Journal of Urban and Regional Analysis 14–2 (2022): 211–241, https://doi.org/10.37043/JURA.2022.14.2.3

TOURISM IMPACT MODELS AS SUSTAINABLE DEVELOPMENT PLANNING TOOLS FOR LOCAL AND REGIONAL AUTHORITIES

Andrei Schvab[a], Natașa Văidianu[a,d], Igor Sîrodoev[a], Hrvoje Ratkajec[b], Marius Skolka[a], Marian Tudor[a], George Cracu[a], Mirela Paraschiv[a], Daciana Sava[a], Irina Florea-Saghin[a], Urska Starc-Peceny[b], Tomi Ilijaš[a], Cristina Căluianu[c]

[a] Ovidius University of Constanța, Constanța, Romania

[b] Arctur, Nova Gorica, Slovenia

[c] Sano Touring Experience, Bucharest, Romania

[d] University of Bucharest, Bucharest, Romania

Abstract: Tourism is considered by the local inhabitants and businesses as an activity that could bring economic development to a very isolated and underdeveloped area such as the Danube Delta, UNESCO protected natural wetland. The aim of this study is to propose the Tourism Impact Model (TIM) as a tool that could be used by the local and regional authorities in managing tourism in such fragile ecosystems so that to maximise its positive effects while the honeypot sites of the delta to attract tourists without provoking irreparable damage to the environment. The results of the TIM analysis applied for Sfântu Gheorghe commune, Romania, evidence that the Danube Delta is under tourism pressure and at high risk of surpassing its human carrying capacity. The conclusions of the analysis show that TIM could be a very useful administrative and policy supporting tool in sustainable development governance if data collection improves in the future.

Keywords:

human pressure; tourism impact assessment; planning tools; sustainable development goals; Danube Delta

Email: natasa.vaidianu@univ-ovidius.ro

Initial submission: 07.09.2021; Revised submission: 10.01.2022; Final acceptance: 25.02.2022

Introduction

Deltas usually represent fragile ecosystems whose management is a challenging task (Cioaca et al. 2007, Gâștescu 2009, Văidianu 2013, Văidianu et al. 2015, Anfuso et al. 2021). The susceptibility of the delta ecosystem to pollution is high, in all its forms, but especially for possible soil and water pollution (Suaria et al. 2015, Gati et al. 2016, Stoica et al. 2016, Constantin et al. 2017, Despina et al. 2020, Garcés-Ordóñez et al. 2020, Landrigan et al. 2020, Llorca et al. 2020, Thushari and Senevirathna 2020, Paltineanu et al. 2022). Finding the right balance between economic development and environmental protection often leads to conflicts between the involved stakeholders (the inhabitants and/or economic developers) and the environmental authorities (Văidianu et al. 2014, Văidianu et al. 2015, Teampău 2020, Yuxi and Linsheng 2020). Service provision is quite a challenging task in such restrictive and remote areas (Profiroiu et al. 2021) and establishing their carrying capacity is still a very delicate planning mission (Association of Ecotourism in Romania 2014, Blaga and Josan 2019, Liu et al. 2020b). Even maintaining the quality of public services at the adequate level to satisfy the needs of the local inhabitants can be difficult (Văidianu 2015, Buză and Posteucă 2020, Sarpong et al. 2020).

Tourism is expected to re-establish the close relations between social and ecological systems in a manner that would allow a more stable coexistence of people and nature (Phelan et al. 2020). Tourism is a tool for promoting territorial resources (Almeida-García et al. 2020), but it is also a driving force which could affect the environmental quality (Jahani et al. 2020). The relationship between visitation and human impact in a fragile ecosystem is not clearly understood, but the impact increases exponentially with each additional tourist (Blaga and Josan 2019, Akadiri et al. 2020). If made wisely, investments in tourism would represent an optimal solution to both provide additional resources for the local authorities to develop and to improve the local living standards (Ghani et al. 2013, Herman et al. 2020), and to reduce the human harm on the natural landscape (Shackleford 1985).

However, the increasing tourist flows put pressure on the local infrastructure and the public service provision (Jovanović and Ilić 2016). As tourism is an important economic activity, if it is sustainably managed, due to its potential to bring benefits to the area's economy (Văidianu et al. 2015, Kubo et al. 2020, Lai et al. 2020), a responsible local development policy based on attracting tourists must consider the future impact of investments in tourism (Fang 2020, Hoang et al. 2020, Nesticò and Maselli 2020, Arabadzhyan et al. 2021). Among other critical issues, the determination of the right size of the provided public services and infrastructure is of paramount importance for such a policy (Murphy 1983). Ultimately, failing to adequately address the challenges caused by the tourist phenomenon will not just contribute to the degradation of service provision for the local community, but it is likely to threaten the achievement of the Sustainable Development Goals (SDGs) (Kimbu and Tichaawa 2018).

The Danube Delta is a fragile space, characterised by several physical and administrative features with a restrictive role, rendering many human activities difficult (Popescu et al. 2020), while the existing ones have already altered and scarred the wetland ecosystem, locally and upstream (Gómez-Baggethun et al. 2019, Petrișor et al. 2020). For these reasons, the Danube Delta represents a strong case study for the assessment of tourism impact, mostly due to the particular landscape that shaped and constrained to a large extent what is possible in terms of human habitation and activities (Tănăsescu and Constantinescu 2020). But the history of human settlements in the Danube Delta is long, varied, and complex, bringing together several ethnic, cultural, and religious groups while the legislative restrictions imposed in the 1990s by declaring the delta a biosphere reserve did not change its ecological reality, although it imposed severe limitations to the traditional and new human uses (Iordachi and Van Assche 2015, Tănăsescu and Constantinescu 2020).

Tourism, specifically ecotourism, was promoted as the solution for the Danube Delta (Tătar et al. 2017, Dima et al. 2020) to conserve its natural assets and to allow its sustainable development by preserving its human history and cultural diversity too (Hontuș 2013, Ghermandi et al. 2020). The previous de-industrialisation of some upstream areas, and the maintaining lower population levels, as well as the new trends in the tourism industry would make ecotourism a promising development strategy for the area (Association of Ecotourism in Romania 2014, Ministry of Regional Development and Public Administration 2016, Dima et al. 2020). However, the Danube Delta in Romania is currently facing an under-regulated tourism development, while the approach of the local elite politics, the hurried tourists, and the under-skilled and the under-financed locals make it hard at this point to see tourism as a driver of community building (Alecu et al. 2016, Phelan et al. 2020, Van Assche et al. 2020).

In this context, the Tourism Impact Model (TIM) could emerge as a data driven strategic planning tool that would sharpen a field-proof instrument for all the stakeholders involved in the decision-making process (Earp and Liconti 2020) aiming at a sustainable (tourism) development (Grilli et al. 2021). Hence, the aim of this paper is to analyse the Tourism 4.0 technologies through TIM in order to unlock the collaboration potential of key enabling technologies from the Industry 4.0 and to build a smart tourism ecosystem for the Danube Delta in which not the tourists, but the local residents and their quality of life is primarily put in the centre of the strategic planning process (Ramkissoon 2020). In this sense, the TIM assessment is made for the village of Sfântu Gheorghe in the Romanian Danube Delta aiming to lead the local and regional authorities involved in the sustainable development process towards the right steps for a future with automatic data collecting in high frequency to allow dynamic real data simulations of possible scenarios for a quick and competent response in all planning situations.

Methodology

Study area

Sfântu Gheorghe is a village located on the seashore in the Danube Delta, and it represents a left-over space in deterioration, being abandoned or marginalised in relation to its development potential (Jucu and Pavel 2019). The village is one of the least accessible settlements in Romania (Man et al. 2015) and it is only reachable by water (Figure 1). Thanks to its remoteness and wildness, it represents an exotic attraction for many tourists who value its wetland landscape, including river canals and large and wild beaches with sand dunes (Tătar et al. 2017, Stoleriu et al. 2019). Since the beginning of its human inhabitation, fishing has been the main source of food and income for the local community (Damian and Dumitrescu 2009) and a tourist activity. So, the natural tourist resources of Sfântu Gheorghe are diversified with cultural attractions such as traditional fish-based cuisine or film festivals (Damian and Dumitrescu 2009, Văidianu 2015).

Figure 1. Local transport infrastructure in Sfântu Gheorghe. Source: Văidianu (2018)

As a tourist location, Sfântu Gheorghe is rather an accommodation or transit point, while most tourists are coming by their own boats or by renting motorboats to visit different popular areas of the Danube Delta during the day (Figure 2), after which they return to their accommodation in the village in the evening (Văidianu 2015, Teampău 2020). Besides this, the local weather conditions strongly induce a very high seasonality of tourism in July and August and almost no tourists arrive in Sfântu Gheorghe during the winter (Ivan 2017, Tătar et al. 2017).

Sfântu Gheorghe stands out as a territory where, on a relatively small area, there are diverse and unique habitats specific to both the coastline and the Danube Delta (Gâștescu 2021). The sea beach in Sfântu Gheorghe is a high tourist attraction by the fact that it is very wide and with a wild landscape of the coastline (Vespremeanu-Stroe

and Tătui 2011, Tătui 2015). Sand dunes up to 2 m high mark the boundary of a wetland made up of marshes, which is margined to the interior of the land by a forest planted in the years 1950-1960 (Vespremeanu-Stroe and Tătui 2011, Tătui 2015). The dunes in the northern part of Sfântu Gheorghe are mobile (Vespremeanu-Stroe et al. 2016), and their movement can be evidenced by the burying of willow bushes or the *Convolvulus persicus* (sand turf), whose habitat is reduced only to the seaside area, where human interventions are very limited or even inexistent (Strat and Holobiuc 2018).

Figure 2. Different ways of tourist transport used in Sfântu Gheorghe. Source: Văidianu (2018)
Legend: top left – international cruise ship on the Danube (Austrian flag); top right – tourists from the cruise ship embarking on local boats for a two-hour trip in the Delta; bottom left – tourist boat on a Delta channel; bottom right – land transport from the village to the beach.

In terms of other biodiversity and natural attractions, the territory of Sfântu Gheorghe offers the ideal habitat for lizards (*Eremias arguta*), which are also found only in this type of sunburned habitat, or specimens of *Vipera ursinii* (steppe viper), a rarity in many regards (Cogălniceanu et al. 2013). The birds in the area include also unique or rare species, and in addition to the omnipresent gulls, there are either flocks of terns of several types (*Sterna hirundo, Sterna sandvicensis*, *Chlidonias niger*, *Chlidonias hybrida*) or much rarer specimens of *Recurvirostra avosetta* (knockback) or *Haematopus ostralegus* (eurasian oystercatcher) (Baciu 2020).

The area where Sfântu Gheorghe's arm spills into the Black Sea is also characterised by another attraction, namely the ever evolving and reconfiguration split known as Sacalin Island (Gâștescu 2009). This territory, formed by low sea beams, is partly covered with grassy vegetation (Niculescu et al. 2016) and it is home for a wide range of pond or seabirds (from the terns and gulls to common and dalmatian pelicans) which find a sheltered nesting place here (Gâștescu 2021). Also, near the mouth of Sfântu Gheorghe's arm into the sea, a compact forest of black alder (*Alnus glutinosa*) has developed over time, covering an area of more than 50 hectares, and representing the only place in the country where it keeps its wild character intact (Doroftei and Covaliov 2007, Niculescu et al. 2016, Romanescu et al. 2018). In this forest, there are large and small flocks of cormorants, *Alcedo atthis* (kingfisher), and *Haliaeetus albicilla* (white-tailed eagle) (Alexe et al. 2020).

Towards the interior of the land, the forest that extends to the canal and northward to Sulina town offers a landscape that resembles the bushes of the African savannahs (Gâștescu 2021). Unique plants, such as areas covered by *Ephedra distachya*, an archaic plant, related to conifers, can also be seen in areas with trees and shrubs (Schneider-Binder and Kuhlke 2015). Of the animals, especially in spring, there are specimens of golden jackal, raccoon dog, wild boar (Murariu 2010) or specimens of *Lacerta agilis* (sand lizard) (Cogălniceanu et al. 2013). And because sandy areas are home to a rich insect fauna, a number of insectivorous birds or even some predator species can also be seen in the area (Gâștescu 2021).

Although Sfântu Gheorghe does not have the official status of a tourist resort, it is a popular place among the tourists during the summer, which has an impact on the local infrastructure and facilities (Văidianu et al. 2015). The local authorities try to take advantage of this popularity and to set tourism projects based on the local heritage, while promoting tourism activities among the priority directions of the future local development (Town Hall of Sfântu Gheorghe 2011). But the decision makers must then be prepared for the increasing tourist demand, and they should provide adequate public services for both the locals and the visitors (Pavel-Nedea and Dona 2017, Stoleriu et al. 2019, Carvache-Franco et al. 2020).

Territorial challenges assessment

To make a comparable assessment for the territorial challenges that Sfântu Gheorge is facing in relation to how the authorities address them, the data included three analysis groups: (1) Sfântu Gheorghe, (2) other rural settlements located entirely or partially within the Danube Delta, and (3) the rest of Tulcea county's villages. For the sake of comparability, all the data were weighted by the corresponding number of inhabitants; in addition, the data for the latter two groups were averaged to address the scale effect. To illustrate the relevant territorial challenges, such infrastructure indicators as drinking water supply and consumption, wastewater network, and construction

permits issued for building new tourist accommodation units were considered. Additionally, the yearly and monthly tourist flows illustrated the tourism activity of each analysed territory.

As evidenced by the data, Sfântu Gheorghe is different from both Tulcea county and the Danube Delta. While there is little difference in the analysed indicators between the rural settlements in the Danube Delta and the other rural areas in Tulcea county, Sfântu Gheorghe stands out for its high values, as well as for its significant fluctuations in some cases.

The tourism activity in Sfântu Gheorghe has a fluctuant trend: there are two local maximums in 2011 and 2019, as well as data gaps before 2005 and in 2015 (Figure 3). Given the increasing number of tourist arrivals, one can expect an increased demand for the local public services in the peak years. So, the local authorities must address this demand to secure the adequate service provision for both the local community and the tourist accommodation units located in the commune (campings, villas, and pensions).

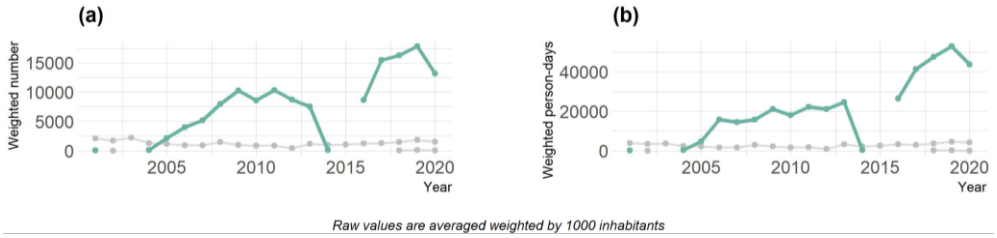

Figure 3. Dynamics of tourist arrivals (a) and overnight stays (b) – yearly data.
Source: National Institute of Statistics (2021)
Legend: green line and dots – Sfântu Gheorghe; grey lines and dots – other rural settlements in the Danube Delta, and the rural settlements in Tulcea county without the first two groups

Thus, the length of the drinking water supply network in Sfântu Gheorghe significantly increased in 1998 and it is superior to the Delta's and county's averages (Figure 4a). The extended network has allowed the enhancement of the capacities of drinking water production, which was made in two phases: 2002 and 2006 (Figure 4b). And there is a huge gap between Sfântu Gheorghe and the other rural settlements. The figures which reflect the water consumption level are also superior in Sfântu Gheorghe compared to the rest of the analysed rural communities (Figure 4c). So, there is an evident parallelism between the local water consumption, with maximums in 2011 and 2020, and the tourist flow fluctuations.

At the same time, it seems that the wastewater network modernization of Sfântu Gheorghe lags behind, despite its increasing tourist arrivals. Only recently, in 2019, this network was significantly extended, throwing Sfântu Gheorghe much higher above the average of the other Danube Delta and Tulcea county's rural communities (Figure 5a).

The high popularity of Sfântu Gheorghe among the tourists feeds the demand for new tourist accommodations. To address this demand, the commune's local authorities issued a number of new building permits for tourist accommodation which is superior to the Delta's and county's averages, registering a peak value in 2018 (Figure 5b).

Generally, the tourist flow has an increasing trend in Sfântu Gheorghe, while the local public administration tries to address the resulting demand in specialised tourist and general public services. But, sometimes, the required investment is being made with quite a long-time lag (such as in the case of the wastewater network).

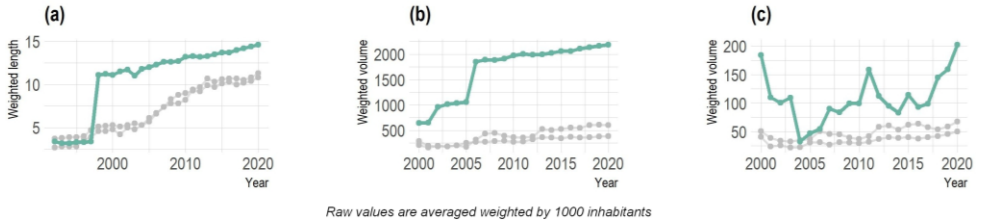

Figure 4. Dynamics of the drinking water supply infrastructure – network length (a), capacity of drinking water production facilities (b), and water consumption (c). Source: National Institute of Statistics (2021)
Legend: see Figure 3

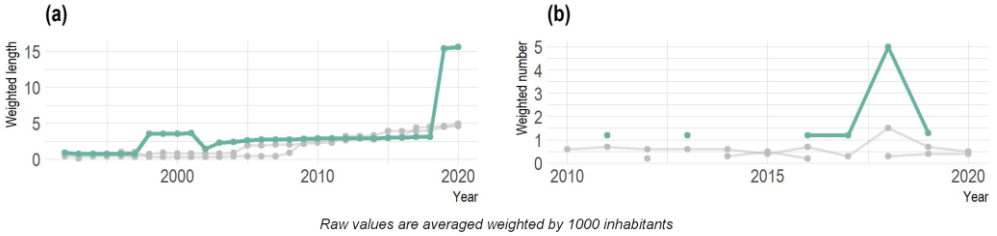

Figure 5. Dynamics of wastewater network (a) and the number of construction permits issued for building new tourist accommodations (b). Source: National Institute of Statistics (2021)
Legend: see Figure 3

Among the European Union members, Romania is one of the countries with the highest seasonality of tourism development (Ferrante et al. 2018). The case of Sfântu Gheorghe is even more contrasting as there is no reported tourism activity in the low season while the tourist flows in the summer season outpass the average values by thousands of times (Figure 6). Taking into consideration the high seasonality of local tourism, the public authorities must be prepared to address the seasonal peaks in the service demand. The pressure on the provided services can be skyrocketing in the several summer months of high tourist activity. As for example, in 2019, the last pre-COVID19 year with the highest annual tourist flow, the number of tourist arrivals (14185 people) exceeded the local population (797 persons) by almost 18 times.

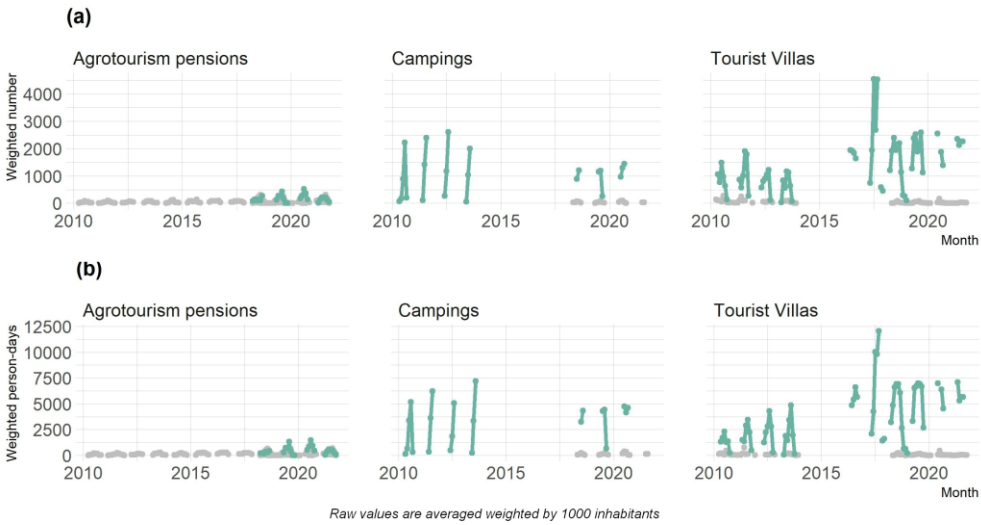

Figure 6. Dynamics of tourist arrivals (a) and overnight stays (b) by accommodation types – monthly data. Source: National Institute of Statistics (2021)
Legend: see Figure 3

As Sfântu Gheorghe relies on its tourism income, as stipulated in the development strategy (Town Hall of Sfântu Gheorghe 2011) and its popularity among the tourists increases (as shown by the recent trends of tourist flows), the local public administration requires a planning tool to properly assess the future local service demand. Only with reliably projected tourist flows and an accordingly dimensioned public service provision, the local authorities can be able to address all territorial challenges in a sustainable manner. Modern modelling approaches allow making such predictions and simulating different scenarios (Mou et al. 2020, Tian et al. 2020), among which the Tourism Impact Model – TIM (Goriup and Ratkajec 2021).

Tourism Impact Model

TIM is a comprehensive tool for modelling and optimising the impact of tourism on a local ecosystem through fostering collaboration between different stakeholders and data providers (Goriup and Ratkajec 2021). It enables the assessment of the impact of tourism on different societal aspects (Environment, Economy, Culture, Health, Education etc.) in order to reach sustainable development in a specific geographical area by following the UN Sustainable Development Goals (Goriup and Ratkajec 2021, Goriup et al. 2022).

The methodology is anchored in the Multi-Attribute Decision Making (MADM) theory (Chankong and Haimes 1983, Saaty 1988, Dyer et al. 1992, Keeney and Raiffa 1993). These methods are based in the decision theory utility theory, and they are well accepted in solving real life complex decision problems (Cestnik and Bohanec 2001,

Leben and Bohanec 2003, Bohanec et al. 2004, Taškova et al. 2007, Montemurro et al. 2018, Kljajić Borštnar and Ilijaš 2019).

The idea of multi attribute decision modelling (DEXi) is based on the decomposition of a large complex problem into smaller problems of less complexity (Bohanec and Rajkovič 1999, Montemurro et al. 2018, Bohanec 2021). The decomposition process is presented with a hierarchical tree of attributes and each alternative is evaluated by each attribute and later on composed back to a single value; so that, the final alternative value is gained through the aggregation of the attribute values from the tree leaves towards the root of the attribute tree (Bohanec and Rajkovič 1999, Montemurro et al. 2018). The DEXi model is developed according to the expert systems modelling (if-then rules) which provides transparent explanations of the evaluation, and it is, compared to the linearly weighted sum, more suitable for expressing nonlinearities in decision knowledge and easier to understand (Bohanec and Rajkovič 1999). The qualitative attribute scales are described by discrete descriptive attribute values, and they are more understandable to the decision maker (Bohanec and Rajkovič 1999, Montemurro et al. 2018). Thus, the hierarchical tree of attributes and the set of decision rules (utility functions) that are defined by an expert (or a group of experts) represent the knowledge base of the analysis (Bohanec and Rajkovič 1999, Bohanec 2021).

The DEXi methodology is an iterative process of the following steps (Bohanec and Rajkovič 1999, Montemurro et al. 2018, Bohanec 2021):

- Problem definition – decision makers have to define the problem, the objective, and the stakeholders. In the following step, the attributes are defined.
- Attributes identification – the attributes are variables or parameters that impact the decision problem. In relation to the tree, they can be: (1) Basic attributes (terminal nodes, leaves of the tree) which represent the input of the model; options are described by their values; (2) Aggregated attributes (internal nodes in the tree) and their values are derived by an aggregation rule from the basic attributes.
- Hierarchical tree of attributes – from the list of attributes, the hierarchical tree of attributes is constructed based on the decomposition of the problem principles and the similarity of attributes. A model can have one or more root attributes which can be further decomposed into descendant attributes.
- Attribute scales – the scale includes the possible values of each attribute, and it needs to be individually defined. The qualitative and discrete DEXi scales include categories like excellent, good, bad. The scales can be unordered or ordered (increasing, decreasing) in relation to their influence on the existing options. The ordering preferences are modelled by an expert (or a group of experts).

- Aggregation rules (utility functions) – they delineate the aggregation of the option evaluation. Every aggregate attribute Y has the X1, X2, …, Xn descendants in the tree of attributes and the corresponding utility function f defines the mapping f=X1, X2, …, XnY. In DEXi, the values of Y include all the combinations of the lower-level attribute values mapped by the utility function. A decision table is used to present the mapping and each row indicates the value of f for one combination of the lower-level attribute values. The rows are thus called decision rules and such rules are called elementary rules. An interval is a subset of consecutive scale values (i.e. value "*« denotes that any value from the scale list is possible; value ">=« denotes "better than or equal to« etc.). Intervals are used together with utility functions, especially when they are edited or represented by complex rules. The complex rules represent utility functions in a more compact and comprehensible way than the elementary rules and they are obtained by joining several elementary rules which have the same function value. Then, weights are used to model the importance of attributes for the final evaluation, and they represent numbers normalised to the sum of 100 maximum. In the qualitative multi-attribute models, attributes are symbolic, and utility functions are defined by decision rules. DEXi provides a link between the weighted sum and the decision rules. Weights are an approximation and not very precise, but they link both ideas, and they are thus more user oriented. There are two types of weights in the DEXi model: local (they refer to a single aggregate attribute and a corresponding utility function), and global weights (considering the structure of the tree and the relative importance of its sub-trees). Weights can be normalised or not, and this is because some scales have more values than others.
- Options – options (alternatives) are basic entities studied in a decision problem. They are evaluated and analysed by a multi-attribute model. An option is presented by its name and a set of values, so that one value is assigned to each attribute in the tree. The option is described by a basic attribute value and the final evaluation result is derived by aggregating the basic values by the utility functions developed. DEXi does work with incomplete and missing data, therefore the final evaluation of an option is derived even if a certain value of a basic attribute is missing or not clear.
- Evaluation of options – each option is represented by a vector of basic attribute values. The defined structure of the model and the utility functions influence the bottom-up aggregation of each option value. The evaluation of each option depends on the value of one or more root attributes of the model. Then, the decision maker can compare, rank, and select the preferred option. In the evaluation, the undefined values of basic attributes are denoted "*« and they are interpreted as a set of all possible

values that can be assigned to the corresponding attributes. DEXi evaluates the options by using all these values and it keeps track of the evaluation results which can be represented by a single value or by a set of values.

TIM is built using the Arctur's AAT (Automated Assessment Tool) platform and it is composed of an online questionnaire, a database, a MADM (Multi-Attribute Decision Making) model and an automatically generated TIM report (Goriup and Ratkajec 2021). The TIM assessment process includes these steps (Goriup and Ratkajec 2021): (1) definition of the geographical area for the TIM assessment; (2) mapping data sources; (3) completing the questionnaire and launching the AAT; (4) validation of results in the form of an automatically generated TIM report.

The TIM assessment can be repeated at any time intervals, and, in this way, it enables the constant monitoring and evaluation of the progress of the tourism impact at the selected location. The assessments are done under the supervision of a TIM certified expert who helps, explains, and guides the user by properly completing the questionnaire and by explaining the results in the report (Goriup and Ratkajec 2021).

The TIM questionnaire includes 310 questions or indicators grouped into 23 categories and 5 groups (Goriup and Ratkajec 2021):

1. Basic info about a specific geographical location (surface, types of tourism, number of tourists);
2. Environment (air quality, consumption of drinking water, disposal and treatment of wastewater and waste treatment, traffic related data etc.);
3. Economy (income, seasonality, employment, local economy etc.);
4. Society and Culture (satisfaction of tourists and local residents, health and safety, cultural and natural heritage etc.);
5. Collaboration (nature and level of collaboration between key stakeholders in tourism – local government, local residents, including NGOs and vulnerable groups, tourism providers and national government).

Beside the above-mentioned indicators, it also includes 138 Standard Data Accuracy Questions (SDAQ) grouped into question sets (one set is composed of three standardised questions) to measure the accuracy of the data provided for the indicators. All in all, the TIM questionnaire is composed of more than 700 questions, but it is a practical and easy to use digital tool (Goriup and Ratkajec 2021).

MADM (Multi-Attribute Decision Making) is a model for question analysis in which different types of questions (qualitative and quantitative) are combined and easily organised into a tree-like structure to enable the generation of the main results (Goriup and Ratkajec 2021). The TIM report visualises the main results of the MADM model in

a custom-made TIM Destination Character Chart (TIM DCC) with the positive (Benefits) and negative (Resource Consumption) effects of tourism and the general condition of the selected location (coloured circle) (Figure 7).

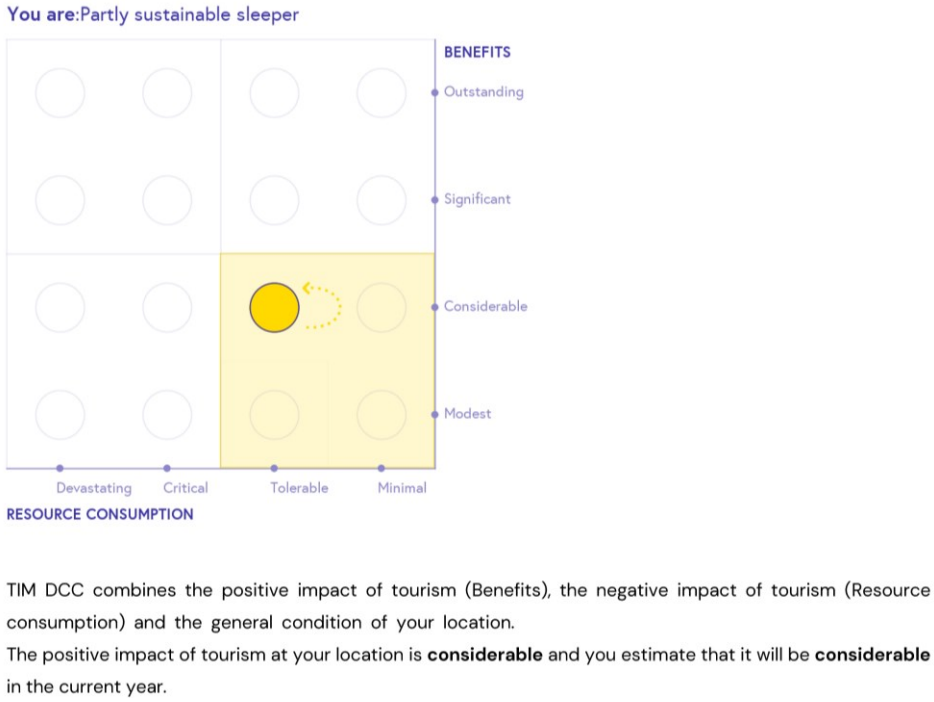

Figure 7. Destination Character Chart (DCC) example. Source: Arctur (2019)

The TIM report visualises the data accuracy results in the form of a Standard Environment Data Accuracy Question (SDAQ) bar too (Figure 8). As the TIM AAT is the perfect tool in measuring the SDGs on a local level because it facilitates the collecting of information relevant for the SDGs assessment, it gives an insight into the destination position on the global scale. Each section includes the list of one or more SDGs and their targets most closely related to the content that follows.

For the Sfântu Gheorghe tourism impact model (TIM) assessment, 2019 existing data and 2020 estimated data were used (Goriup et al. 2022). But there is a caveat regarding data accuracy, which, in general, is low, as much of the data is missing from the official reports and documents. To compensate for the lack of official records, the missing data were replaced by the estimations of local experts with detailed knowledge of the topic and the area.

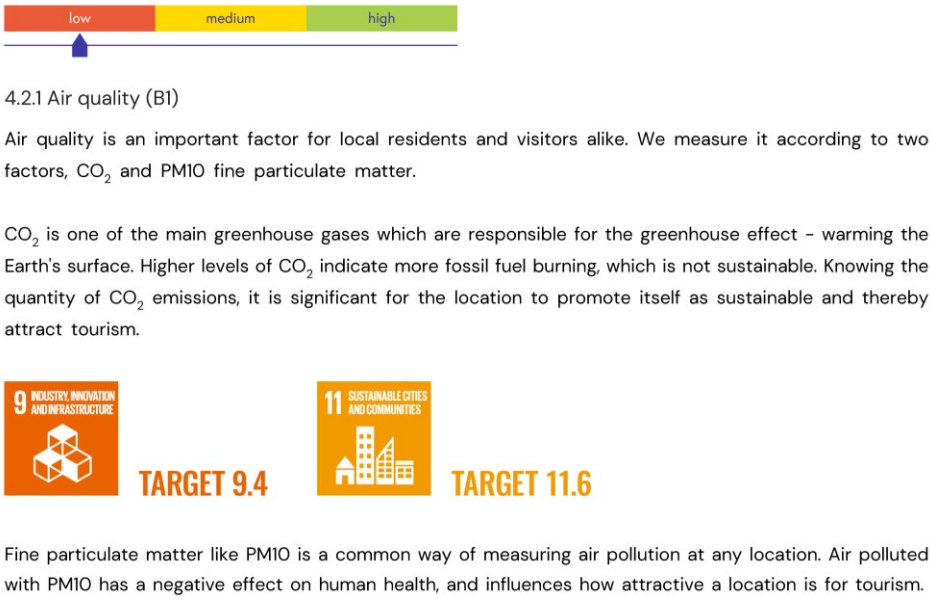

Figure 8. Standard Environment Data Accuracy Question (SDAQ) bar and its relationship with the UN SDGs. Source: Arctur (2019)

Results

The analysis results of TIM assessment evidenced that Sfântu Gheorghe is a partly sustainable sleeper: it gains considerable benefits (2 on a scale of 4) and it has a tolerable resource consumption (2 on a scale of 4) (Table 1). The sleepers stand out for low benefits, but also for low resource consumption. In other words, the environment is not yet under high stress, but neither are the socio-economic gains. This should be a well-established starting point for Sfântu Gheorghe's future development. As the environment is still not excessively altered, no massive investments are needed to bring it back to a sustainable level. However, all future economic and tourism developments should be realised preserving the current environmental conditions.

The implementation of TIM in Sfântu Gheorghe has had the following output:

- The environmental Destination Character Chart (DCC from where onwards) is a misuser: which means that the benefits for the environment are low (2/4), while the resource consumption is high (3/4).
- Air quality DCC for Sfântu Gheorghe is a misuser: the benefits are low (2/4), while the resource consumption is very high (4/4).
- Sewage system DCC is a champion: the benefits are high (3/4), while the resource consumption is low (2/4).

Table 1. Destination Character Chart break-down for Sfântu Gheorghe

	Analysed chapter	Benefits (out of 4)	Resource Consumption (out of 4)	Primary characters
1	Environment	2	3	misuser
2	Air Quality	2	4	exploiter
3	Sewage system	3	2	champion
4	Bathing waters	4	1	champion
5	Drinking water	3	4	exploiter
6	Energy management	2	4	misuser
7	Waste Management	1	4	misuser
8	Sustainable transportation	1	1	sleeper
9	Public transport	4	2	champion
10	Tourism infrastructure	3	1	champion
11	Economy	2	1	sleeper
12	Tourism income	2	1	sleeper
13	Investments	1	1	sleeper
14	Informal economy	1	1	sleeper
15	Tourism accommodation	1	1	sleeper
16	Jobs	2	2	sleeper
17	Local economy	3	1	champion
18	Real estate and consumer goods	1	1	sleeper
19	Society and Culture	3	2	sleeper
20	Events and happenings	2	1	sleeper
21	Collaboration	1	1	sleeper

Legend: Benefits – 1 (red) Modest; 2 (orange) Considerable; 3 (light green) Significant; 4 (dark green) Outstanding.
Resource consumption – 1 (dark green) Minimal; 2 (light green) Tolerable; 3 (orange) Critical; 4 (red) Devastating

- Bathing waters DCC is a champion: the benefits are high (4/4), while the resource consumption is low (1/4).
- Drinking water DCC is an exploiter: the benefits are high (3/4), while the resource consumption is low (4/4). There is high pressure on the drinking water as 40% of the consumption is concentrated in four months (June-September).
- Energy management DCC is a misuser: the benefits are low (2/4), while the resource consumption is very high (4/4). Up to 40% of all the electricity is used by tourism service providers, while in the tourist season this percentage goes up to 75.38%.
- Waste management DCC is a misuser: the benefits are very low (1/4), while the resource consumption is very high (4/4). Tourism operators generate more than 70% of the overall waste produced at Sfântu Gheorghe.
- Sustainable transportation DCC is a sleeper: both the benefits and the resource consumption are very low (1/4).
- Public transport DCC is a champion: the benefits are very high (4/4), while the resource consumption is low (2/4). In the tourist season, 61% of all arrivals in the port are tourism related.
- Tourism infrastructure DCC is a champion: the benefits are high (3/4), while the resource consumption is very low (1/4).
- Economy DCC is a sleeper: the benefits are low (2/4), while the resource consumption is very low (1/4).
- Tourism income DCC is a sleeper: the benefits are low (2/4), while the resource consumption is very low (1/4). More than 80% of the tourism businesses are owned by non-locals.
- Investments DCC is a sleeper: both the benefits and the resource consumption are very low (1/4).
- Informal economy DCC is a sleeper: both the benefits and the resource consumption are very low (1/4). Local experts estimate the volume of the informal economy between 15% and 30%.
- Tourism accommodation capacity DCC is a sleeper: both the benefits and the resource consumption are very low (1/4). There is very high pressure on tourism accommodation in the peak season.
- Jobs DCC is a sleeper: both the benefits and the resource consumption are low (2/4). Official records show a very low number of people employed in tourism.
- Local economy DCC is a champion: the benefits are high (3/4), while the resource consumption is very low (1/4), even if the local experts concluded that tourism has no positive effect on the establishment and the

performance of local supply chains between tourism service providers and the providers of goods and services.

- Real estate and consumer goods DCC are a sleeper: both the benefits and the resource consumption are very low (1/4).
- Society and culture DCC are sleeper: the benefits are high (3/4), while the resource consumption is low (2/4).
- Preservation of heritage DCC is a champion: the benefits are high (3/4), while the resource consumption is low (2/4).
- Events and happenings DCC are a sleeper: the benefits are low (2/4), while the resource consumption is very low (1/4). The majority of events are associated with cultural aspects.
- Collaboration DCC is a sleeper: both the benefits and the resource consumption are very low (1/4).

Discussion

Assessing the carrying capacity of the Danube Delta is crucial to tailor policies and administrative measures for its management (Association of Ecotourism in Romania 2014, Blaga and Josan 2019, Liu et al. 2020b, Wang et al. 2020). The Danube Delta Biosphere Reserve Administration and the local authorities are under a lot of pressure to allow development, but not at the expense of losing the quality of the environment (Sánchez-Arcilla et al. 2016). Especially as the Danube Delta represents a dynamic space under continuous natural transformation, together with its previous stages of human changes of the landscape and local communities (Preoteasa et al. 2016, Vespremeanu-Stroe et al. 2017, Teampău 2020, Petrișor et al. 2020, Tănăsescu and Constantinescu 2020). The pattern of natural landscape change became less predictable overall, with some places now closer to the sea than before, some farther, and some areas getting wetter, while lakes dry up (Constantinescu 2015, Romanescu et al. 2018). The Danube Delta landscape itself and its particularities constitutes a major asset for tourism development, but what was a sign of development in an earlier perspective, now looks more like a negative material dependency which requires further care and sustainable planning (Petrișor et al. 2012, Van Assche et al. 2020).

It is difficult to precisely measure which economic branch or human activity causes negative impacts on the environment in Sfântu Gheorghe (Goriup et al. 2022) as this analysis showed that the economic chapters create a low pressure on the consumption of resources, although the benefits are also low. So, there is a lot to improve in how the economic activity is currently being managed to increase its output.

On the one hand, out of the 21 chapters analysed in our study, in six cases, the benefits are as low as they could have been (modest on our scale), and in the other seven cases,

the benefits are marginal. Only in two cases, the benefits are at maximum according to our scale. On the other hand, when we measure the resource consumption or which pressures experience the different parts of the environment, a maximum resource consumption has resulted in just four cases while in other eleven cases this level was close to minimal. We can thus conclude that the environment is not particularly under high pressure, but the gains are also negligible.

When focusing on the chapters with direct impact on the environment (Air Quality, Sewage system, Bathing waters, Drinking water, Energy management, Waste Management), we notice that the pressure is at its maximum in four out of seven cases while the benefits are maximal only in the case of bathing waters. Public and private investments in this area are very costly, with a depreciation rate that spans over decades. But the benefits are minimal. Thus, some public utilities run close to their capacity as the benefits are low while the necessary investments to expand the network will burden the investors (in many cases local or national authorities) for decades.

An important issue with impact on the sustainability of tourism development in the Danube Delta is that it does not clearly contribute yet to the improvement of the locals' quality of life as envisaged by the government (Ministry of Regional Development and Public Administration 2016), and there are conflicts between the local stakeholders as the beneficiaries of related state support are mainly resourceful non-local investors (Văidianu 2015, Teampău 2020): "the problems range from simpler building designs to a complex process of competing for a 'primitive accumulation of capital' - especially land; from unfair, politically decided, discriminatory proprietorship over land towards incapacitating infrastructure development" (Iorga 2015: 36). Also, the environment and the local tourist entrepreneurs offering traditional accommodation and services face the pressure of tourist demand for ensuring the modern urban comfort to their guests (air conditioning, laminated floors, PVC windows etc.) and a complete visiting experience of the Delta in a short amount of time (Iordachi and Van Assche 2015, Newton et al. 2020, Teampău 2020). Both locals and tourists lack a proper understanding of the wild nature conservation requirements for the Danube Delta as biosphere reserve while the protected area administration is ineffective in ensuring the respect of ecological restrictions (Teampău 2020).

So that, the nature conservation policy of the Danube Delta can be successfully implemented only by applying a proper process of area monitoring in relation to its support capacity, as well as by employing suitable management measures for using the support of ecotourism in this sense (Borja et al. 2020, Kongbuamai et al. 2020). Extremely important for defining and monitoring the carrying capacity of the space in relation with the impact generated by the tourist activities (Pavel-Nedea and Dona 2017, Wang et al. 2020) is the correlation of a complex of factors and not considering only the quantitative presence of the visitors. Thus, in order to study the impact of

tourism in the Danube Delta, it is crucial to analyse and monitor: the number of visitors; the visitor behaviour; their presence as duration and season in relation to the pattern of activity of the fauna and the seasonality of the flora; the type of tourists and recreational activities; the type of local offer and recreation; the performance and characteristics of the management and public administration systems (Association of Ecotourism in Romania 2014, Stoleriu et al. 2019, Liu et al. 2020a, Partelow and Nelson 2020, Rather 2021, Sultan et al. 2021).

Conclusions

The Tourism Impact Model has the potential to act as a strategic planning tool with its built-in transparency in terms of methodology and as it includes the inhabitants, the authorities, and the economic agents in the consultation. TIM has a supervised collecting of data from various sources and their transformation into valuable planning information is aligned with the UN SDGs. All these lead to the creation of a field-based model of the whole spectrum of positive and negative impacts that tourism generates based on the existing data (Mou et al. 2020, Tian et al. 2020). The Tourism Impact Model aims to transpose the complex concepts behind the UNSDGs and to make them easier to perceive by visualising the results and the sets of recommendations for planning improvements. But the most significant advantage of TIM is the possibility of using dynamic real-data simulations of possible scenarios for quick and competent response in all situations of territorial planning and development.

Tourism is the new trend of sustainable development, but its current chaotic growth in the Danube Delta may increase environmental degradation (Ianoș et al. 2012, Gurran et al. 2020, Koçak et al. 2020, Melet et al. 2020). One of the safest directions to avoid the pressures and conflicts generated by tourism and recreation in a protected area (Hjalager 2020) consists in "slowing down" the visitor's experience, especially given the current context of covid pandemic restrictions, activity reconfiguration and supplementary need for ensuring human health (Borja et al. 2020, Sigala 2020, Uğur and Akbiyik 2020, Škare et al. 2021, Williams 2021, Yang et al. 2021). Thus, by promoting the slow visit as a tourism brand of the Danube Delta, the negative impact on the environment will be minimal (Association of Ecotourism in Romania 2014, Almeida-García et al. 2020).

As argued by Schvab et al. (2021), researchers have been trying for a long time to solve the problems related to mass tourism and to provide adequate solutions for the management of tourist flows in protected natural areas or the areas vulnerable to tourist pressure (Iorga 2015, Blaga and Josan 2019, Jahani et al. 2020, Yuxi and Linsheng 2020). As well as to provide strategic urban planning solutions to address the traditional challenges caused by tourism development, such as the management of parking lots in crowded tourist resorts, the municipal waste control and planning

(especially in overpopulated cities), and the post-event or real-time assessment of the number of visitors/tourists in a given area (Schvab et al. 2021). In this context, the Tourism Impact Model (TIM) is one of the Tourism 4.0 technologies that can tackle such problems and provide adequate solutions (Peceny et al. 2020, Goriup and Ratkajec 2021, Goriup et al. 2022).

Although it requires further refinement to better manage the challenges brought by tourism development, Tourism 4.0, and TIM, in particular, represent strategic planning tools for the local, county, or national public authorities. They often develop strategies or urban plans based on the available data which, frequently, in Romania are outdated (in the best-case scenario, the data on which they rely upon is only one year old) or incomplete for a complex analysis (e.g. the multi-annual series or certain types of data are non-existent or very difficult to access. Thus, the decisions taken in the framework of development strategies or other spatial planning documents should be based on today's technologies that allow for almost real-time data collection and adapting the administrative measures of policy scenarios in a much quicker time.

Acknowledgements

This research was conducted in the framework of the European Maritime and Fisheries Fund, grant EASME/EMFF/2019/863621 (T4BS). We would like to thank EASME (now CINEA) for the funding that made the cooperation amongst the authors, and thus this article, possible. We also thank Florina Bușagă (Sfântu Gheorghe Townhall), for providing local data and for answering the questionnaire applied in the project, and Irina Gorgăneanu for the logistic support.

References

AKADIRI S. S., LASISI T. T., UZUNER G., AKADIRI A. C. (2020) Examining the causal impacts of tourism, globalization, economic growth and carbon emissions in tourism island territories: bootstrap panel Granger causality analysis, Current Issues in Tourism 23 (4), 470-484, https://doi.org/10.1080/13683500.2018.1539067.

ALECU I. N., CREȚU R. F., ȘTEFAN P., CREȚU R. C., BEIA S. I. (2016) Size of Unauthorized Tourism of the Danube Delta: Causes, Effects, Solutions, Agriculture and Agricultural Science Procedia 10, 511-518, https://doi.org/10.1016/j.aaspro.2016.09.026.

ALEXE V., KISS J. B., DOROȘENCU C. A., MARINOV M., BOLBOACĂ L.-E., TUDOR M., MURARIU D. (2020) The presence of the White-tailed Sea-eagle (*Haliaeetus albicilla* L.) in Romania, especially in Dobrogea, identified in the ornithological literature: a bibliographical review, Scientific Annals of the Danube Delta Institute 25, 5-18, http://doi.org/10.7427/DDI.25.01.

ALMEIDA-GARCÍA F., DOMÍGUNEZ-AZCUE J., MERCADÉ-MELÉ P., PÉREZ-TAPIA G. (2020) Can a destination really change its image? The roles of information sources, motivations, and visits, Tourism Management Perspectives 34, 100662, https://doi.org/10.1016/j.tmp.2020.100662.

ANFUSO G., POSTACCHINI M., DI LUCCIO D., BENASSAI G. (2021) Coastal Sensitivity/Vulnerability Characterization and Adaptation Strategies: A Review, Journal of Marine Science and Engineering 9 (1), 72, https://doi.org/10.3390/jmse9010072.

ARABADZHYAN A., FIGINI P., GARCÍA C., GONZÁLEZ M. M., LAM-GONZÁLEZ Y. E., LEÓN C. J. (2021) Climate change, coastal tourism, and impact chains – a literature review, Current Issues in Tourism 24 (16), 2233-2268, https://doi.org/10.1080/13683500.2020.1825351.

ARCTUR (2019) Tourism Impact Model, Tourism 4.0, Retrieved from: www.tourism4-0.org.

ASSOCIATION OF ECOTOURISM IN ROMANIA (2014) Evaluating the carrying capacity for visitor management in protected areas. Case study: Danube Delta Biosphere Reserve, DANUBEPARKS STEP 2.0, Retrieved from: www.danube parks.org.

BACIU M. (2020) Păsări din Delta Dunării și împrejurimi / Birds from Danube Delta and surroundings, Bucharest.

BLAGA L., JOSAN I. (2019) Estimating the tourist carrying capacity for protected areas. A case study for Natura 2000 sites from North-Western Romania, Forum Geografic 18 (1), 71-82, http://dx.doi.org/10.5775/fg.2019.067.i.

BOHANEC M. (2021) DEXi: Program for Multi-Attribute Decision Making: User's Manual. Version 5.05, "Jožef Stefan" Institute, Ljubljana, Retrieved from: kt.ijs.si/MarkoBohanec/dexi.html.

BOHANEC M., DŽEROSKI S., ŽNIDARŠIČ M., MESSÉAN A., SCATASTA S., WESSELER J. (2004) Multi-attribute modelling of economic and ecological impacts of cropping systems, Informatica 28, 387-392.

BOHANEC M., RAJKOVIČ V. (1999) Multi-attribute decision modeling: Industrial applications of DEX, Informatica 23, 487-491.

BORJA A., WHITE M. P., BERDALET E., BOCK N., EATOCK C., KRISTENSEN P., LEONARD A., LLORET J., PAHL S., PARGA M., PRIETO J. V., WUIJTS S., FLEMING L. E. (2020) Moving Toward an Agenda on Ocean Health and Human Health in Europe, Frontiers in Marine Science 7, 37, https://doi.org/10.3389/fmars.2020.00037.

BUZĂ A., POSTEUCĂ O. (2020) Cluj-Napoca – Premises of a Potentially Overcrowded Tourist Destination, Analele Universității din Oradea. Seria Geografie 30 (2), 194-204, https://doi.org/10.30892/auog.302109-851.

CARVACHE-FRANCO W., CARVACHE-FRANCO M., CARVACHE-FRANCO O., HERNÁNDEZ-LARA A. B. (2020) Motivation and segmentation of the demand

for coastal and marine destinations, Tourism Management Perspectives 34, 100661, https://doi.org/10.1016/j.tmp.2020.100661.

CESTNIK B., BOHANEC M. (2001) Decision support in housing loan allocation: A case study, IDDM-2001: ECML/PKDD-200, in: Giraud-Carrier C., Lavrač N., Moyle S., Kavšek B. (eds.), Proceedings of ECML/PKDD01 Workshop Integrating Aspects of Data Mining, Decision Support and Meta-learning (IDDM-2001): Positions, Developments and Future Directions, Freiburg, pp. 21-30.

CHANKONG V., HAIMES Y. Y. (1983) Multiobjective decision making: Theory and methodology, North-Holland, New York.

CIOACA E., BREDEWEG B., SALLES P. (2007) Qualitative Reasoning Model to support Sustainable Development decision making – Danube Delta Biosphere Reserve Environmental System case study, Scientific Annals of the Danube Delta Institute 13, 213-222.

COGĂLNICEANU D., ROZYLOWICZ L., SZÉKELY P., SAMOILĂ C., STĂNESCU F., TUDOR M., SZÉKELY D., IOSIF R. (2013) Diversity and distribution of reptiles in Romania, ZooKeys 341, 49-76, https://doi.org/10.3897/zookeys.341.5502.

CONSTANTIN S., CONSTANTINESCU Ș., DOXARAN D. (2017) Long-term analysis of turbidity patterns in Danube Delta coastal area based on MODIS satellite data, Journal of Marine Systems 170, 10-21, https://doi.org/10.1016/j.jmarsys.2017.01.016.

CONSTANTINESCU Ș. (2015) Various Approaches to the Danube Delta: From Maps to Reality, in: Iordachi C., Van Assche K. (eds.), The Bio-Politics of the Danube Delta: Nature, History, Policies, Lexington Books, Lanham, pp. 155-182.

DAMIAN N., DUMITRESCU B. (2009) Sustainable development prospects for the Danube Delta rural communities, Revue Roumaine de Géographie / Romanian Journal of Geography 53 (2), 153-163.

DESPINA C., TEODOROF L., BURADA A., SECELEANU-ODOR D., TUDOR I.-M., IBRAM O., NĂSTASE A., TRIFANOV C., SPIRIDON C., TUDOR M. (2020) Danube Delta Biosphere Reserve—Long-Term Assessment of Water Quality, in: Negm A. M., Romanescu G., Zelenakova M. (eds.), Water Resources Management in Balkan Countries, Springer, Cham, pp. 21-43, https://doi.org/10.1007/978-3-030-22468-4_2.

DIMA C., BURLACU S., BUZOIANU O. A. C. (2020) Strategic Options for the Development of Ecotourism in the Danube Delta in the Context of Globalization, SHS Web Conf. 74, 04005, https://doi.org/10.1051/shsconf/20207404005.

DOROFTEI M., COVALIOV S. (2007) Comparative study of Sulina and Sfântu Gheorghe seaside flora, Scientific Annals of the Danube Delta Institute 13, 13-18.

DYER J. S., FISHBURN P. C., STEUER R. E., WALLENIUS J., ZIONTS S. (1992) Multiple criteria decision making, multiattribute utility theory: the next ten years, Management Science 38 (5), 645-654.

EARP H. S., LICONTI A. (2020) Science for the Future: The Use of Citizen Science in Marine Research and Conservation, in: Jungblut S., Liebich V., Bode-Dalby M. (eds.), YOUMARES 9 - The Oceans: Our Research, Our Future, Springer, Cham, pp. 1-19, https://doi.org/10.1007/978-3-030-20389-4_1.

FANG W.-T. (2020) Rural Tourism, in: Tourism in Emerging Economies: The Way We Green, Sustainable, and Healthy, Springer, Singapore, pp. 103-129, https://doi.org/10.1007/978-981-15-2463-9_5.

FERRANTE M., LO MAGNO G. L., DE CANTIS S. (2018) Measuring tourism seasonality across European countries, Tourism Management 68, 220-235, https://doi.org/10.1016/j.tourman.2018.03.015.

GARCÉS-ORDÓÑEZ O., ESPINOSA DÍAZ L. F., PEREIRA CARDOSO R., COSTA MUNIZ M. (2020) The impact of tourism on marine litter pollution on Santa Marta beaches, Colombian Caribbean, Marine Pollution Bulletin 160, 111558, https://doi.org/10.1016/j.marpolbul.2020.111558.

GATI G., POP C., BRUDAȘCĂ F., GURZĂU A. E., SPÎNU M. (2016) The ecological risk of heavy metals in sediment from the Danube Delta, Ecotoxicology 25, 688-696, https://doi.org/10.1007/s10646-016-1627-9.

GÂȘTESCU P. (2009) The Danube Delta Biosphere Reserve. Geography, biodiversity, protection, management, Revue Roumaine de Géographie / Romanian Journal of Geography 53 (2), 139-152.

GÂȘTESCU P. (2021) The biodiversity of the Danube Delta Biosphere Reserve reflected in the structure of the ecosystems, in: Gâștescu P., Brețcan P. (eds.), 5th International Conference "Water resources and wetlands". Conference Proceedings, Romanian Limnogeographical Association, Târgoviște, pp. 1-19.

GHANI N. A., AZMI N. H., PUTEH D. A. H. M. A. (2013) The impact of the tourism industry on the community's well-being on Langkawi and Redang Islands, Malaysia, Advances in Natural and Applied Sciences 7 (3), 276-283.

GHERMANDI A., CAMACHO-VALDEZ V., TREJO-ESPINOSA H. (2020) Social media-based analysis of cultural ecosystem services and heritage tourism in a coastal region of Mexico, Tourism Management 77, 104002, https://doi.org/10.1016/j.tourman.2019.104002.

GÓMEZ-BAGGETHUN E., TUDOR M., DOROFTEI M., COVALIOV S., NĂSTASE A., ONĂRĂ D.-F., MIERLĂ M., MARINOV M., DOROȘENCU A.-C., LUPU G., TEODOROF L., TUDOR I.-M., KÖHLER B., MUSETH J., ARONSEN E., JOHNSEN S. I., IBRAM O., MARIN E., CRĂCIUN A., CIOACĂ E. (2019) Changes in ecosystem services from wetland loss and restoration: An ecosystem assessment of the Danube Delta (1960–2010), Ecosystem Services 39, 100965, https://doi.org/10.1016/j.ecoser.2019.100965.

GORIUP P. D., RATKAJEC H. (2021) Preliminary application of Tourism 4.0 data analytics in Odessa city reveals challenges and opportunities for sustainable

tourism development, Economic Innovations 23 (4), 36-43, https://doi.org/10.31520/ei.2021.23.4(81).36-43.

GORIUP P., SCHVAB A., RATKAJEC H., STARC-PECENY U., ILIJAŠ T. (2022) Tourism 4.0 tools for facilitation of sustainable tourism data comparison (using a case study from Vylkove and Sfântu Gheorghe in the Danube Delta), Economic Innovations 24 (1), 55-63, https://doi.org/10.31520/ei.2022.24.1(82).55-63.

GRILLI G., TYLLIANAKIS E., LUISETTI T., FERRINI S., TURNER R. K. (2021) Prospective tourist preferences for sustainable tourism development in Small Island Developing States, Tourism Management 82, 104178, https://doi.org/10.1016/j.tourman.2020.104178.

GURRAN N., ZHANG Y., SHRESTHA P. (2020) 'Pop-up' tourism or 'invasion'? Airbnb in coastal Australia, Annals of Tourism Research 81, 102845, https://doi.org/10.1016/j.annals.2019.102845.

HERMAN G. V., ILIEȘ D. C., DEHOORNE O., ILIEȘ A., SAMBOU A., CACIORA T., DIOMBERA M., LĂZURAN A. (2020) Emitter and tourist destination in Romania, Baltic Journal of Health and Physical Activity 12 (5), 120-138, https://doi.org/10.29359/BJHPA.12.Spec.Iss1.14.

HJALAGER A.-M. (2020) Land-use conflicts in coastal tourism and the quest for governance innovations, Land Use Policy 94, 104566, https://doi.org/10.1016/j.landusepol.2020.104566.

HOANG T. T. H., VAN ROMPAEY A., MEYFROIDT P., GOVERS G., VU K. C., NGUYEN A. T., HENS L., VANACKER V. (2020) Impact of tourism development on the local livelihoods and land cover change in the Northern Vietnamese highlands, Environment, Development and Sustainability 22, 1371-1395, https://doi.org/10.1007/s10668-018-0253-5.

HONTUȘ A. C. (2013) Spatial Danube Delta Biosphere Reserve within the context of sustainable tourism, Lucrări Științifice Management Agricol 15 (4), 11-19.

IANOȘ I., STOICA I.-V., TĂLÂNGĂ C., VĂIDIANU N. (2012) Politics of tourism development in Danube Delta Biosphere Reserve, International Multidisciplinary Scientific GeoConference-SGEM 4, 1067-1075, https://doi.org/10.5593/sgem2012/s22.v4032.

IORDACHI C., VAN ASSCHE K. (eds.) (2015) The Bio-Politics of the Danube Delta: Nature, History, Policies, Lexington Books, Lanham.

IORGA A. (2015) Tourism and protected areas: political ecology of the rural tourism in Romanian Danube Delta, Journal of Tourism – studies and research in tourism 20, 34-41.

IVAN O. (2017) 'We make more money now, but we don't talk to each other anymore': on new tourism and capitalism in the Danube Delta, Journal of Tourism and Cultural Change 15 (2), 122-135.

JAHANI A., GOSHTASB H., SAFFARIHA M. (2020) Tourism impact assessment modeling of vegetation density for protected areas using data mining

techniques, Land Degradation & Development 31 (12), 1502-1519, https://doi.org/10.1002/ldr.3549.

JOVANOVIĆ S., ILIĆ I. (2016) Infrastructure as important determinant of tourism development in the countries of Southeast Europe, Ecoforum 5 (1), 288-294.

JUCU I. S., PAVEL S. (2019) Post-Communist Urban Ecologies of Romanian Medium-Sized Towns, Forum geografic 18 (2), 170-183, https://doi.org/10.5775/fg.2019.073.d.

KEENEY R. L., RAIFFA H. (1993) Decisions with multiple objectives: Preferences and Value Trade-Offs, Cambridge University Press, Cambridge, https://doi.org/10.1017/CBO9781139174084.

KIMBU A. N., TICHAAWA T. M. (2018) Sustainable Development Goals and Socio-Economic Development through Tourism in Central Africa: Myth or Reality?, GeoJournal of Tourism and Geosites 23 (3), 780-796, https://doi.org/10.30892/gtg.23314-328.

KLJAJIĆ BORŠTNAR M., ILIJAŠ T. (2019) Assessment of High Performance Computing Services Potential of SMEs, 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), 1414-1418, https://doi.org/10.23919/MIPRO.2019.8756681.

KOÇAK E., ULUCAK R., ULUCAK Z. Ş. (2020) The impact of tourism developments on CO_2 emissions: An advanced panel data estimation, Tourism Management Perspectives 33, 100611, https://doi.org/10.1016/j.tmp.2019.100611.

KONGBUAMAI N., BUI Q., YOUSAF H. M. A. U., LIU Y. (2020) The impact of tourism and natural resources on the ecological footprint: a case study of ASEAN countries, Environmental Science and Pollution Research 27, 19251-19264, https://doi.org/10.1007/s11356-020-08582-x.

KUBO T., URYU S., YAMANO H., TSUGE T., YAMAKITA T., SHIRAYAMA Y. (2020) Mobile phone network data reveal nationwide economic value of coastal tourism under climate change, Tourism Management 77, 104010, https://doi.org/10.1016/j.tourman.2019.104010.

LAI Z., GE D., XIA H., YUE Y., WANG Z. (2020) Coupling coordination between environment, economy and tourism: A case study of China, PLOS ONE 15 (2), e0228426, https://doi.org/10.1371/journal.pone.0228426.

LANDRIGAN P. J., STEGEMAN J. J., FLEMING L. E., ALLEMAND D., ANDERSON D. M., BACKER L. C., BRUCKER-DAVIS F., CHEVALIER N., CORRA L., CZERUCKA D., BOTTEIN M.-Y. D., DEMENEIX B., DEPLEDGE M., DEHEYN D. D., DORMAN C. J., FÉNICHEL P., FISHER S., GAILL F., GALGANI F., GAZE W. H., GIULIANO L., GRANDJEAN P., HAHN M. E., HAMDOUN A., HESS P., JUDSON B., LABORDE A., MCGLADE J., MU J., MUSTAPHA A., NEIRA M., NOBLE R. T., PEDROTTI M. L., REDDY C., ROCKLÖV J., SCHARLER U. M., SHANMUGAM H., TAGHIAN G., VAN DE WATER J. A. J. M., VEZZULLI L.,

WEIHE P., ZEKA A., RAPS H., RAMPAL P. (2020) Human Health and Ocean Pollution, Annals of Global Health 86 (1), 151, http://doi.org/10.5334/aogh.2831.

LEBEN A., BOHANEC M. (2003) Evaluation of life-event portals: Multi-attribute model and case study, in: Wimmer M. A. (ed.), Knowledge Management in Electronic Government, Springer, Berlin, Heidelberg, pp. 25-36, https://doi.org/10.1007/3-540-44836-5_3.

LIU J., AN K., JANG S. (S.) (2020a) A model of tourists' civilized behaviors: Toward sustainable coastal tourism in China, Journal of Destination Marketing & Management 16, 100437, https://doi.org/10.1016/j.jdmm.2020.100437.

LIU R., PU L., ZHU M., HUANG S., JIANG Y. (2020b) Coastal resource-environmental carrying capacity assessment: A comprehensive and trade-off analysis of the case study in Jiangsu coastal zone, eastern China, Ocean & Coastal Management 186, 105092, https://doi.org/10.1016/j.ocecoaman.2020.105092.

LLORCA M., ÁLVAREZ-MUÑOZ D., ÁBALOS M., RODRÍGUEZ-MOZAZ S., SANTOS L. H. M. L. M., LEÓN V. M., CAMPILLO J. A., MARTÍNEZ-GÓMEZ C., ABAD E., FARRÉ M. (2020) Microplastics in Mediterranean coastal area: toxicity and impact for the environment and human health, Trends in Environmental Analytical Chemistry 27, e00090, https://doi.org/10.1016/j.teac.2020.e00090.

MAN T., RUSU R., MOLDOVAN C., IONESCU-HEROIU M., MOLDOVAN N.-S., HĂRĂNGUȘ I. (2015) Spatial impact of the road infrastructure development in Romania. An accessibility approach, Romanian Review of Regional Studies 11 (1), 101-112.

MELET A., TEATINI P., LE COZANNET G., JAMET C., CONVERSI A., BENVENISTE J., ALMAR R. (2020) Earth Observations for Monitoring Marine Coastal Hazards and Their Drivers, Surveys in Geophysics 41, 1489-1534, https://doi.org/10.1007/s10712-020-09594-5.

MINISTRY OF REGIONAL DEVELOPMENT AND PUBLIC ADMINISTRATION (2016) Danube Delta Integrated Sustainable Development Strategy, Retrieved from: www.mdlpa.ro.

MONTEMURRO F., PERSIANI A., DIACONO M. (2018) Environmental Sustainability Assessment of Horticultural Systems: A Multi-Criteria Evaluation Approach Applied in a Case Study in Mediterranean Conditions, Agronomy 8 (7), 98, https://doi.org/10.3390/agronomy8070098.

MOU N., ZHENG Y., MAKKONEN T., YANG T., TANG J. (J.), SONG Y. (2020) Tourists' digital footprint: The spatial patterns of tourist flows in Qingdao, China, Tourism Management 81, 104151, https://doi.org/10.1016/j.tourman.2020.104151.

MURARIU D. (2010) Systematic list of the Romanian vertebrate fauna, Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa" 53 (1), 377-411, https://doi.org/10.2478/v10191-010-0028-1.

MURPHY P. E. (1983) Tourism as a community industry—an ecological model of tourism development, Tourism Management 4 (3), 180-193, https://doi.org/10.1016/0261-5177(83)90062-6.

NESTICÒ A., MASELLI G. (2020) Sustainability indicators for the economic evaluation of tourism investments on islands, Journal of Cleaner Production 248, 119217, https://doi.org/10.1016/j.jclepro.2019.119217.

NEWTON A., ICELY J., CRISTINA S., PERILLO G. M. E., TURNER R. E., ASHAN D., CRAGG S., LUO Y., TU C., LI Y., ZHANG H., RAMESH R., FORBES D. L., SOLIDORO C., BÉJAOUI B., GAO S., PASTRES R., KELSEY H., TAILLIE D., NHAN N., BRITO A. C., DE LIMA R., KUENZER C. (2020) Anthropogenic, Direct Pressures on Coastal Wetlands, Frontiers in Ecology and Evolution 8, 144, https://doi.org/10.3389/fevo.2020.00144.

NICULESCU S., LARDEUX C., GRIGORAS I., HANGANU J., DAVID L. (2016) Synergy Between LiDAR, RADARSAT-2, and Spot-5 Images for the Detection and Mapping of Wetland Vegetation in the Danube Delta, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 9 (8), 3651-3666, https://doi.org/10.1109/JSTARS.2016.2545242.

PALTINEANU C., DUMITRU S. I., LĂCĂTUȘU A.-R. (2022) Assessing land susceptibility for possible groundwater pollution due to leaching – a case study on Romania, Carpathian Journal of Earth and Environmental Sciences 17 (1), 49-57, https://doi.org/10.26471/cjees/2022/017/199.

PARTELOW S., NELSON K. (2020) Social networks, collective action and the evolution of governance for sustainable tourism on the Gili Islands, Indonesia, Marine Policy 112, https://doi.org/10.1016/j.marpol.2018.08.004.

PAVEL-NEDEA A., DONA I. (2017) Assessment of residents' attitudes towards tourism and his impact on communities in the Danube Delta, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development 17 (2), 275-280.

PECENY U. S., URBANČIČ J., MOKOREL S., KURALT V., ILIJAŠ T. (2020) Tourism 4.0: Challenges in Marketing a Paradigm Shift, in: Reyes M. (ed.), Consumer Behavior and Marketing, IntechOpen, London, https://doi.org/10.5772/intechopen.84762.

PETRIȘOR A.-I., IANOȘ I., IUREA D., VĂIDIANU M.-N. (2012) Applications of Principal Component Analysis integrated with GIS, Procedia Environmental Sciences 14, 247-256, https://doi.org/10.1016/j.proenv.2012.03.024.

PETRIȘOR A.-I., HAMMA W., NGUYEN H. D., RANDAZZO G., MUZIRAFUTI A., STAN M.-I., TRAN V. T., AȘTEFĂNOAIEI R., BUI Q.-T., VINTILĂ D.-F., TRUONG Q. H., LIXĂNDROIU C., ȚENEA D.-D., SÎRODOEV I., IANOȘ I. (2020) Degradation of Coastlines under the Pressure of Urbanization and Tourism: Evidence on the Change of Land Systems from Europe, Asia and Africa, Land 9 (8), 275, https://doi.org/10.3390/land9080275.

PHELAN A. (A.), RUHANEN L., MAIR J. (2020) Ecosystem services approach for community-based ecotourism: towards an equitable and sustainable blue economy, Journal of Sustainable Tourism 28 (10), 1665-1685, https://doi.org/10.1080/09669582.2020.1747475.

POPESCU C., MOCANU I., MITRICĂ B., DAMIAN N. (2020) La Vallée Du Danube Roumain – Entre le regard D'Emmanuel De Martonne et les transformations actuelles (The Romanian Danube Valley - between Emmanuel de Martonne's approach and the current changes), Revue Roumaine de Géographie / Romanian Journal of Geography 64 (2), 125-135.

PREOTEASA L., VESPREMEANU-STROE A., TĂTUI F., ZĂINESCU F., TIMAR-GABOR A., CÎRDAN I. (2016) The evolution of an asymmetric deltaic lobe (Sf. Gheorghe, Danube) in association with cyclic development of the river-mouth bar: Long-term pattern and present adaptations to human-induced sediment depletion, Geomorphology 253, 59-73, https://doi.org/10.1016/j.geomorph.2015.09.023.

PROFIROIU A. G., NASTACĂ C.-C., CARAMAN (PUFLEANU) M. (2021) Perceptions on the Implementation of the Integrated Territorial Investment Mechanism (ITI) and Its Impact on Sustainable Development and Resilience of Danube Delta, Transylvanian Review of Administrative Sciences S.I., 104-126, http://dx.doi.org/10.24193/tras.SI2021.6.

RAMKISSOON H. (2020) Perceived social impacts of tourism and quality-of-life: a new conceptual model, Journal of Sustainable Tourism, https://doi.org/10.1080/09669582.2020.1858091.

RATHER R. A. (2021) Monitoring the impacts of tourism-based social media, risk perception and fear on tourist's attitude and revisiting behaviour in the wake of COVID-19 pandemic, Current Issues in Tourism 24 (23), 3275-3283, https://doi.org/10.1080/13683500.2021.1884666.

ROMANESCU G., MIHU-PINTILIE A., TRIFANOV C., STOLERIU C. C. (2018) The variations of physico-chemical parameters during summer in Lake Erenciuc from the Danube Delta (Romania), Limnological Review 18 (1), 21-29, https://doi.org/10.2478/LIMRE-2018-0003.

SAATY T. L. (1988) The analytic hierarchy process, McGraw-Hill, New York.

SÁNCHEZ-ARCILLA A., GARCÍA-LEÓN M., GRACIA V., DEVOY R., STANICA A., GAULT J. (2016) Managing coastal environments under climate change: Pathways to adaptation, Science of The Total Environment 572, 1336-1352, https://doi.org/10.1016/j.scitotenv.2016.01.124.

SARPONG S. Y., BEIN M. A., GYAMFI B. A., ASUMADU SARKODIE S. (2020) The impact of tourism arrivals, tourism receipts and renewable energy consumption on quality of life: A panel study of Southern African region, Heliyon 6 (11), e05351, https://doi.org/10.1016/j.heliyon.2020.e05351.

SCHNEIDER-BINDER E., KUHLKE F. (2015) Habitats with Sea Grape (*Ephedra distachya*) on the dunes of Letea (Danube Delta, Romania), Transylvanian Review of Systematical and Ecological Research 17 (2), 45-56, https://doi.org/10.1515/trser-2015-0062.

SCHVAB A., PARASCHIV M., TUDOR M., CRACU C., FLOREA-SAGHIN I., SÎRODOEV I., TĂTUI-VĂIDIANU N., CĂLUIANU C. (2021) The power of digitalisation in relation to sustainable tourist development of Black Sea coastal areas, Cinq Continents 11 (23), 135-138.

SHACKLEFORD P. (1985) The world tourism organisation—30 years of commitment to environmental protection, International Journal of Environmental Studies 25 (4), 257-264, https://doi.org/10.1080/00207238508710234.

SIGALA M. (2020) Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research, Journal of Business Research 117, 312-321, https://doi.org/10.1016/j.jbusres.2020.06.015.

ŠKARE M., SORIANO D. R., PORADA-ROCHOŃ M. (2021) Impact of COVID-19 on the travel and tourism industry, Technological Forecasting and Social Change 163, 120469, https://doi.org/10.1016/j.techfore.2020.120469.

STOICA C., CAMEJO J., BANCIU A., NITA-LAZAR M., PAUN I., CRISTOFOR S., PACHECO O. R., GUEVARA M. (2016) Water quality of Danube Delta systems: ecological status and prediction using machine-learning algorithms, Water Science & Technology 73 (10), 2413-2421, https://doi.org/10.2166/wst.2016.097.

STOLERIU O. M., BROCHADO A., RUSU A., LUPU C. (2019) Analyses of Visitors' Experiences in a Natural World Heritage Site Based on TripAdvisor Reviews, Visitor Studies 22 (2), 192-212, https://doi.org/10.1080/10645578.2019.1665390.

STRAT D., HOLOBIUC I. M. (2018) The occurrence and conservation status of *Convolvulus persicus* L. (Solanales: Convolvulaceae) on the western Black Sea coast – Romania, Acta Zoologica Bulgarica S11, 125-132.

SUARIA G., MELINTE-DOBRINESCU M. C., ION G., ALIANI S. (2015) First observations on the abundance and composition of floating debris in the North-western Black Sea, Marine Environmental Research 107, 45-49, https://doi.org/10.1016/j.marenvres.2015.03.011.

SULTAN M. T., SHARMIN F., BADULESCU A., STIUBEA E., XUE K. (2021) Travelers' Responsible Environmental Behavior towards Sustainable Coastal Tourism: An Empirical Investigation on Social Media User-Generated Content, Sustainability 13 (1), 56, https://doi.org/10.3390/su13010056.

TAŠKOVA K., STOJANOVA D., BOHANEC M., DŽEROSKI S. (2007) A qualitative decision-support model for evaluating researchers, Informatica 31 (4), 479-486.

TĂNĂSESCU M., CONSTANTINESCU S. (2020) The human ecology of the Danube Delta: A historical and cartographic perspective, Journal of Environmental Management 262, 110324, https://doi.org/10.1016/j.jenvman.2020.110324.

TĂTAR C.-F., HERMAN G. V., DEHOORNE O., ZARRILLI L. (2017) Ecotourism in the Danube Delta, Analele Universității din Oradea. Seria Geografie 27 (1), 122-132.

TĂTUI F. (2015) Comportamentul barelor submerse pe țărmul Deltei Dunării (Nearshore sandbars behavior on Danube Delta coast), Ars Docendi, București.

TEAMPĂU P. (2020) Trouble in paradise: Competing discourses and complex governance in the Romanian danube delta, Marine Policy 112, 103522, https://doi.org/10.1016/j.marpol.2019.103522.

TIAN C., PENG J., ZHANG W., ZHANG S., WANG J. (2020) Tourism environmental impact assessment based on improved AHP and picture fuzzy PROMETHEE II methods, Technological and Economic Development of Economy 26 (2), 355-378, https://doi.org/10.3846/tede.2019.11413.

THUSHARI G. G. N., SENEVIRATHNA J. D. M. (2020) Plastic pollution in the marine environment, Heliyon 6 (8), e04709, https://doi.org/10.1016/j.heliyon.2020.e04709.

TOWN HALL OF SFÂNTU GHEORGHE (2011) Strategia de dezvoltare a comunei Sfântu Gheorghe 2011-2016 (Development Strategy of Sfântu Gheorghe commune 2011-2016), Retrieved from: www.primariasfantugheorghetulcea.ro.

UĞUR N. G., AKBIYIK A. (2020) Impacts of COVID-19 on global tourism industry: A cross-regional comparison, Tourism Management Perspectives 36, 100744, https://doi.org/10.1016/j.tmp.2020.100744.

VAN ASSCHE K., HORNIDGE A.-K., SCHLÜTER A., VĂIDIANU N. (2020) Governance and the coastal condition: Towards new modes of observation, adaptation and integration, Marine Policy 112, 103413, https://doi.org/10.1016/j.marpol.2019.01.002.

VĂIDIANU M.-N. (2013) Fuzzy cognitive maps: diagnosis and scenarios for a better management process of visitors flows in Romanian Danube Delta Biosphere Reserve, Journal of Coastal Research 65 (SP1), 1063-1068, https://doi.org/10.2112/SI65-180.1.

VĂIDIANU N. (2015) Rezervația Biosferei Delta Dunării. Parteneriat între Oameni și Natură pentru Dezvoltare Durabilă (Danube Delta Biosphere Reserve. Partnership between people and nature for sustainable development), Ars Docendi, București.

VĂIDIANU M. N., ADAMESCU M. C., WILDENBERG M., TETELEA C. (2014) Understanding public participation and combining perceptions of stakeholders' for a better management in Danube Delta Biosphere Reserve (Romania), in: Papageorgiou E. I. (ed.), Fuzzy Cognitive Maps for Applied Sciences and Engineering: From Fundamentals to Extensions and Learning Algorithms, Springer, Berlin, Heidelberg, pp. 355-374, https://doi.org/10.1007/978-3-642-39739-4_19.

VĂIDIANU N., PARASCHIV M., SAGHIN I., BRAGHINĂ C. (2015) Social-Ecological Consequences of Planning and Development Policies in the Danube Delta

Biosphere, Romania, Carpathian Journal of Earth and Environmental Sciences 10 (3), 113-124.

VESPREMEANU-STROE A., PREOTEASA L., ZĂINESCU F., ROTARU S., CROITORU L., TIMAR-GABOR A. (2016) Formation of Danube delta beach ridge plains and signatures in morphology, Quaternary International 415, 268-285, https://doi.org/10.1016/j.quaint.2015.12.060.

VESPREMEANU-STROE A., TĂTUI F. (2011) North-Atlantic Oscillation signature on coastal dynamics and climate variability of the Romanian Black Sea coast, Carpathian Journal of Earth and Environmental Sciences 6 (1), 308-316.

VESPREMEANU-STROE A., TĂTUI F., CONSTANTINESCU Ș., ZĂINESCU F. (2017) Danube Delta Coastline Evolution (1856–2010), in: Radoane M., Vespremeanu-Stroe A. (eds.) Landform Dynamics and Evolution in Romania, Springer, Cham, pp. 551-564, https://doi.org/10.1007/978-3-319-32589-7_23.

WANG J., HUANG X., GONG Z., CAO K. (2020) Dynamic assessment of tourism carrying capacity and its impacts on tourism economic growth in urban tourism destinations in China, Journal of Destination Marketing & Management 15, 100383, https://doi.org/10.1016/j.jdmm.2019.100383.

WILLIAMS C. C. (2021) Impacts of the coronavirus pandemic on Europe's tourism industry: Addressing tourism enterprises and workers in the undeclared economy, International Journal of Tourism Research 23 (1), 79-88, https://doi.org/10.1002/jtr.2395.

YANG Y., ALTSCHULER B., LIANG Z., LI X. (R.) (2021) Monitoring the global COVID-19 impact on tourism: The COVID19tourism index, Annals of Tourism Research 90, 103120, https://doi.org/10.1016/j.annals.2020.103120.

YUXI Z., LINSHENG Z. (2020) Identifying conflicts tendency between nature-based tourism development and ecological protection in China, Ecological Indicators 109, 105791, https://doi.org/10.1016/j.ecolind.2019.105791.