Article

Parametric Definition of Slow Tourism Itineraries for Experiencing Seasonal Landscapes. Application of Sentinel-2 Imagery to the Rural Paddy-Rice Landscape in Northern Italy

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Abstract: Slow tourism is a growing phenomenon in Italy; it is assuming a key role in the definition of new strategies for sustainable tourism for the enhancement of landscape and cultural heritage, but also as a driver for the revitalization of marginalized and inner areas of the country. In this framework, the aesthetical phenomena related to seasonal landscape changes (e.g., autumn coloring foliage, spring blooming, controlled paddy-rice fields flooding) that occur in specific environments are emerging as new tourist destinations and are of major interest for the experiential tourism sector. This research shows a GIS-based method to draw up parametric slow tourism itineraries, which are defined according to seasonal landscape changes, by exploiting the high frequency of Sentinel-2 data acquisition. The algorithm defines parametric itineraries within the network of existing local roads by detecting the current landscape conditions through NDVI. The algorithm has been tested in the study area, within the historical agricultural landscape of paddy-rice fields in between Turin and Milan, where high scenic conditions related to the flooding occur over the spring season. This tool can support a range of end users' decisions for the creation of a widespread tourist destination offer year-round, with the aim to promote more sustainable and balanced use of the places and reduce overpressures in the most frequented places.

Keywords: sustainable tourism; slow mobility; cycle tourism; seasonal landscape; Sentinel-2 imagery; parametric itineraries; NDVI; GIS

1. Introduction

In the last decade, the initiatives related to sustainable tourism and particularly to the phenomenon of slow tourism, walking and cycling, have grown in Italy as an opposite form to mass tourism [1,2]. Many actions have been undertaken also in Europe with the aim of supporting the widespread diffusion of sustainable tourism: Cultural Routes of the Council of Europe, which enables new synergies between national, regional and local authorities [3]; the transformation of abandoned railways into greenways; the design of a new sustainable trans-European cycle network, such as EuroVelo, that enables slow connections between European countries [4]. Nowadays, tourists are looking for an authentic and profound travel experience through the landscape marked by the slowness, a desire for escaping, with responsible behavior to the natural environment and gatherings with inhabitants, to better appreciate the local identities and the unique landscapes of a precise territory [5–9]. In a broader sense, the experience economy, mainly based on the active participation of the users and on the strong environmental relationship with surrounding space, shows that consumers unquestionably desire experiences [10], but they are also seeking unusual places to visit and new activities to undertake [7].

In this framework, new locations characterized by high scenic phenomena related to the seasonal landscape changes (e.g., spring blooming, autumn coloring foliage, controlled floods in the countryside) are emerging as new tourist destinations [11,12]. Landscape and tourism are strongly interlaced, in the sense that landscape, especially when it is considered

from an aesthetical point of view, from the outside, is revealed as a factor of attraction for tourism [13–16]. In the tourism sector, new digital tools are required to support regional and local authorities in defining new strategies for tourism development to enhance the users' experiences through the seasonal landscapes.

In this context, the two main research questions to which this article tries to answer are: how to map seasonal landscape changes, localized in specific environmental contexts, according to their spatial-temporal evolution? How to draw up slow tourism itineraries which automatically adapt to the seasonal landscape changes?

Therefore, the main aim of this contribution is to define a tool for mapping new unconventional slow tourism itineraries to experience seasonal landscape changes.

In this perspective, specific knowledge of the location and of the timing of these landscape phenomena is required in order to map itineraries within the existing local roads network and in relation to the site-specific environmental constraints. A GIS-based method is proposed to map parametric slow tourism itineraries, which automatically adapt to the seasonal landscape changes by exploiting the potential of remote sensing (RS) mapping techniques.

2. Theoretical Background

Detecting seasonal landscape changes for tourism development of a territory is a very challenging and complex research topic, which requires a multidisciplinary-based approach, which involves many research fields such as landscape, tourism, remote sensing, mobility and regional planning. This section provides insights about the seasonal landscapes topic in relation to tourism and RS applications for mapping such landscape conditions, which are the most relevant fields of investigation in relation to the scope of this research.

2.1. Seasonal Landscapes and Tourism

The visual character of the landscape is a key factor for the overall quality of a tourist/recreational experience [17]. According to the European Landscape Convention, the landscape has been defined as an area as perceived by people whose character is the result of the action and interaction of natural and/or human factors [18]. On the one hand, this definition implies a dynamic concept of the landscape that evolves over time due to the strong interaction between natural and human factors; on the other hand, it implies a relationship with the people's perception. Particularly, this research refers to the aesthetical dimension of the landscape and its scenic features, which are based on the mutual interaction between the observer and observed reality [19]. The perception of the aesthetical features of the landscape varies from person to person. It is a complex topic that is related to many subjective factors. In the literature, there are many examples that try to establish assessment methods for visual landscape preferences. In this complex topic, many variables are taken into account: inhabitants' and tourists' points of view [20], different spatial landscape features in relation to the observer point of view [21], level of naturalness and human-made interventions and presence of architectural heritage [22].

Seasonal landscapes describe phenomena that, although they may be short and transitory, are recurring and rhythmical on a regular annual basis [23]. The seasonal landscape changes do not affect the structure of the landscape, but they influence our perception of places and our daily activities in different hidden ways [11]. Landscapes can be characterized and recognized by their expressions, in terms of colors and shapes, which provide information about the location and time of the year. In a more synthetic way, seasonality can be defined as the link between the colors and shapes in the landscape and the time of the year [24]. Seasonal changes in vegetation are generally appreciated by tourists [12]. Seasonality influences the perception of the aesthetic features of the landscape that attract people in different ways; seasonal changes can be more attractive in specific environments such as forests, vineyards, grasslands, paddy-rice fields; over the year, these places become major attractions for the tourism sector, due to the high scenic value of phenomena that

characterize themselves. In that sense, the phenomenon of the flowering of cherry trees in the spring; for example, the Ohanami cherry blossom festivals in Japan and the national cherry blossom festival in Washington DC [25]; the autumn coloring of fall foliage touring in Canada, US and Europe; the flooding of terraced paddy fields in Japan, Vietnam, Philippines and Italy are pursued by travelers as a tourist destination [26–30]. Nevertheless, a distinction between natural landscapes and the rural landscapes is necessary; for example, mountainous landscapes, characterized by woods, are mostly related to the phenology of the plants and to the climate factors such as temperature and humidity; rural landscapes, such as paddy-rice fields, change their aspect due to the mutual combinations of natural and human factors.

In choosing a place to visit, people are influenced by the seasons. In the most recent years in Italy, according to the expansion of slow tourism, the aesthetic phenomena related to seasonal landscape changes localized in specific environments are increasing in their appeal and are emerging, at a certain time of the year, as alternative tourist destinations (e.g., the spring blooming in Castelluccio di Norcia in the Umbria region, the blooming of lavender in Sale San Giovanni and the autumn coloring foliage at Oasi Zegna in the Piedmont region). This research tries to highlight the potential of such tourism destinations in the field of sustainable tourism as a driver for the revitalization of the remote and inner areas of the country. In that sense, in recent year policy-makers, both at European and national levels, have been drawing up territorial development plans inspired by sustainability principles and slow tourism to enhance inner places and revitalize local economies [9,31–33].

2.2. Mapping Seasonal Landscape Changes through RS

Nowadays, in the tourism sector, no effective tools are available to help travelers to better plan their trips according to the seasonal landscape changes. For instance, to predict the fall coloring peak, which is a tourism destination in several countries of the world, only reports or rough maps based on meteorological data and users' generated content are available through the web [34–37].

Mapping seasonal landscape changes with high spatial-temporal resolution require more powerful observation tools that enable the tracking of georeferenced information on a map. Many research advances have been made over the last decades on earth observation with the aim to better understand and monitor the behavior of the atmosphere, land and oceans [38,39]. The most appealing seasonal landscape changes, which are of major interest in the tourism sector, are related to vegetation, which is tuned to the seasonality of its environment [40]. The phenology of plants can be detected by exploiting the potential of computing vegetation indices (VIs) [41,42], which are sensitive indicators also for detecting seasonal landscape changes. Detailed and punctual information about vegetation phenology, on limited-size contexts, can be obtained by applying RS technology at ground level and by recording time-series imagery through specific digital cameras [43]; georeferenced information, on large-scale contexts, can be obtained using satellite observations, which provide high spatial-temporal resolution multispectral imagery (MSI) [38]. Most of the RS applications are dedicated to monitoring land use changes in order to investigate agricultural crop status [44–47], forest ecosystems [48,49] and water bodies [50–52]. Few RS applications seem to be devoted to support the tourism sector. Nevertheless, by exploiting time-series datasets from satellite observation, change-detection of seasonal landscape phenomena can be performed by GIS mapping techniques. Regional-scale mapping can be performed by exploiting the high return time of satellite observations and their high spatial resolution [38].

3. Materials and Method

3.1. Study Area

The research has been applied to the historical agricultural landscape of paddy-rice fields in between Turin and Milan, northwest of Italy, which is one of the largest and

the most productive areas in Europe for rice cultivation [53]. This landscape, apparently characterized by a flat morphology, is slightly sloped from the northwest to the southeast, which roughly corresponds to the direction of the rivers coming down from the Alps (Figure 1) [54]. Rice cultivation has thus rationally exploited this natural course of the land for making terraced fields [55]. Over the century, this landscape has been modeled by the Cistercian monks in the XII–XIII centuries, which gave an extraordinary contribution for land reclamations through the construction of a widespread network of canals that supports the rice cultivation.
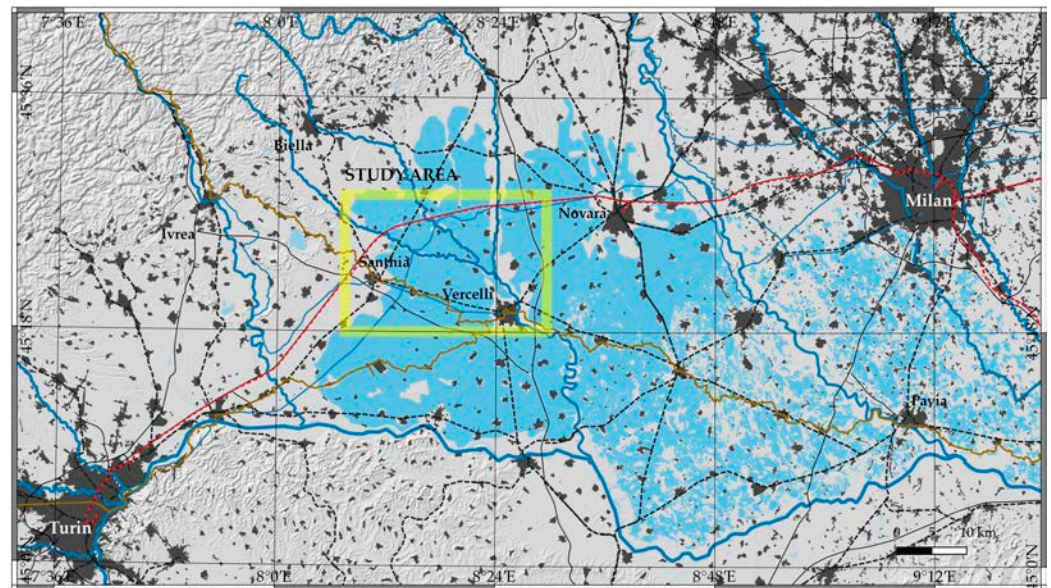

Figure 1. Map of the rural landscapes of paddy-rice fields in between Turin and Milan. The map highlights the hydrographic network that supports rice cultivation. The map has been generated by integrating geographical datasets from the Piedmont and Lombardy regions. The yellow rectangle highlights the study area, between Vercelli and Santhià, that has been analyzed.

In the XIX century, this landscape was subjected to another important infrastructure investment, with the Cavour canal construction, that has implemented the water provision for agricultural purposes in this area [54]. Over the spring season (March, April and June), each farmer, independently, takes the decision to flood their own paddy-rice fields over the seeding stage. Many factors are taken into account by the farmers to fix the best moment to flood paddy-rice fields: temperature, weather forecasts, water availability, rice typology and farm management. In terms of aesthetics, this is the most attractive stage. At the scale of the landscape, the flooding phenomenon becomes much more attractive for tourism when several territorial portions are flooded. The resulting effect is a sort of squared sea, surrounded by rows of trees, historical farmhouses and small rural hamlets that reflect themselves in the water (Figure 2). The duration of the floods is variable for each field because of the thermal insulation effect that the water generates on the growing plants. It is essential to protect them in the first growing stage from thermal variations [56]. A few days after sowing, water is removed from the paddy-rice field to allow the rice plants to take root well in the soil. Then the field is flooded again. The monitoring of these activities, of filling and emptying of the paddy-rice fields, carried out by each farmer independently, has a great influence on the perception of the landscape as a whole. Particularly, the single activities of each farmer affect the people's visual perception, especially when this landscape is seen on a large scale. The algorithm has been tested in the study area, which has been chosen between the towns of Vercelli and Santhià. This area is recognized as one of the most attractive territories to experience the flooded paddy-rice fields, in terms of slow tourism, because it is also crossed by the Via Francigena (Figure 1).
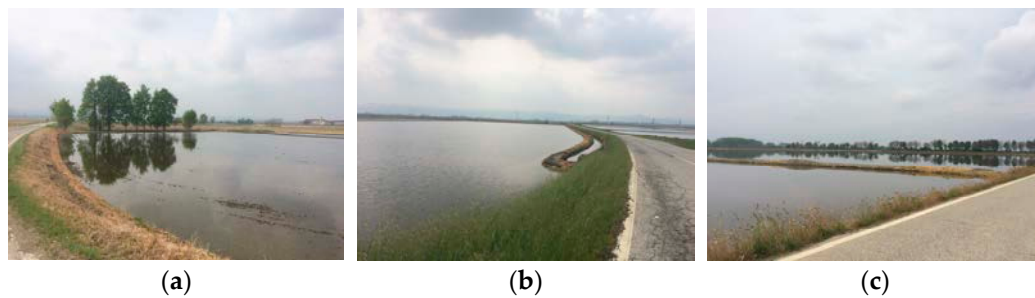
(a) **(b)** **(c)**

Figure 2. Pictures (**a**–**c**) were taken on 28 April 2021. Photograph survey over the flooding period of paddy-rice fields in the area within Leri Cavour, Lucedio and Fontanetto Po, northeast of Turin city.

3.2. Materials

The materials that have been used in the current research are MSI from RS observations by satellite Sentinel-2, VIs that enable mapping seasonal landscape changes and open route service (ORS) API services to draw up slow tourism itineraries.

In the field of RS, the European program named Copernicus, supported by ESA, French Space Agency (CNES) and EUMETSAT, enables the dynamic monitoring of land, marine environment, atmosphere and climate change, but also for security management, by seven Sentinel satellites in orbit [38,57,58]. Sentinel-2 is a wide-swath, high-resolution, multispectral imaging mission supporting Copernicus land monitoring studies. It is a system of two polar-orbiting satellites, in the same orbit, phased at 180° to each other, that provide spatial data. The twin Sentinel-2 satellites enable the detection of landscape changes under cloud-free conditions every 2–3 days at mid-latitudes [59]. In the rural landscape of paddy-rice fields, the high temporal resolution is a key factor to capture the floods. Data products from Sentinel-2 are tiles 100×100 km^2 ortho-images, in UTM/WGS84 projection, which allow monitoring changes on regional-scale contexts. The Sentinel-2 mission provides MSI, containing 13 bands, that shows the reflected radiance from visible and near-infrared (VNIR) to short-wave infrared (SWIR) at different spatial resolutions (10, 20, 60 m) [60]. For the purpose of the current research, only bands from visible and near-infrared, 10 m resolution and a minority of 5% cloud cover have been taken into account. The Sentinel-2 data acquisition is freely accessible on the Copernicus open access hub [61].

One of the most used applications of MSI from RS is about VI computing, such as the normalized difference vegetation index (NDVI) [42], which has been introduced for monitoring vegetation biomass and physiological status by exploiting linear combinations of the red and photographic IR radiances [41,62,63]. VIs are sensitive indicators for monitoring vegetation changes. In the field of RS, to identify rice cultivation, the unique physical feature of paddy-rice fields has been exploited, which is that rice grows on flooded soil [45]. Spectral bands and vegetation indices, such as NDVI, NDWI, EVI and LSWI, that are sensitive to both water and vegetation, have been used to detect rice cultivations on large-scale contexts by exploiting the presence of water in rice fields for agricultural purposes and land use monitoring [45–47]. On the contrary, this research has been applied to the rural landscape of paddy-rice fields with the aim of detecting flooded territorial portions over the spring season for tourism purposes. In this sense, the NDVI, which exploits the surface reflectance in two different spectral bands, near-infrared (785–899 nm) and red (650–680 nm), has been used. NDVI, being a normalized difference, can range between −1 and +1. Positive values of NDVI give information about the presence of vegetation and its healthy status. Negative values enable the detection of heterogeneous objects such as water surfaces, clouds, built-up areas, snow and others.

To draw up slow tourism itineraries, which adapt each time to the landscape changes, the ORS tool has been integrated into the algorithm by exploiting the API services. The ORS API enables many services in the field of travel planning, such as computing routes, navigation information, finding points of interest around or within a given location, isochrones, time–distance matrix and others [64]. The ORS API service has been integrated within the

QGIS plug-in for many application fields; for the scope of the research, the ORS tool enables route computing with different travel modes and a wide range of routing options (foot walking, foot hiking, regular cycling, road cycling, safe cycling, mountain cycling, electric cycling, driving a car, wheelchair) that allow the drawing up of itineraries according to different user profiles. Furthermore, the ORS enables route computing by a points layer, and it can be optimized with road-type restrictions and according to the travel preferences of shortest or fastest route.

3.3. Method

This section is about the method, described as a sequence of work steps, which allows the definition of the algorithm, which is able to draw up parametric slow tourism itineraries for experiencing seasonal landscape changes. The algorithm consists of a workflow, optimized with a QGIS graphical modeler, which combines RS applications from Sentinel-2 observations, NDVI computing for flooded paddy-rice fields mapping and slow routes computing through the ORS tool. The overall workflow has been shown in Figure 3 as a flow chart and in Figure 4 in the visual form of maps. Before starting, it is necessary to define the territorial extension of the study area to run the algorithm.

The data inputs are Sentinel-2 satellite imagery and spectral bands B4 red and B8 near-infrared at 10 m resolution [59]. The vegetation index NDVI is computed through the raster calculator, according to Equation (1).

$$NDVI = \frac{B8\ NIR - B4\ RED}{B8\ NIR + B4\ RED} \tag{1}$$

The threshold NDVI < 0 for computing the NDVI map has been applied in order to detect water surfaces by the pixel-based recognition method. The NDVI threshold has been tested by the ground observations survey made in the study area [56,65].

The resulting map includes different typologies of water surfaces, such as rivers, lakes and permanent water bodies, but also other heterogeneous entities such as particular roof types in built-up areas, which are not related to the flooded paddy-rice fields. Vector masks are available through open street map (OSM) services for built-up areas, waterways and permanent waterbodies. The procedure of deleting misleading information from the NDVI map is named mask processing in the workflow. It enables the isolation of flooded paddy-rice fields in the map from other heterogeneous entities.

To draw up slow mobility itineraries, for walking or cycling, which can be attractive as tourist destinations, it is essential to identify the largest portions of flooded paddy-rice fields to avoid including even very small and isolated portions in the route computing.

In this sense, the first threshold to the flooded paddy-rice map has been applied in terms of surface dimension, which allows the taking into consideration of just the ones above 1 hm². The next step of the workflow is about the computing of centroids for each areal entity, from which it is possible to draw up a density map (heat map) that allows the figuring out of the densest areas in terms of the spatial distribution of flooded paddy-rice fields. The heat map is a fundamental tool in the algorithm; it identifies the hotspots using a kernel density estimation from an input point vector layer. The density is calculated based on the number of points in a location by considering the radius and the weight [52]. The heat map has been set with the following parameters: radius 100 m, weight equal to the surface values of each paddy-rice field. The maximum values, corresponding to the largest areas >15 hm², are selected as hotspots for the itineraries. This threshold has been identified as the one that enables a relevant perception of the phenomenon from the road. Before launching the ORS plug-in for route computing, it is necessary to input the existing OSM roads graph layer, with the aim to snap each hotspot to the roads graph at the nearest point. For route computing, the plugin ORS in the algorithm has been integrated. The ORS enables the drawing up of itineraries by a vector hotspots point layer. The ORS enables the customization of the travel experience by selecting the travel mode (walking, cycling,

driving a car, wheelchair) and the travel preferences (shortest or fastest route). The order of the hotspots along the itinerary can be optimized through an optimization tool.
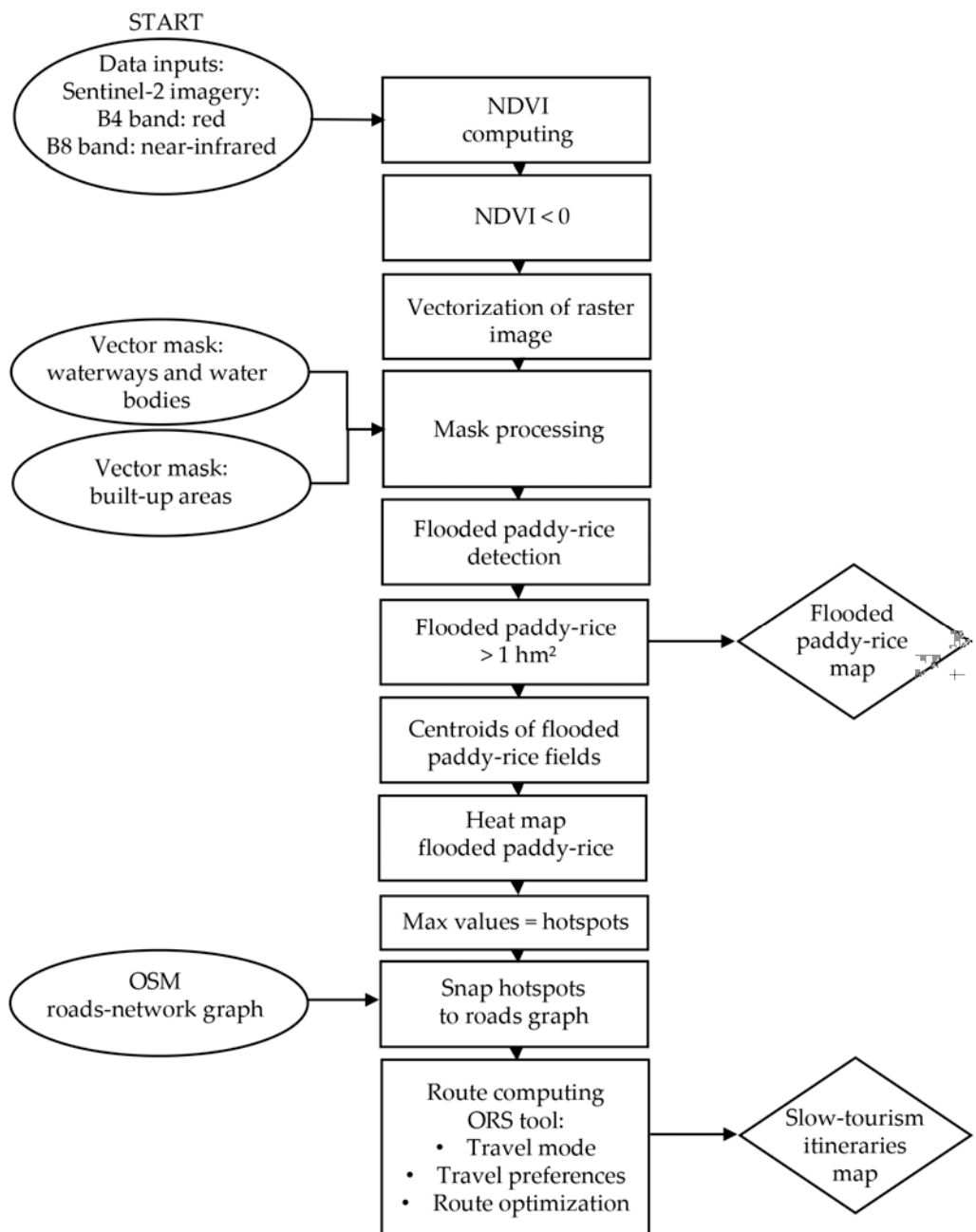

Figure 3. Flowchart of the performed methodology. The algorithm has been generated by a QGIS graphical modeler. On the left, there are the main data inputs; in the middle, there is the sequence of the main work steps of the algorithm. On the right, there are the main outcomes. The first one is the flooded paddy-rice fields map; the second one is the slow tourism itineraries map, generated by the ORS tool. The workflow can be reiterated through the algorithm for each Sentinel-2 data acquisition to generate new itineraries according to the seasonal landscape changes.
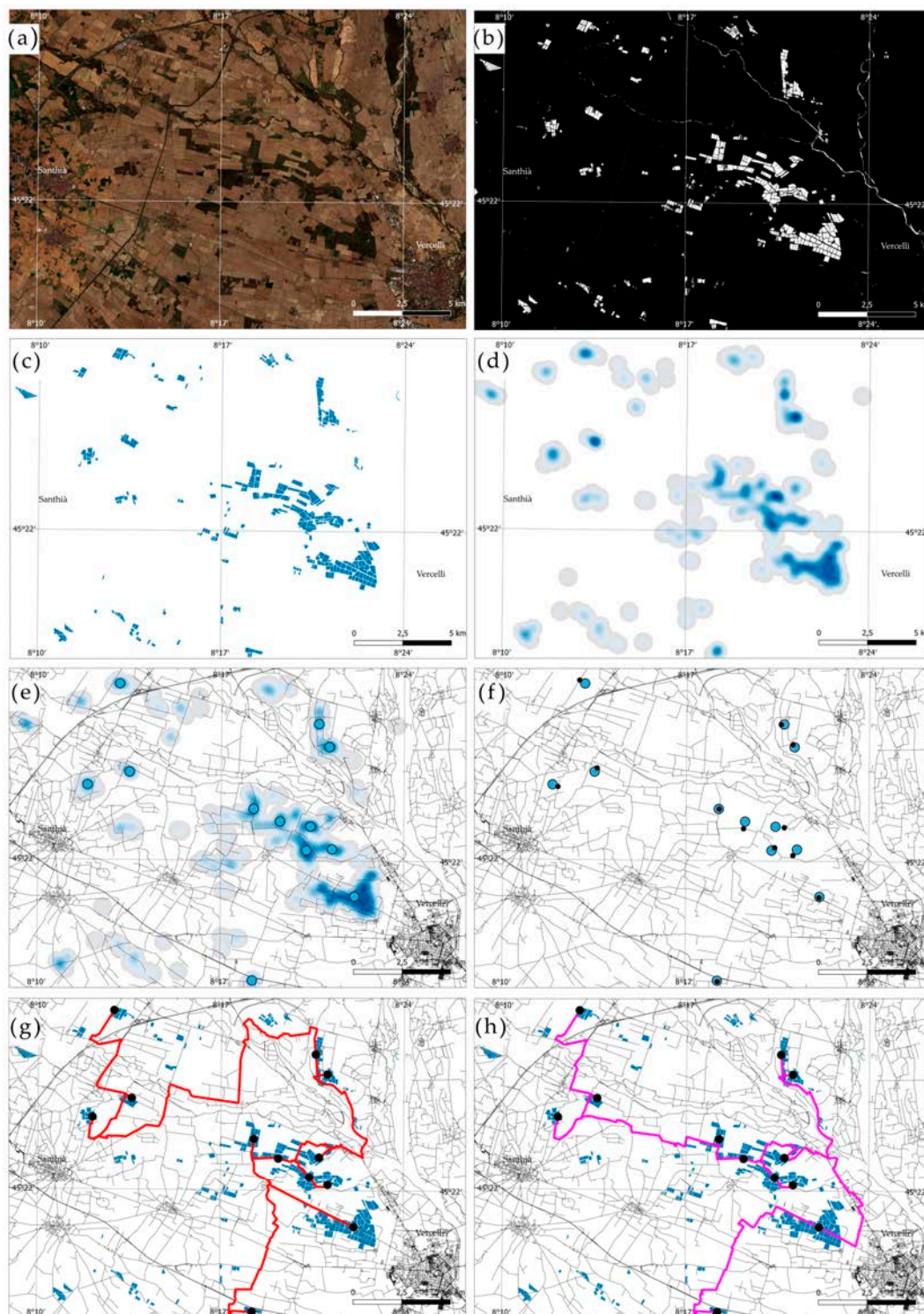
Figure 4. Maps of the GIS workflow. (**a**) Satellite imagery from Sentinel-2A true color. Data acquisition 6 April 2020. (**b**) Computing NDVI < 0. White areas correspond to detected objects. (**c**) Detection of the flooded paddy-rice fields > 1 hm^2, after the mask processing. (**d**) Heat map of the detected flooded paddy-rice fields. Dark blue areas show higher concentrations. (**e**) Detection of the hotspots through the heat map: centroids of the areas >15 hm^2. (**f**) Snap hotspots to the road graph: blue dots correspond to the starting points, derived by the heat map; black dots correspond to the ending points on the roads graph. (**g**) Route computing by ORS tool: definition of the regular-cycle itinerary along the flooded paddy-rice fields. (**h**) Route computing by ORS tool: definition of the foot-walking itinerary along the flooded paddy-rice fields.

4. Results

The main outcomes of the research are the parametric slow tourism itineraries which are mapped according to seasonal landscape changes. The maps, in Figure 5, show the application of the algorithm to Sentinel-2 data acquisitions over spring 2020, which is the most interesting period to perceive the scenic condition of the flooded paddy-rice fields in the study area. The definition of itineraries must be intended as "parametric" because it depends on the external variation of seasonal landscape changes. The algorithm, designed in a GIS platform, was conceived in such a way that any substantial variation in the presence of water in the paddy-rice fields generates an adaptation of the itinerary to the new conditions. As visible in Figure 5, each Sentinel-2 data acquisition shows a different spatial distribution of the flooded paddy-rice fields, which determine new itineraries within the existing roads network. The hotspots, computed by applying the threshold based on the largeness of paddy-rice fields to the heat maps, are the main anchor points for the itineraries' definition. The slow tourism itineraries have been drawn by considering the regular cycling and foot walking travel modes that are more appropriate to experience this scenic landscape condition due to the slowness of the mode. Nevertheless, other travel modes, such as the one by car, can be managed in the algorithm and they are fully compatible with the method. In Table 1 and Figure 6, the technical data of the itineraries have been analyzed, with the aim of checking the total lengths of the itineraries, but also the length of route stretches along the flooded paddy-rice fields. As expected, the maximum value of total lengths in the study area are on 24 April 2020, which seems to be the peak date for the flooding period. On this date, the maximum extension of the flooded paddy-rice fields was reached. In this sense, the total length, as an indicator, can be considered as a mirror of the extension of the temporary landscape condition. Furthermore, the itineraries by cycling and by foot walking are different in their spatial configuration but are quite similar in total length. It is also interesting that on two different dates (24 April 2021 and 5 May 2021), the route percentages along flooded paddy-rice fields are quite the same (approximately 30%) both for cycling and for foot walking itineraries, even though the total lengths are doubled (Table 1). Furthermore, the route percentage along flooded paddy-rice fields is between 20% and 30% of the total length for all itineraries, both for cycling and for foot walking. This means that the leftover stretches of the itinerary can be integrated with other kinds of points of interest that are compatible with the slow tourism experience.

Table 1. Technical data about the examined slow tourism itineraries. Comparison between cycling and foot walking itineraries.

Date of Sentinel-2 Data Acquisition	Cycling			Foot Walking		
	Total length (km)	Length of stretches along flooded paddy-rice fields (km)	Route percentage along flooded paddy-rice fields (%)	Total length (km)	Length of stretches along flooded paddy-rice fields (km)	Route Percentage along flooded paddy-rice fields (%)
6 April 2020	81	15	19	78	17	22
14 April 2020	112	24	21	112	25	25
24 April 2020	206	60	29	205	60	29
5 May 2020	111	32	29	105	33	31
21 May 2020	30	8	27	31	8	26
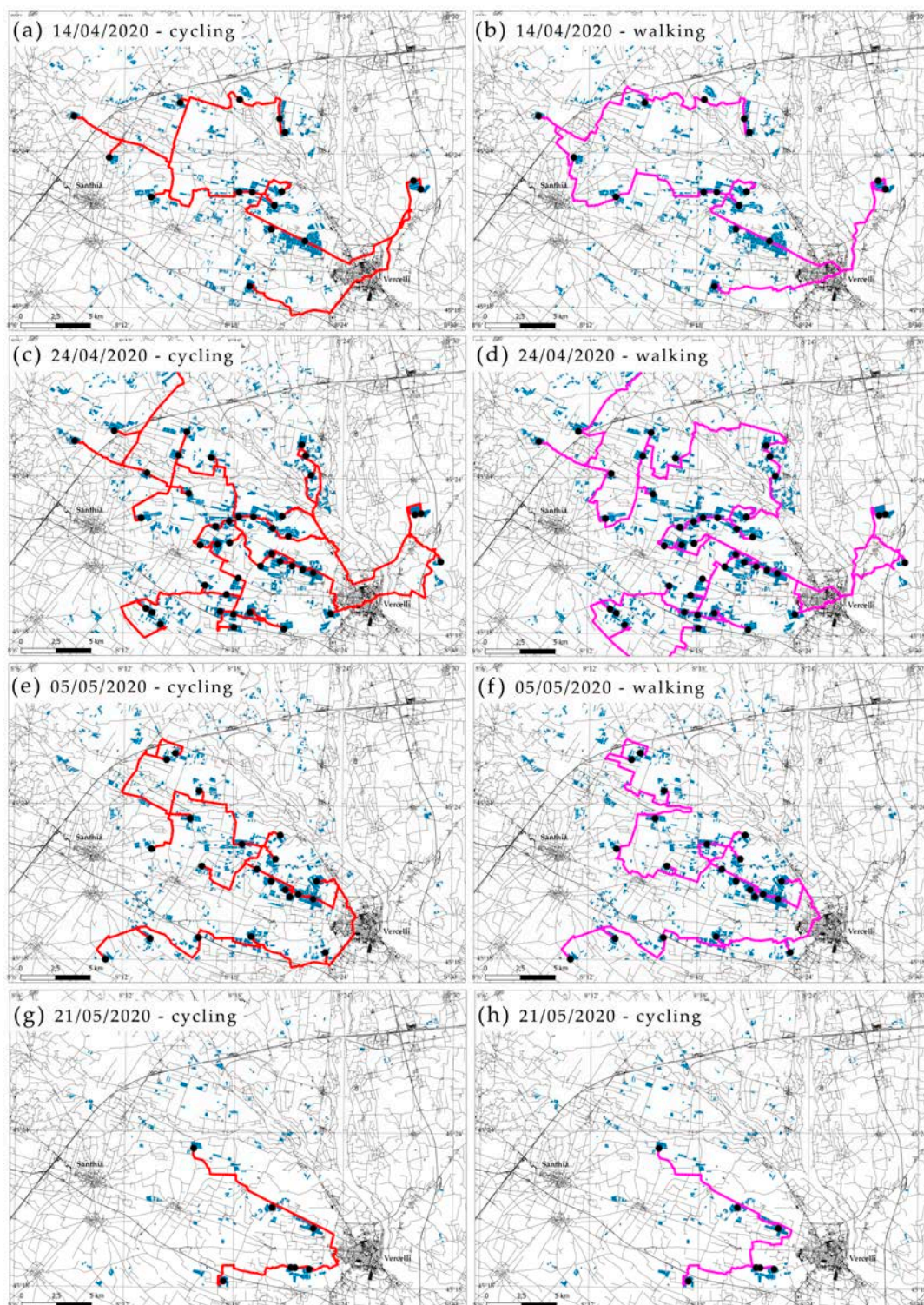
Figure 5. Maps of cycling itineraries (**a**,**c**,**e**,**g**) and foot walking itineraries (**b**,**d**,**f**,**h**) over the spring season in 2020, drawn by the algorithm. The overall image shows how slow tourism itineraries can be automatically drawn according to seasonal landscape changes. For each selected date of Sentinel-2 data acquisition, a slow tourism itinerary for cycling and foot walking travel mode has been drawn according to the flooding of paddy-rice fields. By observing the maps, the variation of the spatial distribution of the flooded paddy-rice fields is visible date by date, as is the parametric adaptation of the itineraries to the temporary landscape condition. The black dots are the main hotspots extracted by the heat maps of the flooded paddy-rice fields that have been used as anchor points to draw up slow tourism itineraries. The algorithm can be run for each Sentinel-2 data acquisition. Technical data about the examined itineraries are shown in Table 1, which highlights the route percentage along the flooded paddy-rice fields.
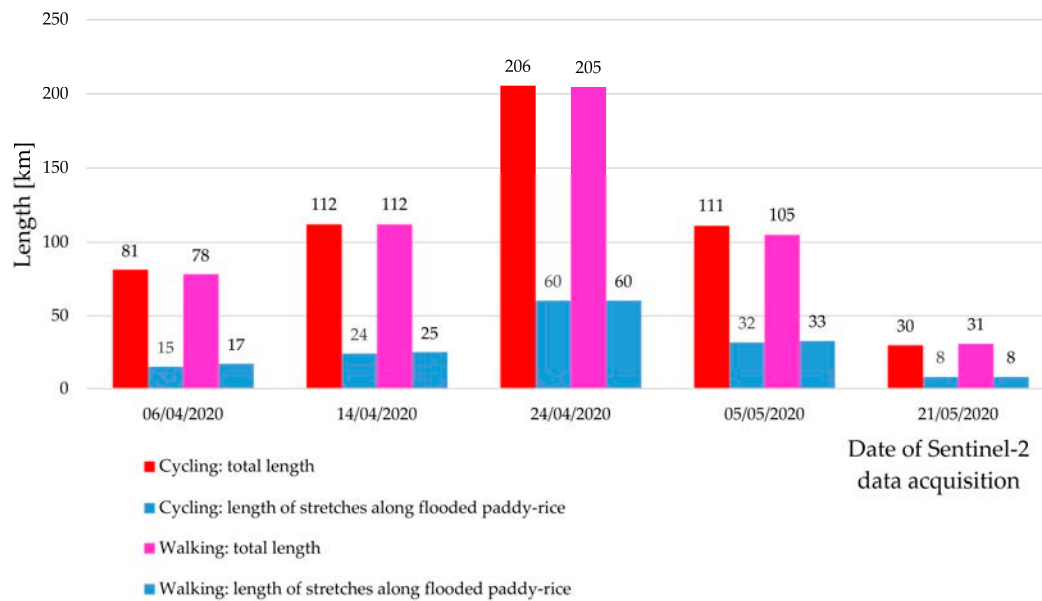
Figure 6. Comparative graph of the mapped itineraries: cycling and foot walking. Notwithstanding the differences in terms of spatial configuration between the two typologies of itineraries, total lengths are quite the same.

5. Discussion

This research has shown a method to draw up parametric slow tourism itineraries for experiencing seasonal landscapes by exploiting the high frequency of Sentinel-2 satellite imagery in the rural landscape of paddy-rice fields. The main advantages of this method are the high replicability of the method in a certain location every 3 days for Sentinel-2 data acquisition at mid-latitude [59] and the scalability to other territorial contexts with similar landscape features. Nevertheless, three main points will be discussed in this paragraph. The first point is about the possible usage of the tool in the tourism sector as a driver for territorial enhancement; the second one is about the itinerary conception and its relationship with the study area; the third one is about the technical issues related to the algorithm and its future development.

In the field of slow tourism, this tool is able to support a range of end users' decisions that can be applied to optimize travel planning choices both for single users, tourist operators and decision-makers, which are operating to define new strategies to enhance the landscape features of a specific territory. The parametric itineraries, if they are integrated in a dynamic map tool available on digital devices (e.g., mobile application, web map), could be exploited as a new tourism product to promote alternative and unconventional tourist destinations. The itineraries, being adaptable to the seasonal landscape conditions, enable more efficient management of tourist flows, avoiding durable overpressures on the most frequented tourist hotspots. By exploiting the existing roads network, used even for other purposes (e.g., agricultural purposes), the tool enhances the existing resources of the territory in a sustainable and balanced manner. Furthermore, the tool can be adapted to other territorial contexts, where scenic phenomena related to vegetation (e.g., autumn coloring foliage, spring blooming) occur seasonally by exploiting the potential of VIs, with the aim to increase the attractiveness of territories from a sustainable tourism point of view. Each landscape phenomenon requires that properly dedicated algorithms are performed according to environmental constraints. If the potential of proximity tourism to explore near-home places is considered also, which has been rediscovered during the pandemic, the advantages for the involved territories by the usage of this tool could be much more interesting even for local communities. In this framework, the experiencing of scenic landscape phenomena through slow itineraries as tourist product can contribute to

generate a new interest, especially for marginalized and inner areas of the countries, as a driver for territorial enhancement in a sustainable, balanced and inclusive manner.

The second point is about the itinerary conception in relation to the rural landscape of paddy-rice fields, examined in the study area. The performed itineraries cross the flooded paddy-rice field landscape only in a range between 20% and 30% of total length. This is a weakness of the algorithm that can be improved by modifying the heat map thresholds in the algorithm, but also by including in the itineraries also other points of interest, such as cultural heritage hotspots, panorama viewpoints and natural protected areas, that could enrich the overall users' travel experience through the landscape. Furthermore, clearer starting and ending points could be imposed on the itineraries (e.g., the railway station, the main square of the town) in order to link the itineraries to a landmark of the territory.

The third point deals with technical issues related to the algorithm and its future development. The algorithm has been tested on the landscape of paddy-rice fields, where the flat morphology does not create any problems with shadows in the pixel-based recognition from Sentinel-2 imagery. In this sense, the algorithm should be tested in other territorial contexts, where the orography is more complex (e.g., mountainous and hilly landscapes), which implies more difficulties in the pixel-based recognition by satellite imagery due to the shadows effect. Another point is about the NDVI threshold, which has been tested in the algorithm, and which enables the detection of flooded paddy-rice fields, but it can be further improved by combining multiple VIs in order to increase the performance of the mapping tool through the pixel-based recognition method. The other point deals with the mask processing, which is a key aspect in water surface detection; in the algorithm, the vector masks have been processed but they can be considered as a limitation of this workflow because no uniform vector datasets are available yet on large-scale contexts; other kinds of masks (e.g., raster formats) could be added to the workflow to increase the performance of the algorithm. Furthermore, in a broader perspective, new mapping tools, which integrate RS and ground sensors, and which exploit georeferenced data from mobile devices of the people and machines that are moving on the earth's surface, are required to investigate complex phenomena such as seasonal landscape changes.

The seasonal landscape changes influence our daily life and the space that surrounds us in a decisive way. New research efforts need to be made to tackle the global challenges of our planet. New digital mapping tools are required to inspire more sustainable actions in the field of tourism with the aim to reduce overpressures on the most frequented places and at the same time encourage the revitalization of the inner areas of the countries. Better integration between different research fields, such as urban planning, tourism, landscape, geomatics and computer sciences, can contribute to building a multidisciplinary research approach to foster innovation and face the global challenges of our planet.

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Informed Consent Statement: Not applicable.

Data Availability Statement: Multispectral Sentinel-2 imagery used in this research as data sources are freely accessible through https://scihub.copernicus.eu/ (accessed on 5 October 2021).

Conflicts of Interest: The author declares no conflict of interest.

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