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A Model to Support Sustainable Resource Management in the "Etna River Valleys" Biosphere Reserve: The Dominance-Based Rough Set Approach

Alessandro Scuderi [1], Luisa Sturiale [2,*], Giuseppe Timpanaro [1], Agata Matarazzo [3], Silvia Zingale [1] and Paolo Guarnaccia [1]

[1] Department of Agriculture, Food and Environment (Di3A), University of Catania, 95127 Catania, Italy; alessandro.scuderi@unict.it (A.S.); giuseppe.timpanaro@unict.it (G.T.); silvia.zingale@gmail.com (S.Z.); paolo.guarnaccia@unict.it (P.G.)
[2] Department of Civil Engineering and Architecture (DICAR), University of Catania, 95127 Catania, Italy
[3] Department Economics and Business (DEI), University of Catania, 9512 Catania, Italy; amatara@unict.it
* Correspondence: luisa.sturiale@unict.it

Abstract: For several decades, studies and conventions have highlighted the importance of the ecosystem services provided by natural resources and biodiversity for humanity and the need to move their management towards a sustainable model. Inthe United Nations 2030 Agenda for Sustainable Development (2015), among its 17 Sustainable Development Goals (SDGs), there isalsoSDG 15, "*Life on Land*", specifically dedicated to biodiversity, forests and desertification. The aim is to "*sustainably manage forests, combat desertification, halt and reverse land degradation, and halt the loss of bio-diversity*". The UNESCO "*MAB—Man and Biosphere*" Programme could achieve this goal by establishing Biosphere Reserves (BRs). Among them, the establishment of the BR "*Etna river valleys*" is an opportunity to adopt sustainable development models in the "Etna Park system" (UNESCO site since 2013) for the regeneration of virtuous relationships between cities and rural areas and the promotion of the conservation of natural resources and biodiversity through strategies of territorial enhancement with a multifunctional vision of agriculture and territory. This research aims to provide, through the methodology of "Rough Sets", a useful tool to support the strategic choices that stakeholders will be called upon to make for the management of the complex environmental, cultural and economic mosaic that characterises the BR "*Etna river valleys*".The results show both weaknesses and strengths in the transition towards a sustainable land management model, which will nonethelesshave to be supported and accompanied by information and financial support.

Keywords: Manand Biosphere Program (MAB); ecosystem services; biodiversity; Etna environment; UN SDGs; decision support model

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1. Introduction

Human action has completely transformed our planet and continues to transform it [1–3]. To meet the growing global demand for goods and services, the balance between man and nature has been upset, and ecosystems have lost their original characteristics, resulting in the continuous and uncontrolled process of the exploitation of natural resources [4]. This balance has led to the intensification of problems, such as pollution, global warming, desertification, deforestation, land degradation, loss of biodiversity and natural habitats [5–7]. Biodiversity—the diversity within species, between species and of species and ecosystems—is being degraded faster than at any time in human history, and the last decades represent the historical period of greatest vulnerability for the ecosystem services due to anthropogenic action [8]. Globally, the risk of extinction for differentspecies has worsened by about 10% in the last three decades. More than 31,000 species are threatened with the risk of extinction, due mainly to the loss of habitats to deforestation, unsustainable

harvest and tradepractices and invasive alien species, as well as their use in unsustainable agriculture operations [3].

In September 2015, the 2030 Agenda for Sustainable Development was proposed as a programmeof action for people, the planet and prosperity and was signed by the governments of the 193 UN member states. It incorporates 17 Sustainable Development Goals (SDGs) into a major action programmefor a total of 169 "targets"and 231 indicators [9]. Among these objectives, the SDG 15, "*Life on Land*", is dedicated to Biodiversity, Forests and Desertification and aims to "*Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*" [10].

Several surveys and reports [11–16] have shown that new governance models are needed to promote and implement sustainability at the local, national and global level. New private sector investment frameworks are required to get SDGs up and running innovative, inclusive and adaptive governance approaches and agreements, multisectoral planningmethods and strategic policy mixes [17,18].

Biosphere reserves (BRs), established under the UNESCO "Man and Biosphere" (UNESCO-MAB) [19] program, aim to reconcile the social and economic development of the territories involved with the conservation of biodiversity through innovative and participatory models of governance. The creation of the BR could achieve the goals set out in SDG 15 "*Life on Land*", which are to promote the conservation of biodiversity, biological resources, the ecosystem and their sustainable use, and to reverse land degradation.

The creation of a BR is not only aimed to preserve biodiversity but also cultural diversity and ecosystem services, and to support local sustainable development.

The governance of biosphere reserves requires models that develop the participation and inclusion of the different local actors involved in the management and valorisation of the resources. The aim is to create a governance that is able to encourage cooperation among stakeholders, build mutual trust, share objectives and resolve conflicts among the different interested parties [20–22].

On Italian territory, there is a remarkable wealth of diversified ecosystems and marked biodiversity. Over the years, Italy has been committed to protecting and enhancing this wealth by following a path that aims to manage and safeguard the natural areas and surrounding territories [23–27].

Sicily is characterised by territories particularly suited to rurality and able to produce many high-quality products [28]. The peculiarity of its products also lies in the presence of old varieties and landraces, which are still grown today using sustainable methods and values. Among the many others, the river valleys of the Etna area are characterised by fertile soils and different microclimates linked to the presence of the Etna Volcano. The combination of all these factors has allowed the diversification and specialisation of many crops, which still today identifies their particular farming localities, such as the pistachios of Bronte (POD), the blood oranges of Sicily (PGI), the hazelnuts of the Nebrodi and the strawberries of Maletto, as well as many horticultural varieties in the Etna area [7].

To valorise the peculiarities of the target area, a participatory endogenous development process has been initiated throughits future recognition as a Biosphere Reserve (BR), called "*Etna river valleys*" [29].

Within the newly established Reserve, this research uses the Rough Sets (RS) methodology and aims to provide useful tools to support the strategic choices of stakeholders. The area supports amodel of territorial development that sustains small farms through the increase in agricultural production with good cultivation practices and the spread of the organic farming method [30]. Additionally, in virtue of the naturalistic and landscape value of the area under study, virtuous strategies such as the establishment of exchange groups with the direct involvement of local producers and innovative itineraries could be activated to broaden the demand for local products, improve their distribution and increase low-impact forms of tourism (sustainable tourism) [7,31–34]. A number of studies are reported in the literature that have evaluated the effectiveness of BRs' management

and have highlighted the related success or failure factors. Many of these analyse specific management practices to achieve the BR's objectives in the contexts analysed [20,22,35–40].

It would be useful to complement the available studies with models that would assist the decisionmaking of interested stakeholders and enable a more comprehensive picture to be composed of the experiences of BR governance and the approaches adopted and repeatable in other contexts [41,42].

This research aims to provide, through the methodology of the "Rough Sets", a useful tool to support the strategic choices that stakeholders will be called to activate for the management of the complex environmental, cultural and economic mosaic that characterises the BR "*Etna river valleys*".

2. Materials

2.1. The Biosphere Reserves: Institution, Objectives and Developments

The Man and Biosphere Program (MAB), born in 1971, is an interdisciplinary programmethat aims at the conservation of biodiversity and biological resources and their sustainable use. It plays a dynamic role by considering the territory as a place of experimentation withsustainable development aimed at improving the relationship between man and nature. Therefore, the BRs recognised by UNESCO demonstrate the possibility of generating wellbeing thanks to the implementation of a sustainable development model, establishing better environmental quality, quality of life and occupational innovation [21,43].

The constitution of the BR has objectives that coincide with some of the targets of SDG 15 "*Life on Land*". In particular, the targets: 15.1, *Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity*; 15.9, *Integrate ecosystem and biodiversity values into national and local planning*; 15.a, *Mobilise and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems* [9].

Since the institution of the first BR in 1976, the current World Network of BRs (WNBR) has grown, nowincluding 714 sites in 129 Countries with a total area of over 600 million hectares (locations and numbers of BRs can be found on UNESCO's website: http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/ accessed on: 20 October 2021). Despitethis, the BRs are still undervalued and underused, and their roles and functions are not recognised and understood by the public and governments. Contrary to this trend, the present work stresses the importance of BRs as useful tools to boost the man–environment harmony and pass on to future generations ways of acting, behaviours and knowledge which reflect a sustainable model of society. According to the cornerstones of the establishment of these areas, the territory should be both economically productive and environmentally sustainable, safeguarding environmental resources and the related ecosystem services, traditional practices and products, and itsartistic and cultural heritage [20,44–46].

Over the years, the programme has been complemented by other documents and action plans which have renewed the objectives to be pursued and highlighted global issues and new challenges.

The following is a brief overview of the main milestones in the development of the MAB programme up to the 2017 youth movement.

- **Seville Strategy (1995):** it sets specific objectives, recommendations at the nationalandinternational level and for each BR, and implementation indicators. It invites the interested parties to acquire all the relevant information elements and to assume a full commitment, both in the planning process and in the management and continuous monitoring of the BRS, as well asthrough the creation of advisory bodies. The Seville Strategy identifies the specific role of BRs in developing a new vision of the relationship between conservation and development.
- **Statutory Framework of the World Network of BRs (WNBR) (1995):** it establishes criteria, functions and procedures for the designation of BRs and sets out the principles for their periodic review.

- **Madrid Action Plan (2008)**: it implements the 2008–2013 MAB (Man and Biosphere Program) Strategy and reiterates the three great challenges of the 21st century: climate change, biodiversity loss and urbanisation; it stresses the strategic importance of involving all stakeholders to ensure the wellbeing of human populations and their development.
- **2015–2025 MAB Strategy (2015):** it defines strategic objectives, which are derived directly from the three functions of BRs and identified in the statutory framework of the WNBR and in the global challenge to climate change (Madrid Action Plan for BRs) (UNESCO 2015) [47].
- **Lima Action Plan (2016):** it establishes objectives, actions and expected results for implementing the 2015–2025 MAB Strategy; it pays particular attention to the achievement of the sustainable development goals and the implementation of the 2030 Agenda (UNESCO 2016) [48].
- **MAB Youth Forum (2017):** the initiative, first announced at the World Conservation Congress in Lima, offered young people the chance to become actors in the MAB programme in the special territories where they live and ensure the sustainable development of their communities, in line with the Lima Action Plan.

Within the institutional structure of the MAB, the Statutory Framework of the WNBR is important, which defines BRs as "*...areas of terrestrial and coastal/marine ecosystems or a combination thereof, which are internationally recognised within the framework of UNESCO's Programme on Man and the Biosphere (MAB), in accordance with the present statutory framework*". It describes the criteria, zoning and functions that a reserve must possess. Article no. 3 indicates, in particular, three equally important and interdependent functions that the BRs must pursue (Figure 1).

Functions of the BRs	Objectives to Be Achieved
1. Conservation	Contribute to the conservation of genetic resources, species, ecosystems and landscapes.
2. Development	Promoting economic and human development that is socially, ecologically and environmentally sustainable.
3. Logistical support	Logistical support to encourage and support research, surveillance, training and environmental education activities.

Figure 1. Functions of the BRs (Art. 3 of the Statutory Framework of the WNBR).

In accordance with Article 4 of the Statutory Framework, there are seven criteria that BRs must satisfy in order to be designated. Four out of the seven criteria refer to the natural characteristics of the territory, and three criteria refer, instead, to perimeter and management.

In particular, each BR must respond to the following criteria:

1. Include a mosaic of ecological systems representative of the main biogeographical regions, including a graduated series of human interventions.
2. Be important for the conservation of biodiversity.
3. Offer the possibility to study and demonstrate approaches to sustainable development at a regional level.
4. Have adequate dimensions to satisfy the aforementioned three peculiar functions, as set out in Article 3.
5. Divide the territory into zones that support the three main functions of the BRs (core, buffer and transition zones).
6. Ensure the involvement and participation of the public, local communities and private entities of the territory in the design and implementation of the functions of the reserve.

7. Provide resource provisions for management mechanisms and human activities in the buffer zones, the definition of a management plan for the Reserve, the designation of authority to implement the plan, and the initiation of research, monitoring, education and training programs.

The zoning foreseen in criterion five includes three zones, according to the level of sensitivity of the ecosystem and the anthropisation of the area. Specifically, they are:

- *Core zone* (one or more): these are territories protected under specific laws and regulations that are suitable for long-term safeguarding, follow the conservation objectives of the BRs, of sufficient size to meet these objectives, and in which only research and zero-impact activities are allowed.
- *Buffer zone* (one or more): surrounding or bordering the core zone, in which only activities compatible with conservation objectives can be carried out, including environmental education, ecotourism, monitoring and scientific research.
- *Transition zone* (one or more): surrounding or bordering the buffer zones, where sustainable use practices are encouraged and developed; it is the part of the reserve where all the activities that allow economic and human development and are socio-culturally and ecologically sustainable are allowed.

In addition to the indicated criteria, the Statutory Framework of the WNBR asks states to develop and apply national criteria specifically tailored to the characteristics of their territories.

2.2. The Biosphere Reserves in Italy and the "Etna River Valleys" Biosphere Reserve Request Proposal (Case Study)

Italy's participation in the MAB programme has made available a model to follow for the promotion of ethical and cultural activities and values linked to environmental conservation and education, the sustainable use of resources and good practices traditionally employed in the country [49].In this way, a significant boost to the Italian Network of BRs, both in numerical terms and in terms of management capacity, as well as in the renewed interest of local communities in the issues and objectives related to sustainable development, has been achieved.

The first enrolments in the MAB programme of Italian BRs date back to the 1970s and relate to areas whose conservation is aimed at maintaining and safeguarding biodiversity. The first to be registered, in 1977, were "Collemeluccio-Montedimezzo" and "Foresta del Circeo", followed in 1979 by "Miramare", and today there are 19 sites distributed in Italy.

The establishment of a BR in Sicily called "*Terre della Biosfera: le valli fluviali dell'Etna*" *("Etna river valleys")* is a local project carried out by the members of the "Terre della Biosfera" association with the "Verdi Bronte" association, the German foundation "Manfred Hermsen Stiftung" and the tour operator "NatourSicily".The candidacy of the "*Etna river valleys*" for becoming a BR has as its main purpose the conservation of the biodiversity of the territory, with particular consideration for the areas outside the protected areas and its peculiar landscape [43,50].

The ambitious project aims to create a point of contact in an area as large and diverse as that envisaged, which includes two provinces (Catania and Messina), three regional natural parks (Nebrodi, Etna and Alcantara) andfour natural reserves (Fiume Fiumefreddo, Bosco di Malabotta, Forrelaviche del Simeto, Oasi di Ponte Barca on the Simeto river), and also incorporates and connects numerous SCIs (Sites of Community Importance) and SPAs (Special Protection Areas) of the European Network "Natura 2000" (Directive 92/43/EEC "Habitat") (Figure 2).

The project of the "*Etna river valleys*" envisages a zoning in three parts of the area under study to allow the achievement of the conservation of natural resources and sustainable development.

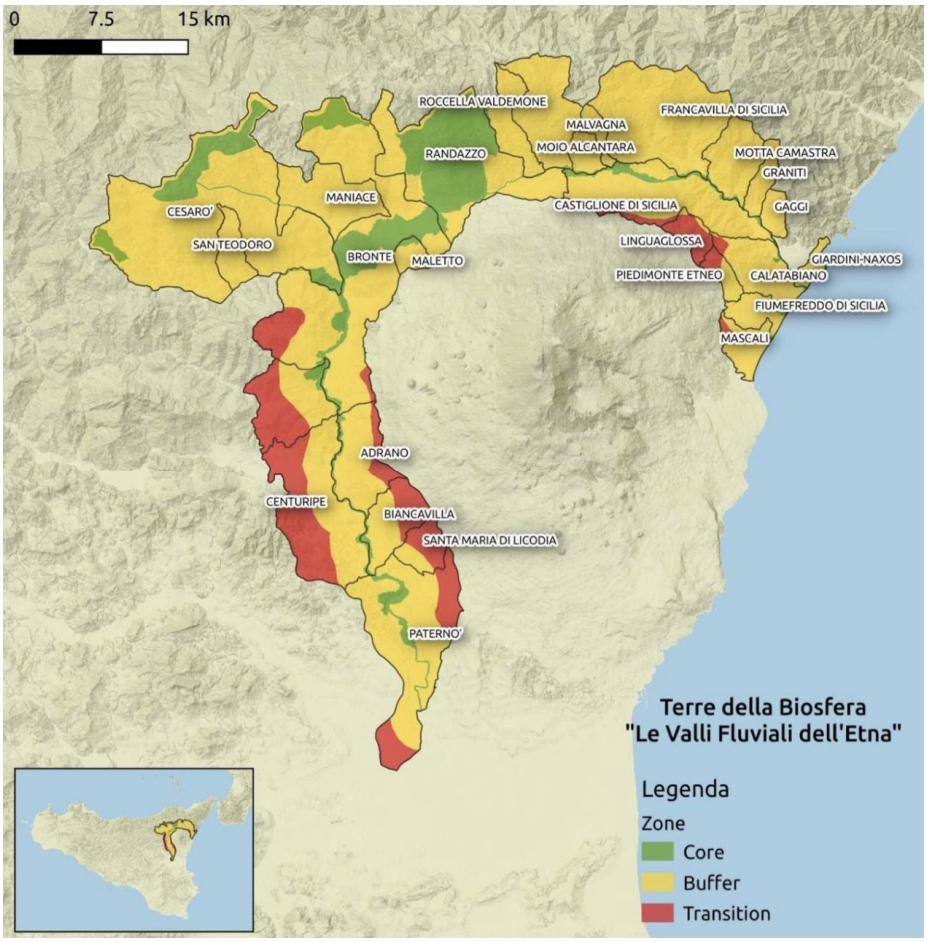

Figure 2. Proposal for zoning the Biosphere Reserve "*Terre della Biosfera—le valli fluviali dell'Etna*".

The *core* zone, which is the area with the highest naturalistic value, includes the south-western portion of the Nebrodi Regional Park, the Regional River Park of the Alcantara River, the Oriented Nature Reserve of Fiumefreddo (CT), Sites of Community Importance (SCIs) and Special Protection Areas (SPAs) of the European Natura 2000 network, and the sources, high valleys and courses of the Simeto and Alcantara rivers. The area thus designated would simplify its management, which already falls into the remit of the respective managing bodies, through management plans and use regulations [36].

The *buffer* zone, which surrounds the *core* zone and protects it from excessive negative anthropic interventions through the reduction of all those activities with a strong ecological impact, is characterised by those territories that are destined for redevelopment.

The *transition* zone is characterised by a strong anthropic presence, both at a demographic level since it includes the inhabited centres and at the economical level due toitspursuit of activities such as agriculture, tourismand small industry.

The actions foreseen by the project for the *core*, *buffer* and *transition* zones are detailed in Figure 3.

The overall vision of the proposed MAB "*Etna river valleys*" reserve entails the progressive transformation of the "*Etna river valleys*" into a large ecological corridor between the three neighbouring regional parks (the Nebrodi regional park, the Alcantara river park and the Etna Regional Park) and results in the proposal of a model of economic development that respects natural resources, biodiversity and landscape aspects, with particular reference to the landscape and traditional agricultural activities.

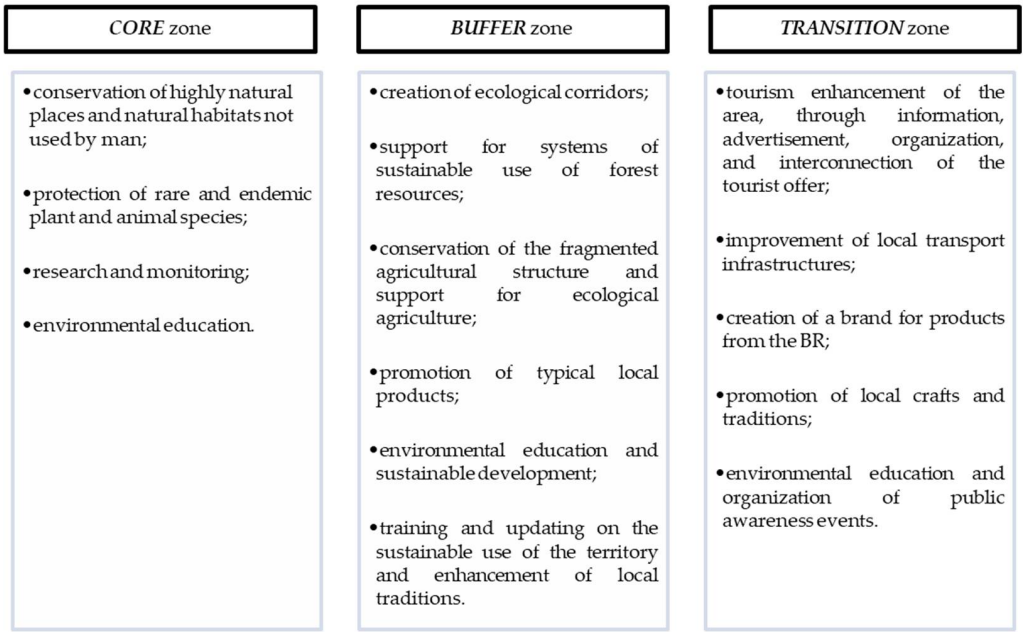

Figure 3. The actions planned in the project for the *core*, *buffer* and *transition* zones.

3. Methodology

3.1. The Theory of Rough Sets

The theory of "Rough Sets", (RS) introduced by Pawlak in 1977 [51] as a powerful dataanalysis tool, was later subjected to in-depth analysis and methodological changes to be applied in multicriteria decision-making problems of classification, choice and ranking, as well as in the presence of purely ordinal data [24,52–54].

The methodology is theoretically based on the hypothesis that with each object in a given universe U, there is associated information expressed using some attributes that describe the aforementioned objects [54].If, for example, the objects are farms that aim to reduce negative externalities on the ecosystem, the information is represented by the production specialisation, the cultivation method, etc. Objects characterised by the same description in terms of the considered attributes are regarded as indiscernible from (or similar to) the available information [52].

The *indiscernibility* relation constitutes the mathematical foundation of the classical theory of RS, intended like the bricks ("*granules*") with which knowledge of reality is built [51,53,55].

Each set of indiscernible objects is called an elementary set and represents an atom ("*granule*") of the knowledge of the universe. Any subset X of the U universe can be defined in terms of granules in a precise way, as a union of elementary sets(as in classical set theory), or in an approximate way. In the latter case, the subset can be characterised by two ordinary sets, called the *lower approximation* and *upper approximation*. A rough set X is defined through the aforementioned approximations, which coincide in the case that X is an ordinary set; the difference between the lower and upper approximation represents the *boundary* of the rough set X [52,54].This approach leads to an approximate representation of reality characterised by the "granularity" of knowledge, similar to the concept of "sharpness" in image theory, which constitutes the key concept of the theory of RS.

The lower approximation of X is constituted by all the elementary sets included in X, whose elements therefore certainly belong to X; the upper approximation is given by all the elementary sets that have a non-empty intersection with X, whose elements can belong to X. The elements that belong to the boundary of X cannot, therefore, be characterised with certainty as to their membership in X using the information available. According to the approach of the rough set, therefore, a concept described in an imprecise way can be replaced by a couple of precise concepts, namely, its lower and upper approximations [53].

The peculiarity of rough sets consists in dealing with an imprecise representation of reality due to the granularity of knowledge, a consequence of the *indiscernibility* between objects having the same description ("*granules*") [53].

Before proceeding with the application of the theory of RS to the multicriteria decision-making problem at hand (ordinal classification, called *sorting*), in relation to the use of natural resources in protected areas and, in particular, to the compatibility between the exercise of agriculture and the protection of the ecosystem [7,56,57], the main concepts of the adopted methodology are explained below.

The *indiscernibility* relation is reflexive, symmetricaland transitive and, therefore, is an equivalence relation. To be able to face all the multicriteria decision-making problems, the *indiscernibility* relation is replaced by the dominance relation: object a dominates object b if a is at least as good as b with respect to all the considered criteria; therefore, this binary relation, thus defined, is reflexive and transitive (partial preorder). In this way, a new RS approach, called the Dominance-based Rough Set Approach (DRSA), has been built; it presupposes that the domain of each considered attribute is preferentially ordered, thus allowing it to explicitly take into consideration the preferences of the Decision Maker (DM) if they are qualitative, orexpressed in ordinal scale [51].The attributes are then called criteria. If even the decision attribute (assignment class) satisfies ordinal properties, we therefore have a partition of objects into classes ordered according to a certain preference. The addressed problem of sorting precisely consists of the assignment of each object to an increasing or decreasing union of decisional classes, predefined by the DM.

The preference model obtained from the DRSA analysis is still presented in the form of decision rules [54] in the form "*if ..., then ...*", where the premise (the conditional profile) represents a sufficient condition for an object to be assigned to a union of ordered classes (decision profile). Each rule is expressed in ordinary language, in terms of evaluations of the objects with respect to a subset of the criteria considered. The syntax of these rules in the DRSA is very rich and is of the type: "if the evaluation of x with respect to the criterion ci is at least (at most) equal to vi, ... and with respect to the criterion cj is at least (at most) equal to vj, and .., then x must be assigned at least (or at most) to class ck".

The conditional and decisional profiles respect the fundamental *dominance principle*: one profile dominates another profile if all the evaluations of the first profile are not worse than the evaluations of the second profile with respect to the criteria considered. The constraint of monotony requires that if the conditional profile of one decision rule dominates the conditional profile of another rule, then the decision profile of the first rule must also dominate that of the second. In other words, if object a dominates object b with respect to the considered criteria, and b is assigned to a certain class Y, then a must be assigned to a class Z not preferentially inferior to X. A set of rules [58] is *complete* if it covers all the objects of the decision table, reassigning the consistent objects to their original classes and the inconsistent ones to the union of classes that refer to that inconsistency. Objects that satisfy both the premise (conditional part) and the conclusion (decision part) of a rule constitute its *support*. Any complete and non-redundant set of rules is called *minimal*.

The decision rules can explain the decisions related to an object of the decision table and help the DM to make decisions regarding new objects that satisfy the conditions expressed by some rules, thus suggesting an appropriate intervention strategy for the DM.

A particularly interesting aspect of the RS lies in the ability to select a subset of attributes and/or criteria, called *reducts,* which alone can express all the knowledge contained in the decision table considered without deteriorating its quality. Therefore, short, easy, understandable and certain decision-making rules can then be obtained even using only the criteria of any one of these *reducts* [59,60].

The minimal sets of decision rules constitute the most concise and non-redundant representation of the knowledge inferred from the decision table containing the sample of examples. The concepts described above constitute the fundamental points of the classical theory of RS and of its subsequent methodological modifications (DRSA) to be able to apply

it to multi-criteria decision-making problems of choice, ranking and sorting. For further information, please refer to the authors [54,55,61,62].

3.2. Survey Design

This study proposes the application of DRSA theory for the analysis of a complex and multifunctional system, such as the BR "*Etna river valleys*", focusing on environmental issues related to the enhancement and use of environmental, cultural and economic resources that characterise the BR "*Etna river valleys*". This methodology supports decision rules that could help define strategies for the management of different economic activities that are compatible with environmental protection and ecosystem maintenance.

Information was collected in 2020 through the administration of a special questionnaire submitted to a sample of farms located in the territory of the BR "Etna river valleys", aiming to collect the level of knowledge about good agricultural practices for the conservation and protection of biodiversity as well as the criticalities and problems of farmers and their degree of satisfaction and adherence to the funds of the Common Agricultural Policy (CAP).Farmers are, in fact, the key stakeholders of this European policy, which, through the financial support of the first and second pillar, also aims to contribute to business development and income stabilisation. Farmers themselves are also the ones who, if properly involved, supported and trained, can develop their ecological knowledge and provide ecosystem services and other benefits to the environment and society.

The reasoned sample was composed of 100 active agricultural entrepreneurs and supporters of the *"Etna river valleys"* project. The he interview was conducted using the direct *face-to-face* method and using a questionnaire structured according to the research objectives as a survey instrument.

The questionnaire was structured into three sections (with a total of 65 questions):

- section 1—questions about company activities;
- section 2—questions about contributions received from the European Union;
- section 3—questions about good practices for the conservation of biodiversity.

Different types of questions were foreseen, in particular:

- open questions;
- closed questions;
- graded questions.

The questionnaires were distributed through the intervention of third parties, trained to facilitate the compilation of the questionnaire by farmers. The interaction between the "multiplier" and respondent allows, in fact, the trust of the respondent to be more easily won, the process of detectionto be optimisedand more complex questions to be submitted.

According to the characteristics and the crops of the territory, the following four homogeneous areas have been considered: "Paternò", "Bronte", "Mojo Alcantara" and "Piedimonte Etneo".

The crops considered were: dried fruit, citrus fruits, orchards, vineyards, olive groves, vegetables and cereals, and forage. Thus, as described in the general methodology, each category was evaluated according to the following criteria (Figure 4):

The evaluation of the single criteria for each crop was made using a qualitative scale on five levels: low, medium-low, medium, medium-high, high. To make the analysed data immediately readable, the qualitative judgments were encoded in a numerical scale, but all the analysis was carried out rigorously through the DRSA on the original ordinal data and not on the forced transformation of them into numerical values. This too is a peculiarity of the method used. The table below shows the encodings numbers of the qualitative scale provided by the interviewees (Figure 5).

Criteria	*Description of the criteria*
a1	Role of sustainability in the territory
a2	Influence on the landscape
a3	Pollution due to conventional agriculture
a4	Ecosystem improvement with organic farming
a5	Profitability of crops
a6	Influence of hydrogeological systems
a7	Abitlity to maintain biodiversity

Figure 4. Description of the criteria.

Level	Code
low	1
low-medium	2
medium	3
medium-high	4
high	5

Source: our elaboration

Figure 5. Numerical encoding of qualitative parameters.

4. Results

The distribution of the main social characteristics of the sample is shown in the following box (Figure 6).

Distribution by main social characteristics of the sample	
Distribution by gender :	
• men	85%
• women	15%
Distribution by age:	
• adults between 18 and 60 years old	83%
• over 60 years old	17%
Distribution by level of education:	
• elementary school degree	12%
• secondary school diploma	17%
• high school diploma	45%
• university degree	26%

Figure 6. Distribution of the main social characteristics of the sample.

Interesting results were obtained from the elaboration through the DSRA of the data that emerged from the questionnaires administered.

The overall decision table was divided into four different tables, one for each area concerned and investigated. Each table is composed of seven rows and nine columns (Figure 7): while each row corresponds to a specific crop ("object") examined, the first seven columns correspond to the decision criteria taken into consideration as described above, and the eighth column (decision) consists of the assignmentmade by theinterviewees of each crop to one of the three classes of merit identified (high, medium, low). In this way, the tables briefly describe the different qualitative levels of each crop as perceived by the decisionmakers in light of the particular points of view of the study, and justify their assignment to a union of classes.

Rules	A1 *Role of sustainability in the territory*	A2 *Influence on the landscape*	A3 *Pollution due to conventional agriculture*	A4 *Ecosytem improvement with organic farming*	A5 *Profitability of crops*	A6 *Influence of hydrogeological systems*	A7 *Ability to maintain biodiversity*
1. Driedfruits (hazelnuts, pistachios, almonds, walnuts)							
2. Citrus fruits							
3. Fruits orchards							
4. Vineyard							
5. Olives							
6. Vegetables							
7. Cereals and forage							

Figure 7. Codification of the crops and criteria considered.

On the basis of the data collected by the questionnaire and taking into account that the data available relate to a sample of only 100 farms, the number of crops (seven) in each table is equal to the number of conditional criteria, and therefore the *reducts* that can be obtained are numerous and not very significant. In our opinion, it is therefore more interesting in the study at hand to search for the decision rules, which more concisely, exhaustively andeffectively describe the different situations obtained for each area. Different minimal sets of decision rules have been chosen, requiring that the conditional parts contain the fewest possible number of criteria, i.e., that the rule be as short and clear as possible.

Tables 1–4 correspond to the decision rules for each area investigated. In these tables, each row contains a rule, the next seven columns refer to the different criteria considered and the last column indicates the objects, called *support*, that satisfy the corresponding rule and therefore justify the assignment to a decision class according to the preferences expressed by the farmers. Note that, of course, "$\leq$medium" means "low or medium", and "$\geq$medium" medium or high.

For example, the above-described rule 1 from Table 1 (Paternò area), using the natural language, will be expressed as follows: "If A4, that is, the ecosystem improvement with organic farming, is at least medium-high, then the cultivation is classified high". This means that if a new crop reaches at least level 4 with respect to criterion A4, then it will be considered high and, therefore, will be assigned to the highest quality level among those considered. The same rule has as support objects 2, 3 and 5, i.e., the corresponding crops of citrus fruit, orchard and olive grove. From the point of view of decision support, wetherefore have to draw farmers' attention to the ecosystem improvement with organic

farming, since this practice in that area allows for the highest qualitative level of the decision classes to be reached. In a similar way, we can obtain decision support from the other decision rules.

Table 1. Decision rules for the "Paternò" area.

Rules	A1	A2	A3	A4	A5	A6	A7	Class	Support
1				≥4				High	2,3,5
2				≤3	≤3			≤Medium	4,6,7
3							≤2	≤Medium	6.7
4					≥4			High	1

(Source: our elaboration).

Table 2. Decision rules for the "Bronte" area.

Rules	A1	A2	A3	A4	A5	A6	A7	Class	Support
1		≤2				≤2		Low	6
2		≥3			≥3			High	1,3,5
3							≤2	Low	6
4					≤2			≤Medium	2.7
5		≤2						≤Medium	2,4.6
6						≥4		High	3
7							≥3	≥Medium	1,2,3,4,5,7

(Source: our elaboration).

Table 3. Decision rules for the "Moio Alcantara" area.

Rules	A1	A2	A3	A4	A5	A6	A7	Class	Support
1		≥4						High	1.3
2					≥3			≥Medium	1,2,3,4,5
3					≤2			Low	6.7
4		≤3						≤Medium	2,4,5,6,7
5		≤3			≥3			Medium	2,4,5

(Source: our elaboration).

Table 4. Decision rules for the "Piedimonte Etneo" area.

Rules	A1	A2	A3	A4	A5	A6	A7	Class	Support
1					≥4			High	1.4
2	≤2	≤2						Low	3.6
3	≤1							Low	6
4					≤3			≤Medium	2,3,5,6,7

(Source: our elaboration).

Rule 2 can be expressed as follows: "If A4, that is, the ecosystem improvement with organic farming, is at most medium, and A5, that is, the profitability of crops, is also at most medium, then the cultivation is classified at most medium, with the supporting objects 4, 6, 7, i.e., vineyards, vegetables and cereals and forage.

We observe that in the Paternò area (Table 1), there are only two classes of assignment (high and medium) by the farmers, since no cultivation has been attributed to the low class. Therefore, in this case and only in this case, the assignment "at the most medium" is equivalent to saying "medium".

Looking at Table 5, it is also clear that in the Paternò area, there are numerous dominance relations (7) between the different types of cultivation. Thus, for example, the first line points out that cultivation 1 (dried fruit) dominates cultivation 4 (vineyard), indicated by "1"in the cell at the intersection between the first row and the fourth column; and for the second line, it shows that cultivation 2 (citrus fruits) dominates 3 (orchard), 4 (Vineyard), 6 (vegetables), 7 (cereals and forage), etc. As noted above, if a dominates b, that means that a is at least as good as b with respect to all considered criteria. Dominance relations in Tables 5 and 6 are antisymmetric: for example, the cell at the intersection between the fourth row and the first column in Table 5 indicates "−1", that is, cultivation 1 (dried fruit) is dominated by cultivation 4 (vineyard).

Table 5. "Paternò" area dominance relations.

	1	2	3	4	5	6	7
1				1			
2			1	1		1	1
3		−1		1		1	
4	−1	−1	−1				
5							
6		−1	−1				
7		−1					

(Source: our elaboration).

Table 6. "Piedimonte Etneo" area dominance relationship.

	1	2	3	4	5	6	7
1							
2				−1			−1
3						1	
4		1					1
5							
6			−1				
7		1		−1			

(Source: our elaboration).

Moreover, from Table 2, it is evident that, among other things, in the Bronte area, the criterion A7 (ability to maintain biodiversity) is able toexplainby itself the assignment of crops to the "low" and "at least medium" classes, and the "medium" evaluation on this criterion is also alone able to discriminate against only the aforementioned decision classes. It is also interesting to note that the criteria A3 (conventional agricultural pollution) and A4 (ecosystem improvement with organic agriculture) were implicitly considered by the experts to be unimportant in planning decisions (class assignment) in the areas of Bronte, Moio Alcantara and Piedimonte Etneo, since none of these criteria are present in the decision rules of the corresponding Tables 3–5.

Conversely, Table 3, which is related to the Moio Alcantara area, shows the high discrimination capacity of the A2 (influence on the landscape) and A5 (profitability of crops) criteria, each of which alone can justify all the assignments and discriminate among the different assignment classes. In a similar way, the A5 criterion (profitability of crops) alone justifies all the assignments and discriminates among the different assignment classes for the "at most medium" (low or medium) and "high" classes in the Piedimonte Etneo area (Table 4).

Finally, it should be noted that the most frequent criteria in the decision rules reported in the presented tables are the criteria A2 (influence on the landscape) and A5 (profitability of crops). This last criterion is present in the conditional part of the decision rules for all areas and therefore can be considered the most importantaspect taken into consideration by the farmers of the aforementioned territory and consequently of strategic importance for future planning. In contrast, it should be noted that criterion A3 (pollution due to conventional cultivation) is not present in any decision rule inferred, and that criteria A1, A4 and A6 are each present in only one of the considered areas.

Once again, we emphasise that decision-making rules, as noted above, offer great support in making decisions. In fact, in particular they: (a) provide by their support a traceable justification of the assignments to the decision classes; (b) offer useful operational information about actions taken to improve the on criteria, showing discriminatory threshold values necessary to advance the allocation of crops in the decision classes.

The information obtained highlight the barriers that determine the non-participation of farmers in the financial proposals promoted by the funds of the I and II pillars of the Common Agricultural Policy, specify the needs and expectations of respondents towards these economic-financial instruments and verify the level of exercise of good agricultural practices necessary for the conservation of biodiversity. The following emerge clearly

- the willingness of the farmers interviewed to make their own contribution to biodiversity conservation;
- the presence in the area of farms that habitually apply good agricultural practices;
- the urgent need for companies to be supported in the promotion of their products on the market;
- the request for reductions in bureaucratic and administrative burdens related to access to funding measures;
- the need to diversify the areas of support and the criteria for access to funding according to company size, type of production and type of territory;
- the need for periodic and systematic communication with and training of the agricultural and rural population on the contents and aims of European, national and regional policies on agriculture, food and the environment;
- the importance of providing institutional communication campaigns that illustrate the role of agriculture in preserving the environment and the different types of initiatives that can be classified as "good agricultural practices", so as to activate a greater degree of sensitivity in the population (demand subjects) towards these important functions of agriculture so that a "premium price" can be recognised.

The CAP, through the financial support of the first and second pillars, has the objective of promoting the development of businesses and the stabilisation of income through an environmentally friendly development model. In order to achieve this objective, however, the main actors are mainly farmers, who must be adequately involved, supported, informed and formed. Unfortunately, as the results show, there is still limited information on the role they play in protecting the environment and landscape and preserving biodiversity. Actions that can develop their ecological knowledge about their role in protecting natural capital, providing ecosystem services and other benefits for the environment and society are therefore strategic.

5. Discussions and Conclusions

The latest progress report on the implementation of Agenda 2030 [3] calls on all countries to do more and calls for immediate action and a fundamental transformation of our relationship with the earth to halt the loss of biodiversity and protect ecosystems for the benefit of current and future generations.

With reference to SDG 15, there have been multiple actions and interventions by states which have led to an increase in protected areas from 2000 to 2018 precisely to protect the biodiversity and to ensure the long-term and sustainable use of natural resources. However, critical areas still exist, and the risk of species extinction has worsened by almost 10% over

the last 25 years, while land degradation has affected one fifth of the land on our planet (2 billion hectares) and the lives of 3.2 billion people, driving species to extinction and intensifying climate change [3,16].

The area investigated, "*Etna river valleys*", represents an opportunity to adopt sustainable development models in the "Etna system". In particular, it could promote the regeneration of virtuous relations between the city and the countryside (food, tourism, renewable energy, waste, etc.), the requalification of the landscape, the protection of biodiversity, the rediscovery of local cultural identity and the relocation of the economy, in line with SDG 15.

This research has shown that, taking into account many different criteria, the territory in question represents a very active territory from the agricultural and production points of view, with the consequence that the prevalent interest is devoted to the criterion of profitability, according to the results of our analysis. Interesting is the high evaluation that is given to the landscape aspects of the territory for potential future tourist developments [63–65]. In terms of the environment, there is limited attention to the pollution of conventional agricultural production, although there is an interest in organic farming [46].These data show that there is still little awareness of the environmental benefits offered by organic farming. Policy makers should therefore take adequate measures to better orient local farmers toward bio-agriculture. It is widely known, in fact, that the current food system, from field to table, is responsible for about 21–37% of total greenhouse gas emissions, according to the IPCC [1]. The largest contribution to this estimate comes from agricultural production, crop and livestock activities, and changes in land use, such as deforestation and land degradation. The Sicilian Region is still far from adopting an environmental model that is completely sustainable, but by adopting the necessary measures and tools, it could become the ideal destination for tourist flows that wish to combine fun and the optimal use of natural resources [65–67].

The ecological transition from a conventional agricultural model to a sustainable model (based on ecological principles, ensuring soil regeneration, the preservation of biodiversity and the production of healthy and nutritious food for the community) must be supported and accompanied by education and financial support.

The results collected could contribute to the debate on the launch of the new regime of the CAP 2021/2027, so that it can be truly aligned with the European Green Deal and the Biodiversity and Farm to Fork strategies, but above all be responsive to the needs of small farmers. In fact, the main CAP subsidy paid per hectare distorts the production model in favour of larger farms and landowners, who are not necessarily farmers. There is a need to create new perspectives for small family farms, which, in the face of a very important role in protecting and enhancing the territory, receive much less support than large "industrial" farms.

In this context, identifying what good agricultural practices are already adopted by farmers in the study area and what challenges need to be addressed to help them operate in a manner favourable to biodiversity, without jeopardising the profitability and competitiveness of their economic activity, have become the key objectives of the project [68]. The development of agroecological practices on a large scale, together with the enhancement of local food products and short, traced and distinctive supply chains, allow, in fact, the various phenomena of environmental degradation mentioned above to be counteracted and rural territories to be revitalised.

The DRSA methodology fits well with the purpose of this research, allowing in such a rather heterogeneous scenario to: also consider purely qualitative data; express the decision rules in terms of particularly richsyntax; be easily read even by non-experts, as they are expressed in natural language; represent effective decision supports that the rules can provide to the decisionmaker for future territorial planning analyses and, finally, provide the justification of each decision rule, showing the supporting objects. Moreover, this approach does not require the specification of any technical parameters, such as subjective

importance weights, assuming as the only model of preferences some decision examples provided by the decision maker [41,59,60].

Therefore, the application presented in this study could be an example of best practice as methodological supports for SGD policy. It is very flexible in its implementation in terms of input data, and the easily understood results represent interesting features, very useful in the kind of studies that consider analyses of different dimensions.

According to the MAB programme [19], community participation becomes strategic in both the establishment and implementation phases of the BRs. Many studies have highlighted the importance of participatory governance for the success of BRs [35,36,38,39] through different approaches depending on the characteristics of the territory (top-down, bottom-up or mixed). Governance models are strategic for the success of BRs, but equally important are the tools that support stakeholders' decisions, tools that in a complex governance operation must be understandable and effective, as the proposed DRSA approach has proven to be. Although the approaches are different, they have in common the objective of conserving biodiversity and promoting sustainable development. Certainly, the numerous BRs established under the MAN programme around the world are highlighting different models of governance that, despite possible limits, could be replicable for the management of other forms of protected areas.

The proposed methodological approach could support local institutions and individual farmers in the choice of strategic actions to activate in order to achieve some of the goals set out in SDGs 15, especially in protected areas, where the relationship between nature and man can become critical and, if not managed in a sustainable way, can cause land degradation and the loss of biodiversity and ecosystem services.

The MAB programme aims to contribute to the achievement of the SDGs and the implementation of the 2030 Agenda for Sustainable Development both within BRs and through the global dissemination of sustainable development models that have been realised through local experiences in BRs. These universal goals must continue to be pursued, and countries must focus on not only growth, but also even more on inclusion and equity, combating climate change, reducing land degradation, protecting biodiversity and environmental sustainability.

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References

1. IPCC. Global Warming of 1.5 °C. An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty. Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., et al., Eds.; 2018; Available online: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_Low_Res.pdf (accessed on 12 September 2021).
2. Pearce, D.W.; Turner, R.K. *Economics of Natural Resources and the Environment*; Il Mulino: Bologna, Italy, 1991.
3. UN. *The Sustainable Development Goals Report 2020*; United Nations. Department of Economic and Social Affairs: New York, NY, USA, 2020.
4. Phillips, A.; Borrini-Feyerabend, G. Embracing diversity, equity and change in the landscape. In *Parchi e Paesaggid'Europa*; Gambino, R., Negrini, G., Eds.; Urbanistica: Rome, Italy, 2009; Volume 139, pp. 52–57.

5. IPCC. *Land Use, Land-Use Change and Forestry. A Special Report of the IPCC*; Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J., Dokken, D.J., Eds.; Cambridge University Press: Cambridge, UK, 2000.
6. OECD. *Mainstreaming Biodiversity for Sustainable Development*; OECD Publishing: Paris, France, 2018.
7. Sturiale, L.; Scuderi, A.; Timpanaro, G.; Matarazzo, B. Use and Sustainable Conservation of the Environmental Resources of the Etna Park (UNESCO Heritage): Evaluation Model Supporting Sustainable Local Development Strategies. *Sustainability* **2020**, *12*, 1453. [CrossRef]
8. MEA—Millenium Ecosystem Assessment. *Ecosystem and Human Well-Being: Synthesis*; MEA: Washington DC, USA, 2005.
9. UN. Goal 15. *Department of Economic and Social Affairs*. 2015. Available online: https://www.un.org/development/desa/dpad/sustainable-development-goal/goal-15-life-on-land/ (accessed on 12 November 2021).
10. UN. *Transforming Our World: The 2030 Agenda for Sustainable Development*; United Nations Department of Economic and Social Affairs: New York, NY, USA, 2015.
11. 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]
12. EEA—European Environment Agency. *Exploring Nature-Based Solutions. The Role of Green Infrastructures in Mitigating the Impacts of Weather and Climate-Change Related Nature Hazards*; EEA Technical Report 12/2015; EEA: Luxembourg, 2015.
13. IPBES. Summary for Policymakers of the IPBES Global Assessment Report on Biodiversity and Ecosystem Services; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2019. Available online: https://zenodo.org/record/3553579#.Yl_ChtNBxPY (accessed on 12 November 2021).
14. Stafford-Smith, M.; Griggs, D.; Gaffney, O.; Ullah, F.; Reyers, B.; Kanie, N.; Stigson, B.; Shrivastava, P.; Leach, M.; O'Connell, D. Integration: The key to implementing the Sustainable Development Goals. *Sustain. Sci.* **2017**, *12*, 911–919. [CrossRef] [PubMed]
15. UNRISD. *Global Trends Challenges and Opportunities in the Implementation of the Sustainable Development Goals*; United Nations Development Programme and United Nations Research Institute for Social Development: Geneva, Switzerland, 2017; Available online: https://www.unrisd.org/en/library/publications/global-trends-challenges-and-opportunities-in-the-implementation-of-the-sustainable-development-goal (accessed on 21 October 2020).
16. UN. *Sustainable Development Outlook 2020 Achieving SDGs in the Wake of COVID-19: Scenarios for Policymakers*; United Nations Department of Economic and Social Affairs: New York, NY, USA, 2020.
17. 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.
18. Sturiale, L.; Scuderi, A. The role of green infrastructures in urban planning for climate change adaptation. *Climate* **2019**, *7*, 119. [CrossRef]
19. UNESCO. The Seville Strategy for the World Network of Biosphere Reserves. 1996. Available online: http://www.unesco.org/mab/docs/Strategy.pdf (accessed on 15 October 2021).
20. Reed, M.G.; Massie, M. Embracing ecological learning and social learning: UNESCO biosphere reserves as exemplars of changing conservation practices. *Conserv. Soc.* **2013**, *11*, 391–405. [CrossRef]
21. Batisse, M. The Biosphere Reserve: A Tool for Environmental Conservation and Management. *Environ. Conserv.* **1982**, *9*, 101–111. [CrossRef]
22. Onaindia, M.; Ballesteros, F.; Alonso, G.; Monge-Ganuzas, M.; Peña, L. Participatory process to prioritize actions for a sustainable management in a biosphere reserve. *Environ. Sci. Policy* **2013**, *33*, 283–294. [CrossRef]
23. Carbone, F. Multifunctional forest planning: The application of an integrated MCDM—GIS model. *Aestimum* **1999**, *37*. [CrossRef]
24. Matarazzo, A.; Clasadonte, M.T.; Ingrao, C. The (dominance based) rough set approach applied to air pollution in a high risk rate industrial area. *Environ. Eng. Manag. J.* **2018**, *17*, 591–599. [CrossRef]
25. 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. In *Green Energy and Technology*; Springer: Berlin/Heidelberg, Germany, 2018; pp. 99–111.
26. 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]
27. Sturiale, L.; Scuderi, A.; Timpanaro, G.; Foti, V.T.; Stella, G. Social and inclusive "value" generation in metropolitan area with the "urban gardens" planning. In *Green Energy and Technology*; Springer: Berlin/Heidelberg, Germany, 2020; pp. 285–302.
28. 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.
29. Guarnaccia, P.; Zingale, S.; Scuderi, A.; Gori, E.; Santiglia, V.; Timpanaro, G. Proposal of a Bioregional Strategic Framework for a Sustainable Food System in Sicily. *Agronomy* **2020**, *10*, 1546. [CrossRef]
30. Foti, V.T.; Scuderi, A.; Timpanaro, G. Organic Social agriculture: A tool for rural development. *Calit. -Access Succes* **2013**, *14*, 266–271.
31. IUCN—International Union for Nature Conservation. *Tourism and Visitor Management in Protected Areas—Guidelines for Sustainability*; Leung, Y.F., Spenceley, A., Hvenegaard, G., Buckley, R., Eds.; IUCN: Gland, Switzerland, 2015.
32. Mantić, A. Nature-based solutions for sustainable tourism development in protected natural areas: A review. *Environ. Syst. Decis.* **2019**, *39*, 249–268. [CrossRef]
33. Salerno, F.; Viviano, G.; Manfredi, E.C.; Coroli, P.; Thakuri, S.; Tartari, G. Multiple carrying capacities from a management-oriented perspective to operationalize sustainable tourism in protected areas. *J. Environ. Manag.* **2013**, *128*, 116–125. [CrossRef]

34. Timpanaro, G.; Scuderi, A.; Foti, V.T.; Lo Giudice, V. The Social Relationships' effectiveness of "agrisocial" farms: A model of sustainable local development. *Rev. Sustain. Stud.* **2015**, *1*, 99–116.
35. Schultz, L.; Duit, A.; Folke, C. Participation, adaptive co-management, and management performance in the world network of biosphere reserves. *World Dev.* **2011**, *39*, 662–671. [CrossRef]
36. Stoll-Kleemann, S.; De La Vega-Leinert, A.C.; Schultz, L. The role of community participation in the effectiveness of UNESCO Biosphere Reserve management: Evidence and reflections from two parallel global surveys. *Environ. Conserv.* **2010**, *37*, 227–238. [CrossRef]
37. Ferreira, A.F.; Zimmermann, H.; Santos, R.; Von Wehrden, H. A Social–Ecological Systems Framework as a Tool for Understanding the Effectiveness of Biosphere Reserve Management. *Sustainability* **2018**, *10*, 3608. [CrossRef]
38. Brenner, L.; Job, H. Challenges to actor-oriented environmental governance: Examples from three mexican biosphere reserves. *J. Econ. Hum. Geogr.* **2013**, *3*, 1–19. [CrossRef]
39. Durand, L.; Figueroa, F.; Trench, T. Inclusion and exclusion in participation strategies in the Montes Azules Biosphere Reserve, Chiapas, Mexico. *Conserv. Soc.* **2014**, *12*, 175–189. [CrossRef]
40. Felix, K.; Cornelius, M.; Hubert, J. Biosphere reserves and their contribution to sustainable development: A value-chain analysis in the Rhön Biosphere Reserve, Germany. *Z. Wirtsch.* **2014**, *58*, 164–180.
41. Abastante, F.; Lami, I.M. A Stakeholders-Oriented Approach to Analyze the Case of the UNESCO's Man and Biosphere Reserve CollinaPo. In *Values and Functions for Future Cities. Green Energy and Technology*; Mondini, G., Oppio, A., Stanghellini, S., Bottero, M., Abastante, F., Eds.; Springer: Cham, Switzerland, 2020.
42. Hein, T.; Blaschke, A.P.; Haidvogl, G.; Hohensinner, S.; Kucera-Hirzinger, V.; Preiner, S.; Reiter, K.; Schuh, B.; Weigelhofer, G.; Zsuffa, I. Optimised management strategies for the Biosphere reserve Lobau, Austria—Based on a multi criteria decision support system. *Ecohydrol. Hydrobiol.* **2006**, *6*, 25–36. [CrossRef]
43. Butti Al Shamsi, K.; Guarnaccia, P.; Cosentino, S.L.; Leonardi, C.; Caruso, P.; Stella, G.; Timpanaro, G. Analysis of relationships and sustainability performance in organic agriculture in the United Arab Emirates and Sicily (Italy). *Resources* **2019**, *8*, 39. [CrossRef]
44. Reed, M.G. The contributions of UNESCO Man and Biosphere Programme and biosphere reserves to the practise of sustainable science. *Sustain. Sci.* **2019**, *14*, 809–821. [CrossRef]
45. Bavington, D. Managerial ecology and its discontents: Exploring the complexities or control, careful use and coping in resource and environmental management. *Environments* **2002**, *30*, 3–21.
46. Williams, B.K. Adaptive management of natural resources: Framework and issues. *J. Environ. Manag.* **2011**, *92*, 1346–1353. [CrossRef]
47. UNESCO. MAB Strategy 2015–2025. Available online: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/MAB_Strategy_2015-2025_final_text.pdf (accessed on 15 October 2021).
48. UNESCO. Lima Action Plan for UNESCO's Man and the Biosphere (MAB) Programme and Its World Network of Biosphere Reserves (2016–2025). Available online: http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/Lima_Action_Plan_en_final.pdf (accessed on 15 October 2021).
49. Foti, V.T.; Scuderi, A.; Stella, G.; Timpanaro, G. Consumer purchasing behavior for "biodiversity-friendly" vegetable products: Increasing importance of informal relationships. *Agric. Econ.* **2019**, *65*, 404–414.
50. Terre della Biosfera. Le Valli Fluviali dell'Etna. Available online: http://www.terrebiosfera.org/ (accessed on 23 October 2020).
51. Pawlak, Z. Rough set approach to knowledge-based decision support. *Eur. J. Oper. Res.* **1997**, *99*, 48–57. [CrossRef]
52. Matarazzo, B.; Greco, S.; Slowinski, R. La teoria degli insiemi approssimati (Rough sets). In *Strategie, Introduzione alla Teoria dei Giochi e delle Decisioni*; Bertino, C., Gambarelli, G., Stach, I., Eds.; Giappichelli: Turin, Italy, 2019; pp. 165–217.
53. Greco, S.; Matarazzo, B.; Slowinski, R. *Rough Approximation of a Preference Relation by Dominance Relations*; ICS Research Report 6/96; Warsaw University of Technology: Warsaw, Poland, 1996.
54. Greco, S.; Matarazzo, B.; Slowinski, R. Rough sets theory for multicriteria decision analysis. *Eur. J. Oper. Res.* **2001**, *129*, 1–47. [CrossRef]
55. Słowiński, R.; Greco, S.; Matarazzo, B. Rough set methodology for decision aiding. In *Springer Handbook of Computational Intelligence*; Springer: Berlin/Heidelberg, Germany, 2015; pp. 349–370.
56. Kandziora, M.; Burkhard, B.; Müller, F. Interactions of ecosystem properties, ecosystem integrity and ecosystem service indicators—A theoretical matrix exercise. *Ecol. Indic.* **2013**, *28*, 54–78. [CrossRef]
57. Young, J.; Watt, A.; Nowicki, P.; Alard, D.; Clitherow, J.; Henle, K.; Niemela, J. Towards sustainable land use: Identifying and managing the conflicts between human activities and biodiversity conservation in Europe. *Biodivers. Conserv.* **2005**, *14*, 1641–1661. [CrossRef]
58. Greco, S.; Matarazzo, B.; Slowinski, R.; Stefanowski, J. An algorithm for induction of decision rules consistent with the dominance principle. In *International Conference on Rough Sets and Current Trends in Computing*; Springer: Berlin/Heidelberg, Germany, 2000; pp. 304–313.
59. Boggia, A.; Rocchi, L.; Paolotti, L.; Musotti, F.; Greco, S. Assessing Rural Sustainable Development potentialities using a Dominance-based Rough Set Approach. *J. Environ. Manag.* **2014**, *144*, 160–167. [CrossRef] [PubMed]
60. Ferretti, P.; Zolin, M.B.; Ferraro, G. Relationships among sustainability dimensions: Evidence from an Alpine area case study using Dominance-based Rough Set Approach. *Land Use Policy* **2020**, *92*, 104457. [CrossRef]

61. Greco, S.; Matarazzo, B.; Slowinski, R. Decision rule approach. In *Multiple Criteria Decision Analysis, State of the art, Strategy*; Figueira, J., Greco, S., Ehrgott, M., Eds.; Springer: Berlin/Heidelberg, Germany, 2005; pp. 507–561.
62. 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]
63. Parco dell'Etna. Studio Dei Flussi Turistici. 2020. Available online: unescoparcoetna.it (accessed on 25 October 2021).
64. Scuderi, A.; Sturiale, L.; Timpanaro, G.; Chinnici, G. The participatory planning for preservation and valorization of environmental heritage. In *New Metropolitan Perspectives 2020*; Bevilacqua, C., Calabro, F., Della Spina, L., Eds.; Springer Nature: Cham, Switzerland, 2021.
65. Butti Al Shamsi, K.; Compagnoni, A.; Timpanaro, G.; Cosentino, S.L.; Guarnaccia, P. A sustainable organic production model for "food sovereignty" in the United Arab Emirates and Sicily-Italy. *Sustainability* **2018**, *10*, 620. [CrossRef]
66. Matarazzo, A.; Maugeri, E.; Gullo, E.; Romano, P.; Spedalieri, F.; Licciardello, A. The Bioeconomy in Sicily: New green marketing strategies applied to the sustainable tourism sector. *Procedia Environ. Sci. Eng. Manag.* **2017**, *3*, 135–142.
67. Spadaro, G.; Nicotra, A.; Iurato, S.; Matarazzo, A.; Mannino, M. Environmental Management Strategies in Smart Sicilian Food and Technology Chains. *Procedia Environ. Sci. Eng. Manag.* **2020**, *7*, 185–193.
68. Scuderi, A.; Sturiale, L. Multi-criteria evaluation model to face phytosanitary emergencies: The case of citrus fruits farming in Italy. *Agriculture* **2016**, *62*, 205–214. [CrossRef]