibilità* **2017**, *2*, 1–10.
9. Gallenti, G.; Troiano, S.; Marangon, F.; Bogoni, P.; Campisi, B.; Cosmina, M. Environmentally sustainable versus aesthetic values motivating millennials' preferences for wine purchasing: Evidence from an experimental analysis in Italy. *Agric. Food Econ.* **2019**, *7*, 12. [CrossRef]
10. Munaretto, S.; Siciliano, G.; Turvani, M. Integrating adaptive governance and participatory multicriteria methods: A framework for climate adaptation governance. *Ecol. Soc.* **2014**, *19*, 74. [CrossRef]
11. Pearce, D.W.; Turner, R.K. *Economia Delle Risorse Naturali e Dell'Ambiente*; II Mulino: Bologna, Italy, 1991.
12. Romano, D.; Carbone, F. La valutazione economica dei benefici ambieniali: Un confronto fra approcci non di mercato. *Riv. Econ. Agrar.* **1993**, *48*, 19–62.

13. Torrieri, F.; Concilio, G.; Nijkamp, P. Decision Support Tools for Urban Contingency Policy. A Scenario Approach to Risk Management of the Vesuvio Area in Naples—Italy. *J. Contingencies Crisis Manag.* **2002**, *10*, 95–112. [CrossRef]
14. Van Der Berghr, J.M.; Buttonn, K.J.; Nijkamp, P.; Pepping, G. *Meta-Analysis in Environmental Economics*; Kluwer Academic Publishers: Dordrecht, The Netherlands, 1997.
15. Tempesta, T.; Vecchiato, D. The value of a properly maintained hiking trail network and a traditional landscape for mountain recreation in the Dolomites. *Resources* **2018**, *7*, 86. [CrossRef]
16. Timpanaro, G.; Scuderi, A.; Foti, V.T.; Lo Giudice, V. The Social Relationships' effectiveness of "agrisocial" farms: A model of sustainable local development. *Riv. Studi Sulla Sostenibilità* **2015**, *1*, 99–116.
17. Soderberg, H.; Karman, E. *MIKA: Methodologies for Integration of Knowledge Areas—The Case of Sustainable Urban Water Management*; Dept. of Built Environment & Sustainable Development, Chalmers Architecture, Chalmers University of Technology: Goeteborg, Sweden, 2003.
18. Sturiale, L. Possibili modelli di valutazione.della compatibilità tra sviluppo .e tutela con particolare attenzione alle aree protette. In Proceedings of the Atti del XXX Incontro di Studio CeSET. Gestione delle risorse naturali nei territori rurali e nelle aree protette: Aspetti economic, giuridici ed estimativi, Potenza, Italy, 5–6 October 2000; pp. 161–195.
19. Simoncini, A. Quadro giuridico e amministrativo. In *The Ministry of the Environment and Ced-Ppn (European Centre for Documentation on the Planning of Natural Parks, Department of Territorial, of the Politecnic of Turin), Il Sistema Nazionale Delle Aree Protette Nel Quadro Europeo: Classificazione, Pianificazione E Gestione*; Altra linea edizioni: Turin, Italy, 2002; pp. 22–34.
20. Vargas Isaza, O.L. La evaluación multicriterio social y suaporte a la conservación de los bosques social multicriteria. *Rev. Fac. Nac. Agron. Medellín* **2005**, *58*, 2665–2683.
21. WCED (World Commission on Environment and Development). *Our Common Future*; Oxford University Press: Oxford, UK, 1987.
22. Sturiale, L. Criteri di valutazione per la fruizionesostenibiledellerisorsenaturali in areeprotette. In *Pagine Di Estimo, Allegato N. 19–20 Quaderni Del Dipartimento Patrimonio Architettonico Ed Urbanistico*; Gangemi Editore: Roma, Italy, 2000; pp. 9–14.
23. Casini, L.; Bernetti, L.; Menghini, S. Teoria delle "libertà" e metodi multicriterio per l'analisi delle condizioni di sviluppo rurale. *Riv. Econ. Agrar.* **1997**, *52*, 29–59.
24. Maestrelli, S. I parchi: Una risorsa nazionale per lo sviluppo di qualità. *Geogr. Ital. Rev.* **2001**, *2*, 219–225.
25. Scuderi, A.; Sturiale, L. Analysis of social network applications for organic agrifood products. *Int. J. Agric. Resour. Gov. Ecol.* **2014**, *10*, 176–189.
26. Carbone, F. La pianificazionemultifunzionaledelleforeste: l'applicazione di un modellointegrato MCDM—GIS. *Aestimum* **1999**, *37*, 67–101.
27. Nicoletti, A. Parchi e areeprotette. *La Nuova Ecol.* **1999**, *2*, 18.
28. Ferretti, V.; Bottero, M.; Mondini, G. A spatial decision support tool to study risk and opportunities of complex environmental systems. *J. Environ. Account. Manag.* **2015**, *3*, 197–212. [CrossRef]
29. MIPAAF. *Le Aree Protette in Italia*; MIPAAF: Roma, Italy, 2019.
30. Scuderi, A.; Sturiale, L.; Foti, V.T. The challenges and opportunity of protected natural areas in Italy: The case study of "Simeto oasis". *Qual. Access Success* **2017**, *18*, 401–408.
31. Foti, V.T.; Scuderi, A.; Stella, G.; Sturiale, L.; Timpanaro, G.; Trovato, M.R. The integration of agriculture in the politics of social regeneration of degraded urban areas. *Green Energy Technol.* **2018**, 99–111.
32. Timpanaro, G.; Sturiale, L.; Foti, V.T. Sustainability as a business strategy in sicilian viniculture. *Qual. Access Success* **2016**, *17*, 186–191.
33. Scuderi, A.; Sturiale, L. Multi-criteria evaluation model to face phytosanitary emergencies: The case of citrus fruits farming in Italy. *Agric. Econ. (Czech Republic)* **2016**, *62*, 205–214. [CrossRef]
34. Papale, F.; Sturiale, C. *Analisi del Settore Agro-Zootecnico*; Parco dell'Etna: Nicolosi, Italy, 1994.
35. Calabrò, F.; Cassalia, G.; Tramontana, C. Evaluation Approach to the Integrated Valorization of Territorial Resources: The Case Study of the Tyrrhenian Area of the Metropolitan City of Reggio Calabria. In *New Metropolitan Perspectives, ISHT 2018, Proceedings of the Smart Innovation, Systems and Technologies—SIST, Reggio Calabria, 22–25 May 2018*; Calabrò, F., Della Spina, L., Bevilacqua, C., Eds.; Springer: Berlin/Heidelberg, Germany, 2019; Volume 101, pp. 3–12.

36. Sturiale, C. L'esercizio dell'agricoltura nei Parchi e Riserve. In Proceedings of the Atti del Convegno Provincialesu"Parchi e Riserve: Quale modello per un corretto sviluppo del territorio locale", Castiglione di Sicilia, Italy, 18 October 1997; pp. 34–48.
37. Pawlak, Z. Rough set approach to knotoledge-based decision support. *Eur. J. Oper. Res.* **1997**, *99*, 48–57. [CrossRef]
38. Greco, S.; Lo Cascio, S.; Matarazzo, B.; Slowinski, R. A new rough set approach to evaluation of bankrupcty risk. In *New Operational Tools in the Management of Financial Risks*; Zopounidis, C., Ed.; Kluwer: Dordrecht, The Netherlands, 1997.
39. Greco, S.; Matarazzo, B.; Slowinski, R. Rough approximation of a preference relation by fuzzy dominance relations. In Proceedings of the 1st International Workshop on Preferences and decision, Trento, Italy, 5–7 June 1997; pp. 70–72.
40. Greco, S.; Matarazzo, B.; Slowinski, R. Rough approximation of a preference relation by dominance relations. In *ICS Research Report*; Warsaw University of Technology: Varsavia, Poland, 1996.
41. Greco, S.; Matarazzo, B.; Slowinski, R. Rough sets theory for multicriteria decision analysis. *Eur. J. Oper. Res.* **2001**, *129*, 1–47. [CrossRef]
42. Greco, S.; Matarazzo, B.; Slowinski, R. Dominance-based Rough Set Approach to decision under uncertainty and time preference. *Ann. Oper. Res.* **2010**, *176*, 41–75. [CrossRef]
43. Greco, S.; Matarazzo, B.; Slowinski, R. Rough sets methodology for sorting problems in presence of multiple attributes and criteria. *Eur. J. Oper. Res.* **2002**, *138*, 247–259. [CrossRef]
44. Matarazzo, B. L'approccio dei rough sets all'analisi delle decisioni. In Proceedings of the Atti del XXI Convegno Annuale, A.M.A.S.E.5., Roma, Italy, 10–13 September 1997.
45. Matarazzo, B.; Greco, S.; Slowinski, R. La teoria degli insiemi approssimati. In *Strategie, Introduzione Alla Teorie Dei Giochi e Delle Decisioni*; Stach, B.G., Ed.; Editore Giappichelli: Torino, Italy, 2019.
46. Chinnici, G.; Pecorino, B.; Scuderi, A. Environmental and economic performance of organic citrus growing. *Qual. Access Success* **2013**, *14*, 106–112.
47. Foti, V.T.; Scuderi, A.; Timpanaro, G. Organic Social agricoltur: A tool for rural development. *Calit. Access Success* **2013**, *14*, 266–271.
48. Sturiale, L.; Scuderi, A. The evaluation of green investments in urban areas: A proposal of an eco-social-green model of the city. *Sustainability* **2018**, *10*, 12. [CrossRef]
49. Fandel, G.; Gal, T. *Multiple Criteria Decision Making Theory and Applications*; Springer: Berlin/Heidelberg, Germany, 1980.
50. Borrini-Feyerabend, G.; Phillips, A. Politiche del paesaggio per la conservazione dellanatura. Diversità, equità e cambiamento. *Urbanistica* **2009**, *139*, 52.
51. Ferretti, V.; Bottero, M.; Mondini, G. Decision making and cultural heritage: An application of the Multi-Attribute Value Theory for the reuse of historical buildings. *J. Cult. Herit.* **2014**, *15*, 644–655. [CrossRef]
52. Sturiale, L.; Trovato, M.R. ICTs and smart territories. the knowledge and use of the UNESCO heritage by using the QR codes system. In Proceedings of the7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment, HAICTA 2015, Kavala, Greece, 17–20 September 2015; Volume 1498, pp. 946–956.
53. Bresso, M. Riflessioni per la costruzione di un paradigma economico-ecologico. *Oikos* **1991**, *43*, 201–220.
54. Sturiale, L.; Scuderi, A. The role of green infrastructures in urban planning for climate change adaptation. *Climate* **2019**, *7*, 119. [CrossRef]
55. Calabrò, F.; Mallamace, S.; Meduri, T.; Tramontana, C. Unused Real Estate and Enhancement of Historic Centers: Legislative Instruments and Procedural Ideas. In *New Metropolitan Perspectives, ISHT 2018, Proceedings of the Smart Innovation, Systems and Technologies—SIST, Reggio Calabria, 22–25 May 2018*; Calabrò, F., Della Spina, L., Bevilacqua, C., Eds.; Springer: Berlin/Heidelberg, Germany, 2019; Volume 101, pp. 464–474.
56. Sturiale, L.; Scuderi, A.; Timpanaro, G.; Foti, V.T.; Stella, G. Social and inclusive "value" generation in metropolitan area with the "urban gardens" planning. *Green Energy Technol.* **2020**, 285–302.