



Digital technologies for the development of sustainable tourism in mountain areas

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ABSTRACT

The promotion of sustainable tourism models in mountain areas represents a critical success factor for the territory and the environment. In political and economic literature there has been much debate in the attempt to interpret the phenomenon of growth and development with the changing socio-economic environment. Today the topic remains at the center of the debate of many economic policy authorities due to the exodus phenomena occurring in internal areas. In this study, we examined how the resources of mountain areas can create income opportunities as a function of the diffusion of sustainable income. On the one hand, in mountain environments, we have natural resources that represent common goods that must be maintained precisely according to the opportunities they create for sustainable tourism where they represent its essential feature. The complexity of the economic phenomena, which on the one hand leads to an exodus from these environments, determines the need to create new management structures, that can satisfy the needs of the local community and guarantee appropriate management of natural resources. In this study, we analyzed the relationships between sustainable tourism models and natural resource management considering the case of the Ficuzza Forest and applying new digital technologies such as mobile apps that allow you to make hotel reservations, read reviews about the best restaurant in the area, and buy museum tickets to avoid the queue. Starting from the theoretical framework, and subsequently analyzing the empirical case, we highlighted the utility flows that descend from the Bosco. The resulting results have considerable relevance for the planning of mountain territories. The study highlights that the interconnection between public and private management models can guarantee the growth and development of mountain territories.

1. Introduction

After the COVID-19 pandemic period, the tourism sector is experiencing strong growth [15]. In developed countries, the tourism sector performs well and developing countries also perceive tourism as an opportunity for growth and development [4,5]. Talking about tourism today means talking about the sustainable paradigm of tourism activities. Today, despite the definition of sustainable development [1], there are further definitions and tools on the topic which are often inconsistent. This situation is the result of the evolution of the concept of sustainable development and the spread of tourism which takes on new contours. If we want it in rational terms, the definition of sustainable development is from the perspective of a "person who thinks about the future" not as something that does not belong to him but as something that enters into his objective function. Hence the definition of sustainable development and such development must satisfy the needs of

current generations without compromising the ability of future generations to satisfy those same needs [18]. Other definitions of sustainable development highlight the role played by the environmental component [21], and therefore tourism activities must also take into account the environmental constraint when designing tourist growth paths understood as sustainable development. So if on the one hand we started with a definition of sustainable development, over time this has been expanded and modified in an attempt to define the concept more coherently, thus allowing its extension to a series of development areas: landscape, cultural, gastronomic. In all these activities where tourism represents a source of value creation, planning must take sustainability into account. Therefore, if in the past tourist activity was seen as an activity divorced from the environment, over the years we have moved towards a definition of tourism where the constraints of natural resources must be taken into due consideration. Tourism that respects the environment where it finds a source of competitive advantage. Natural

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resources are the engine of tourism linked to rural areas, landscape, and gastronomy and are a function of the usefulness of natural resources and the production of ecosystem services vital for the entire planet Earth. We can therefore consider natural resources as inputs into the economy and their availability is a determining factor within the entire economic and tourism system. Considering tourism is linked to natural resources, and that tourism finds the source of competitive advantage in natural resources, the non-renewability of natural resources requires their use to be planned in the most efficient way possible. Therefore, the use of natural resources, which constitute the source of the competitive advantage of territorial tourism, requires planning according to the needs of man living in a given time without compromising the needs of future generations. Indeed, it should not be forgotten that natural resources provide a wide range of ecological services that not only function as direct inputs into the economic system but are also involved in the regulation, support, and coordination of the Earth's ecosystem [16]. Even climate changes, together with the ecological limits dictated by limited natural resources, lead us to consider that tourism activities linked to natural resources must be planned to have a positive impact on the ecosystem in the medium and long term. The increase in per capita income in developed economies has led to a connection between globalization and tourism. The growth in tourist demand, and the economic effects that it produces, also in terms of dangers to the environment, lead us to think that the growth of tourism must develop within a sustainability paradigm. Activities related to tourism development require an adaptation of the sustainability paradigm. This is particularly suitable for mountain areas where sustainability must take into account environmental and landscape constraints of considerable importance. Some authors [13,21] have highlighted, and have debated a lot, the particular conditions that mountain areas have at this time, their limitations, and their opportunities for growth and development based on potential demand. In this scenario, the objectives of this research are twofold: on the one hand, we want to understand the mountain ecosystem and identify its possible utility flows, enhancing those that best satisfy tourist activities and recreational purposes; identify the most appropriate tools to manage utility flows based on sustainable principles that integrate tourism activities. This analysis is conducted using a case study—the Ficuzza Forest—and then connected to a more general framework. In the present study, after having made a review of the goods and services provided by the woods of the Apennine area, we focused on their possible use for tourist and recreational purposes based on new digital technologies. The digitization of the tourism sector assumes particular importance for the creation of ultra-broadband coverage of areas of cultural interest, of an open type of wireless access usable by citizens and tourists alike. These proposals stem from an indisputable fact: a tourist, in the course of his or her trip, increasingly relies on his or her smartphone or tablet to search for a restaurant to eat at, a museum to visit, or a hotel to sleep in. Mobile marketing is inextricably linked to tourism, and a company or facility active in this sector cannot help but take advantage of this trend if it wants to stand out from its competitors [3,8,19]. For example, making an app that knows how to meet the real needs of tourists by providing answers in an easy, intuitive, and immediate way is a great way to improve one's offerings and increase brand reputation (and is, of course, a big advantage over the competition). Next, we analyzed the sustainable management of a mountain landscape. We then discussed the case study on the mountain management of the Ficuzza Forest. This study aims to make a cognitive contribution to the enormous potential that mountain territories have for growth and economic development linked to the tourism sector, all from a sustainability perspective.

2. The goods and services of the forests

2.1. Economic impacts

Forests provide a variety of ecosystem services. They produce wood,

supply us with clean drinking water, regulate the local climate, contribute to the conservation of biodiversity and living spaces for animals and plants, protect against natural dangers, and provide recreational spaces for humans. Furthermore, forests absorb a lot of carbon and thus represent the earth's largest reservoir of CO₂. Using the widely accepted definition that the services provided by ecosystems can be defined as "the benefits that people obtain from ecosystems" [14] allows us to understand not only how an ecosystem such as a forest contains all types of services but also how the utility flows it generates have both local and global effects. Similar results are obtained starting from an alternative definition that distinguishes between environmental services and goods: the former is the availability of services provided by a natural resource, and the latter is the flow or stock of capital that it represents [7].

2.2. Environmental benefits

In the particular case of forests, as previously mentioned, both the environmental services they provide and their products are numerous. Wanting to make a classification of forest ecosystems, we can distinguish four different categories: carbon sequestration, biodiversity conservation, protection of aquifers and hydrogeological functions, the beauty of the natural landscape, enjoyed through forms of contingent use such as tourism and ecotourism or contemplation, and awareness of spiritual values [23]. This last function involves a strong relationship between at least three elements: nature, culture, and local community. These three aspects highlight the role played by culture and local communities in the management and use of natural resources [22]. In a forest management context, this concept further emphasizes the multifunctional dimension of the forest. This aspect is of particular importance today due to the new vision we have of the environment and natural resources. A growing awareness of the multifunctionality of the forest has led to their widespread management from this perspective: recognizing both the functions mentioned above and the numerous other services and goods provided by the forest, this approach underlines the need to plan forest management in two phases. The first is the identification of the significant functions performed by the forest for the ecosystem; the second is the identification of the type of forest management most suitable both for carrying out these functions and for obtaining these products and services. A forest system is no longer seen only as a supplier of wood products, but also of different goods and services, which satisfy multiple social needs and offer new opportunities for use [20].

2.3. Socio-cultural influences

The demand for goods and services provided by the forest is increasingly diversified and the ability to satisfy such multiple needs is, therefore, changing and increasing. This transformation poses problems of compatibility and coexistence both for forest management itself and for the satisfaction of the claims of local communities. The fulfillment of the functions of the forest can be understood at two levels: global and local. The first refers to the general functions obtained from particular forest management models; the latter involves other functions linked to the production of goods and services that can both satisfy the needs of local communities and generate additional sources of income for them. Forest management capable of achieving both these objectives is necessary for long-term sustainability and operational and management methods are therefore necessary that simultaneously guarantee long-term sustainability and allow products and services to be translated into sources of income for local populations [9]. This production represents potential utility streams capable of satisfying a variety of consumer demands, although their appropriation and management are not always conflict-free. From this point of view, landscape is one of the most controversial utility streams involved in forest management. The most critical issues concern not only the definition of landscape and the determination of its value but also the determination of access,

conservation, and management of resources which can be understood as the multiple flows of utility generated by this ecosystem.

3. Wooded landscapes from the point of view of tourist use

The role of the mountain landscape is widely recognized in the literature and includes various meanings and facets [21]. The landscape represents an environment that is shaped by a man who, for his own needs (to do business or spend free time), also shapes it according to constraints. In other words, a man who settles in a natural environment adapts and shapes it, creating the landscape, according to his own life needs. If these needs are linked to business activity, viticultural, olive, citrus, etc. landscapes are created. An essential feature of these landscapes is that they are created by man for the exercise of business activities. Therefore, in light of the definition we have given, namely that the landscape is the result of continuous changes caused by the interaction between human activities and the environment, this involves two considerations. The first consideration concerns the vision and study of the factors that determine such transformations of landscapes; the second vision concerns the evaluation of the landscape which, depending on the continuous changes to which it is subject, must be dynamic and adapted to the particular historical context of the area, clearly the dynamism must be in full respect of the environment [10]. If we consider mountain tourism, it finds its source in the mountain landscape. The mountain landscape represents the driving force of recreational activities and the mountain landscape itself represents the main source of tourist attractiveness [2]. A tourist goes to the mountains for the beauty of the landscape. In the mountain area, by landscape, we mean all the elements, both natural and man-made, which include the socio-cultural characteristics of agricultural activity, pastoral activity, and mountain forests [11]. In particular, Briassoulis [2], in analyzing the relationship between common natural resources and sustainable tourism development, defines the landscape as a source of tourist attractiveness. The mountain landscape formed by the forest can perform various functions in the field of tourism. It can be functional for tourist activities, either as a "source of resources" (i.e. through the forest we can develop certain activities) or simply as a landscape backdrop to enjoy. In the first case, the mountain landscape of the forest is seen as a resource that can be used by the consumer as in the case of adventure parks. In this case, only a limited area of forest is used but access to it is regulated to guarantee exclusive and specific use of the resource. In the second case, the wooded landscape constitutes a general resource, without a single specific recreational use. The affected area is very large but well-delimited. However, exclusive use cannot be guaranteed. The description of the value and function of forest landscapes as a strategic variable of tourism activity revealed two important characteristics that determine consumers' opportunities to access and use forest landscapes: excludability and rivalry. The economic utility of all landscapes, including wooded ones, can be usefully framed through these two characteristics. Natural resources in general and mountain-provided resources such as forests, in particular, are becoming increasingly sought after and subject to competing claims for their use. Consequently, it is necessary to devise new governance models to manage and assign economic value to these resources to create effective tools for their correct maintenance and use. There is a wide range of tools and intervention mechanisms for the management of natural resources [21]. Payment for environmental services (PES) systems are financial mechanisms for commercializing natural goods and services through the introduction of incentives that encourage local actors to produce the relevant goods and services. Other mechanisms include integrated conservation and development projects and sustainable forest management practices aimed not only at encouraging management strategies that guarantee the availability and quality of these assets over time but also at raising awareness among local populations of the presence of these environmental services and guaranteeing them an additional source of income.

4. Sustainable forest landscape management and information technology

For the management of mountain landscapes to be sustainable in the long term, it must be adequate and guarantee sufficient income to the local population in such a way as to allow man to remain in the territory. Adequate mountain management requires that the production of those goods and services that constitute the utility flows for an ecosystem and its local population is guaranteed. Without these goods and services, the local population could not survive. In the mountains, there must be a coexistence of forces ranging from the primary sector to the secondary to the tertiary sector. Together with the mountain landscape, made up of woods, animals, and pastures, a series of activities must be developed that are capable of generating additional income for local populations. This management must be able to provide additional income to local populations. In mountain landscapes, the link between local populations and the forest involves a process of continuous transformation. This transformation process is the result of interventions carried out by man according to his socio-cultural needs which have shaped the mountain landscape. The man who settles in an environment adapts it according to his own needs and according to the new needs that arise in society. The connection between local populations and the mountain landscape is very important for communities living in mountain environments. The conservation and management of the mountain landscape in a given community is often an expression of the connection between that community and its surrounding environment. Traditionally the mountain environment was considered hostile to human settlement and its production and transformation activities; an environment where production costs are higher than in hilly and plain environments. To survive and carve out a life in the mountains, over time, man has been forced to adapt to the socio-economic environment. In the era of the globalized economy, we ask ourselves whether this situation can still be pursued. The answer to this question depends on the age of the man. In fact, for older generations, living in harmony with the forest also brings satisfaction based on their life ambitions which are all in harmony with nature. For the new generations, this situation is not feasible based on the needs they have. Then we need to think about multifunctional management of the forest, taking into account the multiple potential products and related sources of income. Indeed, one of the most important functions of adequate forest management, in addition to obtaining raw materials, such as wood from forests, is the conservation of the landscape and natural resources as a backdrop for recreational activities and the preservation of natural heritage [21]. Forest management must be multifunctional, take into account the forest's status as a public good, and must be able to provide local populations with sufficient products and services so that they feel that the forest represents a source of income and therefore as an economic multiplier capable of generate goods and services. Depending on this vision of the forest, which represents the vision that determines growth and long-term economic balance, the appropriate tools to promote such management imply a mix of self-government of public goods and the introduction of payment mechanisms. After describing this entire scenario we must highlight that the role of forests for tourism activities must consider network technologies. In particular, the Internet has also changed how tourists relate to tourism. It has expanded the possibilities for choosing and organizing free time for holidays. In particular, the change is observed in the phase in the collection of information relating to the places to visit, the trip, the accommodation facilities, the decision-making process, the planning of the trip itself, and the purchase of the related services. But the most important transformations in the way in which tourists relate to tourism have been set in motion in the last decade with the transition from the static web of the nineties to the so-called dynamic web, or web 2.0 [17], which makes it possible not only to consult portals and search engines but also to interact with users on the internet. All these digital innovations, such as mobile technologies (smartphones, tablets, etc.), apps, geolocation, and social networks,

have extended the use of the internet also to the consumption and post-consumption phases, contributing to making the experience increasingly satisfying, engaging, and personalized tourism. Applications and social networks are used by tourists not only to search for information but also to share experiences in all phases of the trip and subsequently, contributing, in fact, to redefining the tourist offer. For historical environments and particular locations, information technologies have become a tool from which to acquire information and to use to define marketing, image, and reputation strategies [12].

5. Materials and methods

The Ficuzza Forest is located in the heart of the Palermo hinterland in an area of approximately 7400 hectares of dense forest which, like a green spot, extends along all the hills of this area of Sicily. At the beginning of the 19th century, after being saved from deforestation due to the impervious territory, this wonderful wooded area falling between the municipalities of Monreale, Mezzojuso, Godrano, Marineo, and Corleone, was purchased by King Ferdinand III of Bourbon who made it his hunting reserve. On that occasion the King himself had the splendid Royal Hunting Lodge built which still today, like a hospitable hostess, presents itself in all its splendor at the entrance to the reserve to welcome the numerous hikers and visitors who come to Ficuzza to enjoy this lush protected area. In the following years, right around the Casina Reale, various housing structures began to arise which over time constituted what is now the very small village of Ficuzza, a hamlet of the municipality of Corleone which only has around 200 residents. The Reserve represents the largest forest in western Sicily and is a protected natural area of the Sicilian Region. The reserve area includes the Bosco della Ficuzza, the Rocca Busambra, the Wood of Cappelliere, and the Gorgo del Drago and since 2013 it has become part of the Monti Sicani Park. This is home to approximately 80 % of the animal species present in Sicily, including birds and wildlife. There are numerous species of birds of prey including the golden eagle, the peregrine falcon, the Egyptian vulture, the black kite, and the red kite; then there are many mammals such as the fox, the wild cat, the weasel, the marten, and the wild boar. As regards the flora, however, it is made up of splendid arboreal specimens that dot the forest (holm oaks, cork oaks, deciduous oaks, oak oaks, field maples, chestnut trees), and many endemic species among which the Busambra cornflower, the Boccone perlina, stand out the fennel from Boccone, the "ciomolino" from Sicily, the wonderful Sicilian snapdragon, and the Tineo violet. Finally, what characterizes the reserve is the variety of its environments, from woods to shrublands, from rocky and semi-rocky areas to river areas, from prairies to garrigues, which make this part of Sicily a truly enchanted place. Tourism development plays a role of primary importance, both in the use of the resource and in adequately valorizing it and therefore in preserving and maintaining it in the long term; the Ficuzza Forest represents a distinctive feature of the territory which characterizes the territory as suitable for recreation, thus offering economic opportunities through the creation of valid alternative ways to generate supplementary income. Several restaurants have opened near the Bosco which offer gastronomic excellence based on recipes from the Sicilian cuisine of the past. Valorization for tourism purposes is only one of the potential uses of this resource and the economic benefits for local populations are, in turn, only one of the needs that the resource is called upon to satisfy. We must not underestimate the other useful elements provided by the forest landscape and by the forest as a whole. However, to ensure long-term sustainable management of the Forest, all these interests and functions must be considered together in a multi-objective function. The critical aspects of management arise from the coordination of all the aspects that must be kept in mind in the sustainable tourism system of mountain areas. This aspect is of particular importance and requires careful planning. Given the high complexity of the organizations and interests, ensuring sustainable management of the Ficuzza Forest is not simple. In particular, tourism development faces some limitations related to the

large number of stakeholders and utility flows that are not complemented by adequate compensation mechanisms and tools. Furthermore, a necessary condition not only for attracting tourist flows to mountain areas but also for maintaining a competitive position on the part of established tourist destinations, is that the offer is visible, accessible, and usable by tourists through digital technologies. The presence of social networks is fundamental, which now accompany and influence the tourist in all phases of the trip [6], as is the availability of downloadable applications on mobile devices capable of making the tourist experience increasingly satisfying and engaging. In the study, we interviewed an experimental sample of potential tourists explaining the Komoot app where you can find and customize adventures in the surroundings of Bosco Ficuzza, navigate with ease, and much more. The subjects interviewed were selected by going to the Bosco di Ficuzza in the period from August 2023 to January 2024. The number of interviewees responded to the objective of the study which is to understand how mountain tourism can spread with digital applications therefore we did not proceed with probability sampling but with a reasoned sample.

6. Results and discussions

The units surveyed (570 units) were asked to download the app and analyze it and then to express an opinion on the app and whether it was helpful concerning the objectives of the person interviewed. Almost all of the interviewees were fully satisfied and declared that the app was useful for what they requested. Mountain landscape management is extremely complex and involves a wide range of factors. In recent times, the management of public goods implies a new relationship and a new vision that affects local communities. The Ficuzza Forest examined in this study is an excellent example of this situation. The multiplicity of uses is due both to the extraordinary importance of the landscape from the point of view of fauna and the ecosystem in general, and to the numerous opportunities it offers for tourism. The mountain landscape of the Bosco di Ficuzza performs at least two functions within the local tourist offer: it is both an asset in its own right and a backdrop for carrying out recreational activities. Although these uses undoubtedly constitute potential sources of income for the local population, their conservation, and maintenance also entail positive externalities and high costs. Management is not facilitated by the numerous public and private stakeholders. In this scenario, the solution could be a form of territorial self-government understood as a form of control of growth and development. Self-government of the territory between public and private draws up a growth plan for businesses and the territory in general, which also pays attention to those aspects that make the territory usable in all aspects from the gastronomic, hotel, and hospitality aspects of the territory in general. Self-government imposes forms of control that can guarantee the effectiveness of the action carried out for the territory. The introduction of payment mechanisms, for tourists or visitors, is another solution that goes with a view to growth and self-financing. These resources should constitute a direct source of income for local populations, simultaneously covering, at least in part, the costs incurred for the conservation and management of the resource. In the case study of the Ficuzza Forest, the cost of use is the compensation generated by the flow of utility of the Forest itself. The implementation of a system of management tools for the Ficuzza Forest, which due to the specific characteristics of its utility flows, must necessarily be complex, and must take into account the large number of stakeholders involved in the governance system (Region, local population, Municipality, businesses, restaurant activities, hotel facilities in the area). It is therefore imperative that the implementation of these management tools takes into account the peculiarities of the local system without which the territory could not be governed for a good use of the Forest itself. A combination of management tools based on the involvement of the parties involved is necessary in order not only to preserve and implement the utility flows generated by natural resources. Therefore, the utility flows generated by

the Ficuzza Forest require the right mix of management tools. The management of the Forest should adopt a multifunctional approach to maximize the flow of expected services. This approach must start from the recognition of those assets that require a public management regime which are represented by the conservation of biodiversity, the protection of aquifers, and the improvement of hydrogeological functions which should find adequate payment mechanisms for tourist activities. These tourist activities can be based on the direct use of the forest, in this case, we speak of use value, for example, adventure parks, and/or on indirect or fundamental use, in this case, we speak of landscape or optional value such as thematic paths. Activities such as hunting, fishing, or gathering small fruits, truffles, and mushrooms should follow common property management regimes for community members and payment mechanisms for non-community members. Limiting the availability of permits allows us to reward forest management systems that preserve and increase these resources and fully regulate their consumption, thus preventing excessive exploitation. Instead, for those service flows with more clearly definable market values (such as timber), payment mechanisms are the most appropriate management tool. Mountain areas are a complex system where a diversity of actors and objectives come into play.

7. Conclusions

The long-term survival of mountain areas for tourism is mainly linked to a new collaborative approach between different stakeholders. However, the development of tourist activities based on the goods and services generated by the forest certainly offers an economic opportunity for local communities, since such activities can create additional sources of income, and integrate those traditionally provided by the forest. However, these opportunities are today significantly linked to the services that the territory can provide and above all to the IT services that represent a communication strategy for the territory in the smart-phone era. According to the sustainable development paradigm, appropriate mountain management that includes recreational needs can offer a range of opportunities and provide a long-term perspective. From this perspective, digital technologies appear increasingly important. These technologies allow us to overcome some limitations and act as a source of global knowledge for all those territories that otherwise would not have a voice. Digital technologies, specifically the app taken into consideration, prove to be a useful tool for tourists to achieve their objectives and respect the environment. The app also responds to effective and efficient requirements for the economic entity as it allows the tourist to achieve the objective of building his/her itinerary in the shortest time possible and choosing the best opportunities offered by the area. The app also allows you to achieve economic and environmental sustainability objectives. A limitation encountered in the research that would deserve an expansion in the study is to verify an expansion of the potential offered in the app, this would certainly deserve a more detailed study in terms of the interconnections that would be established for a better sustainable growth of the territory.

Ethical

I declare that the drafting of the paper “Digital technologies for the development of sustainable tourism in mountain areas” respects international ethical standards.

CRedit authorship contribution statement

Filippo Sgroi: Writing – review & editing, Writing – original draft,

Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Federico Modica:** Writing – original draft, Formal analysis.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Data availability

Data will be made available on request.

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